(n) Make-up Obligation -- The total cost of meeting the obligation of the Basin to the area at or below Whittier Narrows, pursuant to the Judgment in the Long Beach Case.

(o) Minimal Producer -- Any party whose Production in any Fiscal Year does not exceed five (5) acre feet.

(p) Natural Safe Yield -- The quantity of natural water supply which can be extracted annually from the Basin under conditions of long term average annual supply, net of the requirement to meet downstream rights as determined in the Long Beach Case (exclusive of Pumped export), and under cultural conditions as of a particular year.

(q) Operating Safe Yield -- The quantity of water which the Watermaster determines hereunder may be Pumped from the Basin in a particular Fiscal Year, free of the Replacement Water Assessment under the Physical Solution herein.

(r) Overdraft -- A condition wherein the total annual Production from the Basin exceeds the Natural Safe Yield thereof.

(s) Overlying Rights -- (Prior Judgment Section 4 (r) [1]) The right to Produce water from the Basin for use on Overlying Lands, which rights are exercisable only on specifically defined Overlying Lands and which cannot be separately conveyed or transferred apart therefrom.

(t) Physical Solution -- (Prior Judgment Section 4 (s)) The Court decreed method of managing the waters of the Basin so as to achieve the maximum utilization of the Basin and its water supply, consistent with the rights herein declared.

(u) Prescriptive Pumping Right -- (Prior Judgment

Section 4 (t)) The highest continuous extractions of water by a Pumper from the Basin for beneficial use in any five (5) consecutive years after commencement of Overdraft and prior to filing of this action, as to which there has been no cessation of use by that Pumper during any subsequent period of five (5) consecutive years, prior to the said filing of this action.

(v) Produce or Producing -- (Prior Judgment Section 4 (u)) To Pump or Divert water.

(w) Producer -- (Prior Judgment Section 4 (v)) A party who Produces water.

(x) Production -- (Prior Judgment Section 4 (w)) The annual quantity of water Produced, stated in acre feet.

(y) Pump or Pumping -- (Prior Judgment Section 4 (x)) To extract Ground Water from the Basin by Pumping or any other method.

(z) Pumper -- (Prior Judgment Section 4 (y)) Any party who Pumps water.

(aa) Pumper's Share -- (Prior Judgment Section 4 (z)) A Pumper's right to a percentage of the entire Natural Safe Yield, Operating Safe Yield and appurtenant Ground Water storage.

(bb) Relevant Watershed -- (Prior Judgment Section 4(aa)) That portion of the San Gabriel River watershed tributary to Whittier Narrows which is shown as such on Exhibit "A", and the exterior boundaries of which are described in Exhibit "B".

(cc) Replacement Water -- (Prior Judgment Section 4 (bb)) Water purchased by Watermaster to replace:

(1) Production in excess of a Pumper's Share of Operating Safe Yield; (2) The consumptive use portion resulting from the exercise of an Overlying Right; and (3) Production in excess of a Diverter's right to Divert for Direct Use.

(dd) Responsible Agency -- (Prior Judgment Section 4 (cc)) The municipal water district which is the normal and appropriate source from whom Watermaster shall purchase Supplemental Water for replacement purposes under the Physical Solution, being one of the following:

(1) Upper District -- Upper San Gabriel Valley Municipal Water District, a member public agency of The Metropolitan Water District of Southern California (MWD).

(2) San Gabriel District -- San Gabriel Valley Municipal Water District, which has a direct contract with the State of California for State Project Water.

(3) Three Valleys District -- Three Valleys Municipal Water District, formerly, "Pomona Valley Municipal Water District", a member public agency of MWD.

(ee) Stored Water -- (Prior Judgment Section 4 (dd)) Supplemental Water stored in the Basin pursuant to a contract with Watermaster as authorized by Section 34(m).

(ff) Supplemental Water -- (Prior Judgment Section 4 (ee)) Nontributary water imported through a Responsible Agency.

(gg) Transporting Parties -- (Prior Judgment Section 4 (ff)) Any party presently transporting water (i.e., during the 12 months immediately preceding the making of the findings herein) from the Relevant Watershed or Basin to an area outside thereof, and any party presently or hereafter having an interest in lands or having a service area outside the Basin or Relevant Watershed contiguous to lands in which it has an interest or a service area within the Basin or Relevant Watershed. Division by a road, highway, or easement shall not interrupt contiguity. Said term shall also include the City of Sierra Madre, or any party supplying water thereto, so long as the corporate limits of said City are included within one of the Responsible Agencies and if said City, in order to supply water to its corporate area from the Basin, becomes a party to this action bound by this Judgment.

(hh) Water Level -- (Prior Judgment Section 4 (gg)) The measured Elevation of water in the Key Well, corrected for any temporary effects of mounding caused by replenishment or local depressions caused by Pumping.

(ii) Year -- (Prior Judgment Section 4 (hh)) A calendar year, unless the context clearly indicates a contrary meaning.

11. Exhibits. (Prior Judgment Section 5) The following exhibits are attached to this Judgment and incorporated herein by this reference:

Exhibit "A" -- Map entitled "San Gabriel River Watershed Tributary to Whittier Narrows", showing the boundaries and relevant geologic and hydrologic features in the portion of the watershed of the San Gabriel River lying upstream from Whittier Narrows.

Exhibit "B" -- Boundaries of Relevant Watershed.

Exhibit "C" -- Table Showing Base Annual Diversion

Rights of Certain Diverters.

Exhibit "D" -- Table Showing Prescriptive Pumping Rights and Pumper's Share of Each Pumper.

Exhibit "E" -- Table Showing Production Rights of Each Integrated Producer.

Exhibit "F" -- Table Showing Special Category Rights.

Exhibit "G" -- Table Showing Non-consumptive Users.

Exhibit "H" -- Watermaster Operating Criteria.

Exhibit "J" -- Puente Narrows Agreement.

Exhibit "K" -- Overlying Rights, Nature of Overlying Right, Description of Overlying Lands to which Overlying Rights are Appurtenant, Producers Entitled to Exercise Overlying Rights and their Respective Consumptive Use Portions, and Map of Overlying Lands.

Exhibit "L" -- (New) List of Producers And Their Designees, as of June 1988.

Exhibit "M" -- (New) Watermaster Members, Officers and Staff, Including Calendar Year 1989.

II. <u>DECREE</u>

NOW, THEREFORE, IT IS HEREBY DECLARED, ORDERED, ADJUDGED AND DECREED:

A. DECLARATION OF HYDROLOGIC CONDITIONS

12. <u>Basin as Common Source of Supply.</u> (Prior Judgment Section 6) The area shown on Exhibit "A" as Main San Gabriel Basin overlies a Ground Water basin. The Relevant Watershed is the watershed area within which rights are herein adjudicated. The waters of the Basin and Relevant Watershed constitute a common source of natural water supply to the parties herein.

13. Determination of Natural Safe Yield. (Prior Judgment Section 7) The Natural Safe Yield of the Main San Gabriel Basin is found and declared to be one hundred fifty-two thousand seven-hundred (152,700) acre feet under Calendar Year 1967 cultural conditions.

14. Existence of Overdraft. (Prior Judgment Section 8) In each and every Calendar Year commencing with 1953, the Basin has been and is in Overdraft.

B. DECLARATION OF RIGHTS

15. Prescription. (Prior Judgment Section 9) The use of water by each and all parties and their predecessors in interest has been open, notorious, hostile, adverse, under claim of right, and with notice of said overdraft continuously from January 1, 1953 to January 4, 1973. The rights of each party herein declared are prescriptive in nature. The following aggregate consequences of said prescription within the Basin and Relevant Watershed are hereby declared:

(a) Prior Prescription. Diversions within the Relevant Watershed have created rights for direct consumptive use within the Basin, as declared and determined in Sections 16 and 18 hereof, which are of equal priority *inter se*, but which are prior and paramount to Pumping Rights in the Basin.

(b) Mutual Prescription. The aggregate Prescriptive Pumping Rights of the parties who are Pumpers now exceed, and for many years prior to filing of this action, have exceeded, the Natural Safe Yield of the Basin. By reason of said condition, all rights of said Pumpers are declared to be mutually prescriptive and of equal priority, *inter se*.

(c) Common Ownership of Safe Yield and Incidents Thereto. By reason of said Overdraft and mutual Prescription, the entire Natural Safe Yield of the Basin, the Operating Safe Yield thereof and the appurtenant rights to Ground Water storage capacity of the Basin are owned by Pumpers in undivided Pumpers' Shares as hereinafter individually declared, subject to the control of Watermaster, pursuant to the Physical Solution herein decreed. Nothing herein shall be deemed in derogation of the rights to spread water pursuant to rights set forth in Exhibit "G".

16. Surface Rights. (Prior Judgment Section 10) Certain of the aforesaid prior and paramount prescriptive water rights of Diverters to Divert for Direct Use stream flow within the Relevant Watershed are hereby declared and found in terms of Base Annual Diversion Right as set forth in Exhibit "C". Each Diverter shown on Exhibit "C" shall be entitled to Divert for Direct Use up to two hundred percent (200%) of said Base Annual Diversion Right in any one (1) Fiscal Year; provided that the aggregate quantities of water Diverted in any consecutive ten (10) Fiscal Year period shall not exceed ten (10) times such Diverter's Base Annual Diversion Right.

17. Ground Water Rights. (Prior Judgment Section 11) The Prescriptive Pumping Right of each Pumper, who is not an Integrated Producer, and his Pumper's Share are declared as set forth in Exhibit "D".

18. Optional Integrated Production Rights. (Prior Judgment Section 12) Those parties listed on Exhibit "E" have elected to be treated as Integrated Producers. Integrated Production Rights have two (2) historical components:

(1) a fixed component based upon historic Diversions for Direct Use; and

(2) a mutually prescriptive Pumper's Share component based upon Pumping during the period 1953 through 1967.

Assessment and other Watermaster regulation of the rights of such parties shall relate to and be based upon each such component. So far as future exercise of such rights is concerned, however, the gross quantity of the aggregate right in any Fiscal Year may be exercised, in the sole discretion of such party, by either Diversion or Pumping or any combination or apportionment thereof; provided, that for Assessment purposes the first water Produced in any Fiscal Year (other than "carry-over", under Section 49 hereof) shall be deemed an exercise of the Diversion component, and any Production over said quantity shall be deemed Pumped water, regardless of the actual method of Production.

19. Special Category Rights. (Prior Judgment Section 13) The parties listed on Exhibit "F" have water rights in the Relevant Watershed which are not ordinary Production rights. The nature of each such right is as described in Exhibit "F".

20. Non-consumptive Practices. (Prior Judgment Section 14) Certain Producers have engaged in Water Diversion and spreading practices which have caused such Diversions to have a

non-consumptive or beneficial impact upon the aggregate water supply available in the Basin. Said parties, and a statement of the nature of their rights, uses and practices, are set forth in Exhibit "G". The Physical Solution decreed herein, and particularly its provisions for Assessments, shall not apply to such non-consumptive uses. Watermaster may require reports on the operations of said parties.

21. Overlying Rights. (Prior Judgment Section 14.5) Producers listed in Exhibit "K" hereto were not parties herein at the time of the original entry of Judgment herein. They have exercised in good faith Overlying Rights to Produce water from the Basin during the periods subsequent to the entry of Judgment herein and have by self-help initiated or maintained appurtenant Overlying Rights. Such rights are exercisable without quantitative limit only on specifically described Overlying Land and cannot be separately conveyed or transferred apart therefrom. As to such rights and their exercise, the owners thereof shall become parties to this action and be subject to Watermaster Replacement Water Assessments under Section 45 (b) hereof, sufficient to purchase Replenishment Water to offset the net consumptive use of such Production and practices. In addition, the gross amount of such Production for such overlying use shall be subject to Watermaster Administrative Assessments under Section 45 (a) hereof and the consumptive use portion of such Production for overlying use shall be subject to Watermaster's In-Lieu Water Cost Assessments under Section 45 (d) hereof. The Producers presently entitled to exercise Overlying Rights, a description of the Overlying Land to which

Overlying Rights are appurtenant, the nature of use and the consumptive use portion thereof are set forth in Exhibit "K" hereto. Watermaster may require reports and make inspections of the operations of said parties for purposes of verifying the uses set forth in said Exhibit "K", and, in the event of a material change, to redetermine the net amount of consumptive use by such parties as changed in the exercise of such Overlying Rights. Annually, during the first two (2) weeks of June in each Calendar Year, such Overlying Rights Producers shall submit to Watermaster a verified statement as to the nature of the then current uses of said Overlying Rights on said Overlying Lands for the next ensuing Fiscal Year, whereupon Watermaster shall either affirm the prior determination or redetermine the net amount of the consumptive use portion of the exercise of such Overlying Right by said Overlying Rights Producer.

C. INJUNCTION

22. Injunction Against Unauthorized Production. (Prior Judgment Section 15) Effective July 1, 1973, each and every party, its officers, agents, employees, successors and assigns, to whom rights to waters of the Basin or Relevant Watershed have been declared and decreed herein is ENJOINED AND RESTRAINED from Producing water for Direct Use from the Basin or the Relevant Watershed except pursuant to rights and Pumpers' Shares herein decreed or which may hereafter be acquired by transfer pursuant to Section 55, or under the provisions of the Physical Solution in this Judgment and the Court's continuing jurisdiction, provided that no party is enjoined from Producing up to five (5) acre feet per Fiscal Year.

23. Injunction re Non-consumptive Uses. (Prior Judgment Section 16) Each party listed in Exhibit "G", its officers, agents, employees, successors and assigns, is ENJOINED AND RESTRAINED from materially changing said non-consumptive method of use.

24. Injunction Re Change in Overlying Use Without Notice Thereof To Watermaster. (Prior Judgment Section 16.5) Each party listed in Exhibit "K", its officers, agents, employees, successors and assigns, is ENJOINED AND RESTRAINED from materially changing said overlying uses at any time without first notifying Watermaster of the intended change of use, in which event Watermaster shall promptly redetermine the consumptive use portion thereof to be effective after such change.

25. Injunction Against Unauthorized Recharge. (Prior Judgment Section 17) Each party, its officers, agents, employees, successors and assigns, is ENJOINED AND RESTRAINED from spreading, injecting or otherwise recharging water in the Basin except pursuant to: (a) an adjudicated non-consumptive use, or (b) consent and approval of or Cyclic Storage Agreement with Watermaster, or (c) subsequent order of this Court.

26. Injunction Against Transportation From Basin or Relevant Watershed. (Prior Judgment Section 18) Except upon further order of Court, all parties, other than Transporting Parties and MWD in its exercise of its Special Category Rights, to the extent authorized therein, are ENJOINED AND RESTRAINED from transporting water hereafter Produced from the Relevant Watershed or Basin outside the areas thereof. For purposes of

this Section, water supplied through a city water system which lies chiefly within the Basin shall be deemed entirely used within the Basin. Transporting Parties are entitled to continue to transport water to the extent that any Production of water by any such party does not violate the injunctive provisions contained in Section 22 hereof; provided that said water shall be used within the present service areas or corporate or other boundaries and additions thereto so long as such additions are contiguous to the then existing service area or corporate or other boundaries; except that a maximum of ten percent (10%) of use in any Fiscal Year may be outside said then existing service areas or corporate or other boundaries.

D. CONTINUING JURISDICTION

27. Jurisdiction Reserved. (Prior Judgment Section 19) Full jurisdiction, power and authority are retained by and reserved to the Court for purposes of enabling the Court upon application of any party or of the Watermaster, by motion and upon at least thirty (30) days notice thereof, and after hearing thereon, to make such further or supplemental orders or directions as may be necessary or appropriate for interim operation before the Physical Solution is fully operative, or for interpretation, enforcement or carrying out of this Judgment, and to modify, amend or amplify any of the provisions of this Judgment or to add to the provisions thereof consistent with the rights herein decreed. Provided, that nothing in this paragraph shall authorize:

(1) modification or amendment of the quantities specified in the declared rights of any party;

(2) modification or amendment of the manner of exercise of the Base Annual Diversion Right or Integrated Production Right of any party; or

(3) the imposition of an injunction prohibiting transportation outside the Relevant Watershed or Basin as against any Transporting Party transporting in accordance with the provisions of this Judgment or against MWD as to its Special Category Rights.

E. WATERMASTER

28. Watermaster to Administer Judgment. (Prior Judgment Section 20) A Watermaster comprised of nine (9) persons, to be nominated as hereinafter provided and appointed by the Court, shall administer and enforce the provisions of this Judgment and any subsequent instructions or orders of the Court thereunder.

29. Qualification, Nomination and Appointment. (Prior Judgment Section 21) The nine (9) member Watermaster shall be composed of six (6) Producer representatives and three (3) public representatives qualified, nominated and appointed as follows:

(a) Qualification. Any adult citizen of the State of California shall be eligible to serve on Watermaster; provided, however, that no officer, director, employee or agent of Upper District or San Gabriel District shall be qualified as a Producer member of Watermaster.

(b) Nomination of Producer Representatives. A meeting of all parties shall be held at the regular meeting of Watermaster in November of each year, at the offices of Watermaster. Nomination of the six (6) Producer representatives shall be by cumulative voting, in person or by proxy, with each Producer entitled to one (1) vote for each one hundred (100) acre feet, or portion thereof, of Base Annual Diversion Right or Prescriptive Pumping Right or Integrated Production Right.

(c) Nomination of Public Representatives. On or before the regular meeting of Watermaster in November of each year, the three (3) public representatives shall be nominated by the boards of directors of Upper District (which shall select two [2]) and San Gabriel District (which shall select one [1]). Said nominees shall be members of the board of directors of said public districts.

(d) Appointment. All Watermaster nominations shall be promptly certified to the Court, which will in ordinary course confirm the same by an appropriate order appointing said Watermaster; provided, however, that the Court at all times reserves the right and power to refuse to appoint, or to remove, any member of Watermaster.

30. Term and Vacancies. (Prior Judgment Section 22) Each member of Watermaster shall serve for a one (1) year term commencing on January 1, following his appointment, or until his successor is appointed. In the event of a vacancy on Watermaster, a successor shall be nominated at a special meeting to be called by Watermaster within ninety (90) days (in the case of a Producer representative) or by action of the appropriate district board of directors (in the case of a public representative).

31. Quorum. (Prior Judgment Section 23) Five (5) members

of the Watermaster shall constitute a quorum for the transaction of affairs of the Watermaster. Action by the affirmative vote of five (5) members shall constitute action by Watermaster, except that the affirmative vote of six (6) members shall be required:

(a) to approve the purchase, spreading or injection of water for Ground Water recharge, or

(b) to enter in any Agreement pursuant to Section 34 (m) hereof.

32. Compensation. (Prior Judgment Section 24) Each Watermaster member shall receive compensation of One Hundred Dollars ($100.00) per day for each day's attendance at meetings of Watermaster or for each day's service rendered as a Watermaster member at the request of Watermaster, together with any expenses incurred in the performance of his duties required or authorized by Watermaster. No member of the Watermaster shall be employed by or compensated for professional services rendered by him to Watermaster, other than the compensation herein provided, and any authorized travel or related expense.

33. Organization. (Prior Judgment Section 25) At its first meeting in each year, Watermaster shall elect a chairman and a vice chairman from its membership. It shall also select a secretary, a treasurer and such assistant secretaries and assistant treasurers as may be appropriate, any of whom may, but need not be, members of Watermaster.

(a) Minutes. Minutes of all Watermaster meetings shall be kept which shall reflect all actions taken by Watermaster. Draft copies thereof shall be furnished to any party who files a request therefor in writing with Watermaster. Said draft copies of minutes shall constitute notice of any Watermaster action therein reported; failure to request copies thereof shall constitute waiver of notice.

(b) Regular Meetings. Watermaster shall hold regular meetings at places and times to be specified in Watermaster's rules and regulations to be adopted by Watermaster. Notice of the scheduled or regular meetings of Watermaster and of any changes in the time or place thereof shall be mailed to all parties who shall have filed a request therefor in writing with Watermaster.

(c) Special Meetings. Special meetings of Watermaster may be called at any time by the chairman or vice chairman or by any three (3) members of Watermaster by written notice delivered personally or mailed to each member of Watermaster and to each party requesting notice, at least twenty-four (24) hours before the time of each such meeting in the case of personal delivery, and forty-eight (48) hours prior to such meeting in the case of mail. The calling notice shall specify the time and place of the special meeting and the business to be transacted at such meeting. No other business shall be considered at such meeting.

(d) Adjournments. Any meeting of Watermaster may be adjourned to a time and place specified in the order of adjournment. Less than a quorum may so adjourn from time to time. A copy of the order or notice of adjournment shall be conspicuously posted on or near the door of the place where the meeting was held within twenty-four (24) hours after adoption of the order of adjournment.

34. Powers and Duties. (Prior Judgment Section 26) Subject to the continuing supervision and control of the Court, Watermaster shall have and may exercise the following express powers, and shall perform the following duties, together with any specific powers, authority and duties granted or imposed elsewhere in this Judgment or hereafter ordered or authorized by the Court in the exercise of its continuing jurisdiction.

(a) Rules and Regulations. To make and adopt any and all appropriate rules and regulations for conduct of Watermaster affairs. A copy of said rules and regulations and any amendments thereof shall be mailed to all parties.

(b) Acquisition of Facilities. To purchase, lease, acquire and hold all necessary property and equipment; provided, however, that Watermaster shall not acquire any interest in real property in excess of year-to-year tenancy for necessary quarters and facilities.

(c) Employment of Experts and Agents. To employ such administrative personnel, engineering, geologic, accounting, legal or other specialized services and consulting assistants as may be deemed appropriate in the carrying out of its powers and to require appropriate bonds from all officers and employees handling Watermaster funds.

(d) Measuring Devices, etc. To cause parties, pursuant to uniform rules, to install and maintain in good operating condition, at the cost of each party, such necessary measuring devices or meters as may be appropriate; and to inspect and test any such measuring device as may be necessary.

(e) Assessments. To levy and collect all Assessments specified in the Physical Solution.

(f) Investment of Funds. To hold and invest any and all funds which Watermaster may possess in investments authorized from time to time for public agencies in the State of California.

(g) Borrowing. To borrow in anticipation of receipt of Assessment proceeds an amount not to exceed the annual amount of Assessments levied but uncollected.

(h) Purchase of and Recharge with Supplemental Water. To purchase Supplemental Water and to introduce the same into the Basin for replacement or cyclic storage purposes, subject to the affirmative vote of six (6) members of Watermaster.

(i) Contracts. To enter into contracts for the performance of any administrative powers herein granted, subject to approval of the Court.

(j) Cooperation With Existing Agencies. To act jointly or cooperate with agencies of the United States and the State of California or any political subdivision, municipality or district to the end that the purposes of the Physical Solution may be fully and economically carried out. Specifically, in the event Upper District has facilities available and adequate to accomplish any of the administrative functions of Watermaster, consideration shall be given to performing said functions under contract with Upper District in order to avoid duplication of facilities.

(k) Assumption of Make-up Obligation. Watermaster shall assume the Make-up Obligation for and on behalf of the Basin.

(m) Water Quality. Water quality in the Basin shall be a concern of Watermaster, and all reasonable steps shall be taken to assist and encourage appropriate regulatory agencies to enforce reasonable water quality regulations affecting the Basin, including regulation of solid and liquid waste disposal.

(n) Cyclic Storage Agreements. To enter into appropriate contracts, to be approved by the Court, for utilization of Ground Water storage capacity of the Basin for cyclic or regulatory storage of Supplemental Water by parties and non-parties, for subsequent recovery or Watermaster credit by the storing entity, pursuant to uniform rules and conditions, which shall include provision for:

(1) Watermaster control of all spreading or injection and extraction scheduling and procedures for such stored water;

(2) calculation by Watermaster of any special costs, damages or burdens resulting from such operations;

(3) determination by Watermaster of, and

accounting for, all losses in stored water, assuming that such stored water floats on top of the Ground Water supplies, and accounting for all losses of water which otherwise would have replenished the Basin, with priorities being established as between two or more such contractors giving preference to parties over non-parties; and

(4) payment to Watermaster for the benefit of the parties hereto of all special costs, damages or burdens incurred (without any charge, rent, assessment or expense as to parties hereto by reason of the adjudicated proprietary character of said storage rights, nor credit or offset for benefits resulting from such storage); provided, that no party shall have any direct interest in or control over such contracts or the operation thereof by reason of the adjudicated right of such party, the Watermaster having sole custody and control of all Ground Water storage rights in the Basin pursuant to the Physical Solution herein, and subject to review of the Court.

(o) Notice List. Maintain a current list of party designees to receive notice hereunder, in accordance with Section 54 hereof.

35. Policy Decisions -- Procedure. (Prior Judgment Section 27) It is contemplated that Watermaster will exercise discretion in making policy decisions relating to Basin management under the Physical Solution decreed herein. In order to assure full participation and opportunity to be heard for

those affected, no policy decision shall be made by Watermaster until thirty (30) days after the question involved has been raised for discussion at a Watermaster meeting and noted in the draft of minutes thereof.

36. Reports. (Prior Judgment Section 28) Watermaster shall annually file with the Court and mail to the parties a report of all Watermaster activities during the preceding year, including an audited statement of all accounts and financial activities of Watermaster, summary reports of Diversions and Pumping, and all other pertinent information. To the extent practical, said report shall be mailed to all parties on or before November 1.

37. Review Procedures. (Prior Judgment Section 29) Any action, decision, rule or procedure of Watermaster (other than a decision establishing Operating Safe Yield, see Section 43[c]) shall be subject to review by the Court on its own motion or on timely motion for an Order to Show Cause by any party, as follows:

(a) Effective Date of Watermaster Action. Any order, decision or action of Watermaster shall be deemed to have occurred on the date that written notice thereof is mailed. Mailing of draft copies of Watermaster minutes to the parties requesting the same shall constitute notice to all such parties.

(b) Notice of Motion. Any party may, by a regularly noticed motion, petition the Court for review of said Watermaster's action or decision. Notice of such motion shall be mailed to Watermaster and all parties. Unless so ordered by the Court, such petition shall not operate to stay the effect of such Watermaster action.

(c) Time for Motion. Notice of motion to review any Watermaster action or decision shall be served and filed within ninety (90) days after such Watermaster action or decision.

(d) De Novo Nature of Proceeding. Upon filing of such motion for hearing, the Court shall notify the parties of a date for taking evidence and argument, and shall review de novo the question at issue on the date designated. The Watermaster decision or action shall have no evidentiary weight in such proceeding.

(e) Decision. The decision of the Court in such proceeding shall be an appealable Supplemental Order in this case. When the same is final, it shall be binding upon the Watermaster and the parties.

F. PHYSICAL SOLUTION

38. Purpose and Objective. (Prior Judgment Section 30) Consistent with the California Constitution and the decisions of the Supreme Court, the Court hereby adopts and Orders the parties to comply with this Physical Solution. The purpose and objective of these provisions is to provide a legal and practical means for accomplishing the most economic, long term, conjunctive utilization of surface, Ground Water, Supplemental Water and Ground Water storage capacity to meet the needs and requirements of the water users dependent upon the Basin and Relevant Watershed, while preserving existing equities.

39. Need for Flexibility. (Prior Judgment Section 31) In

order that Watermaster may be free to utilize both existing and new and developing technological, social and economic concepts for the fullest benefit of all those dependent upon the Basin, it is essential that the Physical Solution hereunder provide for maximum flexibility and adaptability. To that end, the Court has retained continuing jurisdiction to supplement the broad discretion herein granted to the Watermaster.

40. Watermaster Control. (Prior Judgment Section 32) In order to develop an adequate and effective program of Basin management, it is essential that Watermaster have broad discretion in the making of Basin management decisions within the ambit hereinafter set forth. Withdrawal and replenishment of supplies of the Basin and Relevant Watershed and the utilization of the water resources thereof, and of available Ground Water storage capacity, must be subject to procedures established by Watermaster in implementation of the provisions of this Judgment. Both the quantity and quality of said water resource are thereby preserved and its beneficial utilization maximized.

41. General Pattern of Contemplated Operation. (Prior Judgment Section 33) In general outline (subject to the specific provisions hereafter and to Watermaster Operating Criteria set forth in Exhibit "H"), Watermaster will determine annually the Operating Safe Yield of the Basin and will notify each Pumper of his share thereof, stated in acre feet per Fiscal Year. Thereafter, no party may Produce in any Fiscal Year an amount in excess of the sum of his Diversion Right, if any, plus his Pumper's Share of such Operating Safe Yield, or his

Integrated Production Right, or the terms of any Cyclic Storage Agreement, without being subject to Assessment for the purpose of purchasing Replacement Water. In establishing the Operating Safe Yield, Watermaster shall follow all physical, economic, and other relevant parameters provided in the Watermaster Operating Criteria. Watermaster shall have Assessment powers to raise funds essential to implement the management plan in any of the several special circumstances herein described in more detail.

42. Basin Operating Criteria. (Prior Judgment Section 34) Until further order of the Court and in accordance with the Watermaster Operating Criteria, Watermaster shall not spread Replacement Water when the water level at the Key Well exceeds Elevation two hundred fifty (250), and Watermaster shall spread Replacement Water, insofar as practicable, to maintain the water level at the Key Well above Elevation two hundred (200).

43. Determination of Operating Safe Yield. (Prior Judgment Section 35) Watermaster shall annually determine the Operating Safe Yield applicable to the succeeding Fiscal Year and estimate the same for the next succeeding four (4) Fiscal Years. In making such determination, Watermaster shall be governed in the exercise of its discretion by the Watermaster Operating Criteria. The procedures with reference to said determination shall be as follows:

(a) Preliminary Determination. On or before Watermaster's first meeting in April of each year, Watermaster shall make a Preliminary Determination of the Operating Safe Yield of the Basin for each of the succeeding five Fiscal Years. Said determination shall be made in the form of a report containing a summary statement of the considerations, calculations and factors used by Watermaster in arriving at said Operating Safe Yield.

(b) Notice and Hearing. A copy of said Preliminary Determination and report shall be mailed to each Pumper and Integrated Producer at least ten (10) days prior to a hearing to be held at Watermaster's regular meeting in May, of each year, at which time objections or suggested corrections or modifications of said determinations shall be considered. Said hearing shall be held pursuant to procedures adopted by Watermaster.

(c) Watermaster Determination and Review Thereof. Within thirty (30) days after completion of said hearing, Watermaster shall mail to each Pumper and Integrated Producer a final report and determination of said Operating Safe Yield for each such Fiscal Year, together with a statement of the Producer's entitlement in each such Fiscal Year stated in acre feet. Any affected party, within thirty (30) days of mailing of notice of said Watermaster determination, may, by a regularly noticed motion, petition the Court for an Order to Show Cause for review of said Watermaster finding, and thereupon the Court shall hear such objections and settle such dispute. Unless so ordered by the Court, such petition shall not operate to stay the effect of said report and determination. In the absence of such review proceedings, the Watermaster determination shall be final.

44. Reports of Pumping and Diversion. (Prior Judgment

Section 36) Each party (other than Minimal Producers) shall file with the Watermaster quarterly, on or before the last day of January, April, July and October, a report on a form to be prescribed by Watermaster showing the total Pumping and Diversion (separately for Direct Use and for non-consumptive use, if any,) of such party during the preceding calendar quarter.

45. Assessments -- Purpose. (Prior Judgment Section 37) Watermaster shall have the power to levy and collect Assessments from the parties (other than Minimal Producers, non-consumptive users, or Production under Special Category Rights or Cyclic Storage Agreements) based upon Production during the preceding Fiscal Year. Said Assessments may be for one or more of the following purposes:

(a) Watermaster Administration Costs. Within thirty (30) days after completion of the hearing on the Preliminary Determination of the Operating Safe Yield of the Basin and Watermaster's determination thereof, pursuant to Section 43 hereof, Watermaster shall adopt a proposed budget for the succeeding Fiscal Year and shall mail a copy thereof to each party, together with a statement of the level of Administration Assessment levied by Watermaster which will be collected for purposes of raising funds for said budget. Said Assessment shall be uniformly applicable to each acre foot of Production.

(b) Replacement Water Costs. Replacement Water Assessments shall be collected from each party on account of such party's Production in excess of its Diversion

Rights, Pumper's Share or Integrated Production Right, and on account of the consumptive use portion of Overlying Rights, computed at the applicable rate established by Watermaster consistent with the Watermaster Operating Criteria.

(c) Make-Up Obligation. An Assessment shall be collected equally on account of each acre foot of Production, which does not bear a Replacement Assessment hereunder, to pay all necessary costs of Administration and satisfaction of the Make-Up Obligation. Such Assessment shall not be applicable to water Production for an Overlying Right.

(d) In-Lieu Water Cost. Watermaster may levy an Assessment against all Pumping to pay reimbursement for In-Lieu Water Costs except that such Assessment shall not be applicable to the non-consumptive use portion of an Overlying Right.

(e) Basin Water Quality Improvement. For purposes of testing, protecting or improving the water quality in the Basin, Watermaster may, after a noticed hearing thereon, fix terms and conditions under which it may waive all or any part of its Assessments on such ground water Production and if such Production, in addition to his other Production, does not exceed such Producer's Share or entitlement for that Fiscal Year, such stated Production shall be allowed to be carried over for a part of such Producer's next Fiscal Year's Producer's Share or entitlement. In connection therewith, Watermaster may also waive the provisions of Sections 25, 26 and 57 hereof, relating to Injunction Against Unauthorized Recharge, Injunction Against Transportation From Basin or Relevant Watershed, and Intervention After Judgment, respectively. Nothing in this Judgment is intended to allow an increase in any Producer's annual entitlement nor to prevent Watermaster, after hearing thereon, from entering into contracts to encourage, assist and accomplish the clean up and improvement of degraded water quality in the Basin by non-parties herein. Such contracts may include the exemption of the Production of such Basin water therefor from Watermaster Assessments and, in connection therewith, the waiver of the provisions of Judgment Sections 25, 26, and 57 hereof.

46. Assessments -- Procedure. (Prior Judgment Section 38) Assessments herein provided for shall be levied and collected as follows:

(a) Levy and Notice of Assessment. Within thirty (30) days of Watermaster's annual determination of Operating Safe Yield of the Basin for each Fiscal Year and succeeding four (4) Fiscal Years, Watermaster shall levy applicable Administration Assessments, Replacement Water Assessments, Make-up Water Assessments and In-Lieu Water Assessments, if any. Watermaster shall give written notice of all applicable Assessments to each party on or before August 15, of each year.

(b) Payment. Each Assessment shall be payable, and each party is Ordered to pay the same, on or before

September 20, following such Assessment, subject to the rights reserved in Section 37 hereof.

(c) Delinquency. Any Assessment which becomes delinquent after January 1, 1980, shall bear interest at the annual prime rate plus one percent (1%) in effect on the first business day of August of each year. Said prime interest rate shall be that fixed by the Bank of America NT&SA for its preferred borrowing customers on said date. Said prime interest rate plus one percent (1%) shall be applicable to any said delinquent Assessment from the due date thereof until paid. Provided, however, in no event shall any said delinquent Assessment bear interest at a rate of less than ten percent (10%) per annum. Such delinquent Assessment and interest may be collected in a Show Cause proceeding herein or any other legal proceeding instituted by Watermaster, and in such proceeding the Court may allow Watermaster its reasonable costs of collection, including attorney's fees.

47. Availability of Supplemental Water From Responsible Agencies. (Prior Judgment Section 39) If any Responsible Agency shall, for any reason, be unable to deliver Supplemental Water to Watermaster when needed, Watermaster shall collect funds at an appropriate level and hold them in trust, together with interest accrued thereon, for purchase of such water when available.

48. Accumulation of Replacement Water Assessment Proceeds. (Prior Judgment Section 40) In order to minimize fluctuation in Assessments and to give Watermaster flexibility in Basin

management, Watermaster may make reasonable accumulations of Replacement Water Assessments. Such moneys and any interest accrued thereon shall only be used for the purchase of Replacement Water.

49. Carry-over of Unused Rights. (Prior Judgment Section 41) Any Pumper's Share of Operating Safe Yield, and the Production right of any Integrated Producer, which is not Produced in a given Fiscal Year may be carried over and accumulated for one Fiscal Year, pursuant to reasonable rules and procedures for notice and accounting which shall be adopted by Watermaster. The first water Produced in the succeeding Fiscal Year shall be deemed Produced pursuant to such Carry-over Rights.

50. Minimal Producers. (Prior Judgment Section 42) In the interest of Justice, Minimal Producers are exempted from the operation of this Physical Solution, so long as such party's annual Production does not exceed five (5) acre feet. Quarterly Production reports by such parties shall not be required, but Watermaster may require, and Minimal Producers shall furnish, specific periodic reports. In addition, Watermaster may conduct such investigation of future operations of any Minimal Producer as may be appropriate.

51. Effective Date. (Prior Judgment Section 43) The effective date for commencing accounting and operation under this Physical Solution, other than for Replacement Water Assessments, shall be July 1, 1972. The first Assessment for Replacement Water shall be payable on September 20, 1974, on account of Fiscal Year 1973-74 Production.

G. MISCELLANEOUS PROVISIONS

52. Puente Narrows Flow. (Prior Judgment Section 44) The Puente Basin is tributary to the Main San Gabriel Basin. All Producers within said Puente Basin have been dismissed herein, based upon the Puente Narrows Agreement (Exhibit "J"), whereby Puente Basin Water Agency agreed not to interfere with surface inflow and to assure continuance of historic subsurface contribution of water to Main San Gabriel Basin. The Court declares said Agreement to be reasonable and fair and in full satisfaction of claims by Main San Gabriel Basin for natural water from Puente Basin.

53. San Gabriel District - Interim Order. (Prior Judgment Section 45) San Gabriel District has a contract with the State of California for State Project Water, delivered at Devil Canyon in San Bernardino County. San Gabriel District is HEREBY ORDERED to proceed with and complete necessary pipeline facilities as soon as practical.

Until said pipeline is built and capable of delivering a minimum of twenty-eight thousand eight-hundred (28,800) acre feet of State Project water per year, defendant cities of Alhambra, Azusa, and Monterey Park shall pay to Watermaster each Fiscal Year a Replacement Assessment at a uniform rate sufficient to purchase Replenishment Water when available, which rate shall be declared by San Gabriel District. When water is available through said pipeline, San Gabriel District shall make the same available to Watermaster, on his reasonable demand, at said specified rate per acre foot. Interest accrued on such funds shall be paid to San Gabriel

District.

54. Service Upon and Delivery to Parties of Various Papers. (Prior Judgment Section 46) Service of the Judgment on those parties who have executed the Stipulation for Judgment shall be made by first class mail, postage prepaid, addressed to the Designee and at the address designated for that purpose in the executed and filed counterpart of the Stipulation for Judgment, or in any substitute designation filed with the Court.

Each party who has not heretofore made such a designation shall, within thirty (30) days after the Judgment shall have been served upon that party, file with the Court, with proof of service of a copy thereof upon Watermaster, a written designation of the person to whom and the address at which all future notices, determinations, requests, demands, objections, reports and other papers and processes to be served upon that party or delivered to that party are to be so served or delivered.

A later substitute designation filed and served in the same manner by any party shall be effective from the date of filing as to the then future notices, determinations, requests, demands, objections, reports and other papers and processes to be served upon or delivered to that party.

Delivery to or service upon any party by Watermaster, by any other party, or by the Court, of any item required to be served upon or delivered to a party under or pursuant to the Judgment may be made by deposit thereof (or by copy thereof) in the mail, first class, postage prepaid, addressed to the Designee of the party and at the address shown in the latest designation filed by that party.

55. Assignment, Transfer, etc., of Rights. (Prior Judgment Section 47) Any rights Adjudicated herein except Overlying Rights, may be assigned, transferred, licensed or leased by the owners thereof; provided however, that no such assignment shall be complete until the appropriate notice procedures established by Watermaster have been complied with. No water Produced pursuant to rights assigned, transferred, licensed, or leased may be transported outside the Relevant Watershed except by:

(1) a Transporting Party, or

(2) a successor in interest immediate or mediate to a water system on lands or portion thereof, theretofore served by such a Transporting Party, for use by such successor in accordance with limitations applicable to Transporting Parties, or

(3) a successor in interest to the Special Category rights of MWD.

The transfer and use of Overlying Rights shall be limited, as provided in Section 21 hereof, as exercisable only on the specifically defined Overlying Lands and they cannot be separately conveyed or transferred apart therefrom.

56. Abandonment of Rights. (Prior Judgment Section 48) It is in the interest of reasonable beneficial use of the Basin and its water supply that no party be encouraged to take and use more water in any Fiscal Year than is actually required. Failure to Produce all of the water to which a party is entitled hereunder shall not, in and of itself, be deemed or constitute

an abandonment of such party's right, in whole or in part. Abandonment and extinction of any right herein Adjudicated shall be accomplished only by:

(1) a written election by the party, filed in this case, or

(2) upon noticed motion of Watermaster, and after hearing.

In either case, such abandonment shall be confirmed by express subsequent order of this Court.

57. <u>Intervention After Judgment.</u> (Prior Judgment Section 49) Any person who is not a party or successor to a party and who proposes to Produce Water from the Basin or Relevant Watershed, may seek to become a party to this Judgment through a Stipulation For Intervention entered into with Watermaster. Watermaster may execute said Stipulation on behalf of the other parties herein but such Stipulation shall not preclude a party from opposing such Intervention at the time of the Court hearing thereon. Said Stipulation For Intervention must thereupon be filed with the Court, which will consider an order confirming said Intervention following thirty (30) days' notice to the parties. Thereafter, if approved by the Court, such Intervenor shall be a party bound by this Judgment and entitled to the rights and privileges accorded under the Physical Solution herein.

58. <u>Judgment Binding on Successors, etc.</u> (Prior Judgment Section 50) Subject to specific provisions hereinbefore contained, this Judgment and all provisions thereof are applicable to and binding upon and inure to the benefit of not

only the parties to this action, but as well to their respective heirs, executors, administrators, successors, assigns, lessees, licensees and to the agents, employees and attorneys in fact of any such persons.

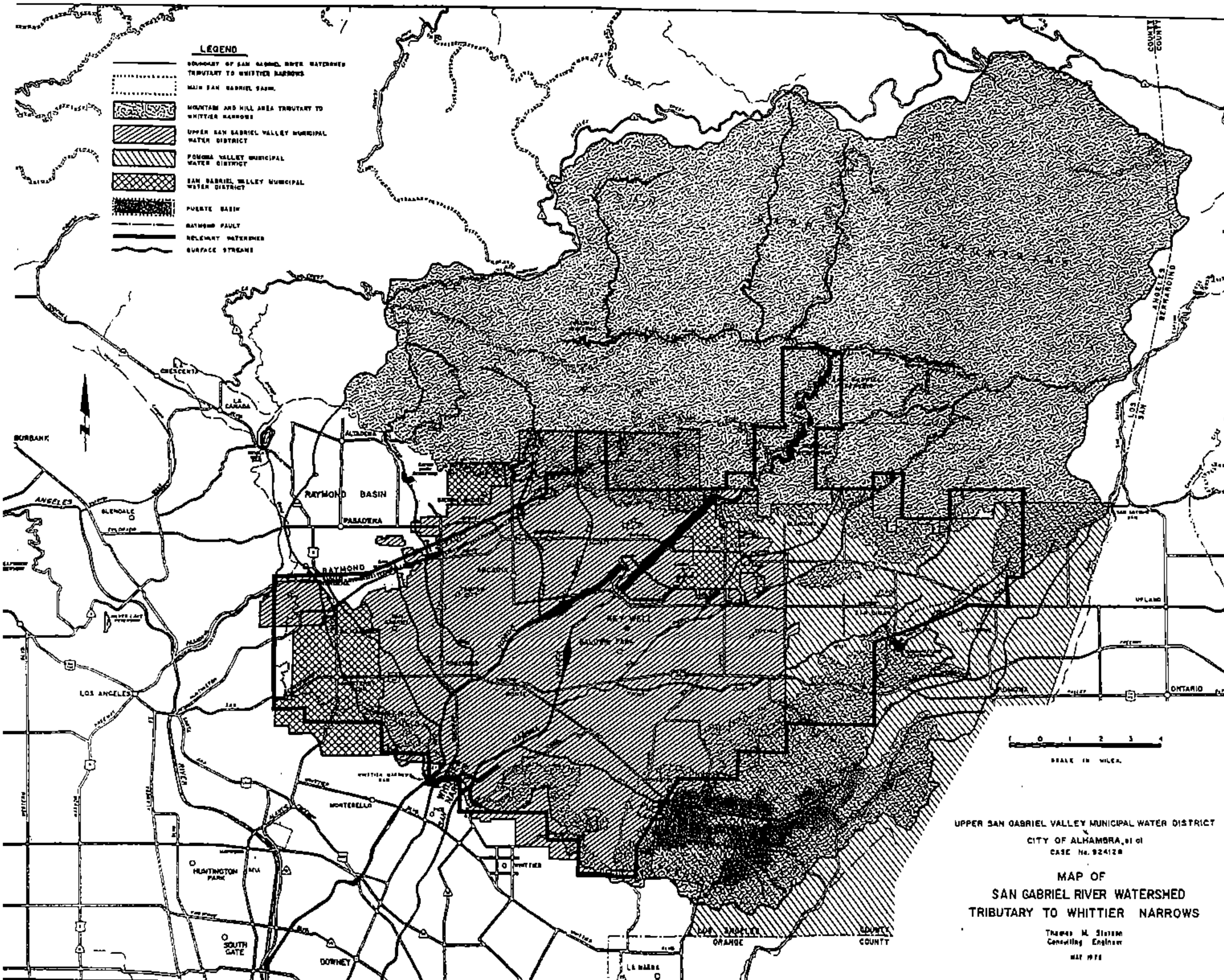
59. Water Rights Permits. (Prior Judgment Section 51) Nothing herein shall be construed as affecting the relative rights and priorities between MWD and San Gabriel Valley Protective Association under State Water Rights Permits Nos. 7174 and 7175, respectively.

60. Costs. (Prior Judgment Section 52) No party shall recover any costs in this proceeding from any other party.

61. Entry of Judgment. (New) The Clerk shall enter this Judgment.

DATED: August 24, 1989.

s/ Florence T. Pickard
Florence T. Pickard, Judge
Specially Assigned



LEGEND
BOUNDARY OF SAN GABRIEL RIVER WATERSHED TRIBUTARY TO WHITTIER NARROWS
MAIN SAN GABRIEL BASIN
MOUNTAIN AND HILL AREA TRIBUTARY TO WHITTIER NARROWS
UPPER SAN GABRIEL VALLEY MUNICIPAL WATER DISTRICT
POMONA VALLEY MUNICIPAL WATER DISTRICT
SAN GABRIEL VALLEY MUNICIPAL WATER DISTRICT
PUENTE BASIN
RAYMOND FAULT
SURFACE STREAMS
BURBANK
CRESCENTA
LA CANADA
ALTADENA
RAYMOND BASIN
PASADENA
RAYMOND
GLENDALE
ANGELES
LOS ANGELES
RIVER
MONTEBELLO
HUNTINGTON PARK
SOUTH GATE
DOWNEY
WHITTIER
LA HABRA
UPLAND
ONTARIO
LOS ANGELES COUNTY
ORANGE COUNTY
0 1 2 3 4
SCALE IN MILES
UPPER SAN GABRIEL VALLEY MUNICIPAL WATER DISTRICT
v.
CITY OF ALHAMBRA, et al
CASE No. 924128
MAP OF
SAN GABRIEL RIVER WATERSHED
TRIBUTARY TO WHITTIER NARROWS
Thomas M. Stetson
Consulting Engineer

Exhibit "B"

BOUNDARIES OF RELEVANT WATERSHED

The following described property is located in Los Angeles County, State of California:

Beginning at the Southwest corner of Section 14, Township 1 North, Range 11 West, San Bernardino Base and Meridian;

Thence Northerly along the West line of said Section 14 to the Northwest corner of the South half of said Section 14;

Thence Easterly along the North line of the South half of Section 14 to the East line of said Section 14;

Thence Northerly along the East line of said Section 14, Township 1 North, Range 11 West and continuing Northerly along the East line of Section 11 to the Northeast corner of said Section 11;

Thence Easterly along the North line of Section 12 to the Northeast corner of said Section 12;

Thence Southerly along the East line of said Section 12 and continuing Southerly along the East line of Section 13 to the Southeast corner of said Section 13, said corner being also the Southwest corner of Section 18, Township 1 North, Range 10 West;

Thence Easterly along the South line of Sections 18, 17, 16 and 15 of said Township 1 North, Range 10 West to the Southwest corner of Section 14;

Thence Northerly along the West line of Section 14 to the Northwest corner of the South half of Section 14;

Thence Easterly along the North line of the South half of Section 14 to the East line of said section;

Thence Northerly along the East line of said Section 14, and continuing Northerly along the West line of Section 12 of said Township 1 North, Range 10 West to the North line of said Section 12;

Thence Easterly along the North line of said Section 12, to the Northeast corner of said Section 12, said corner being also the Southwest corner of Section 6, Township 1 North, Range 9 West;

Thence Northerly along the West line of said Section 6 and continuing Northerly along West line of Sections 31 and 30, Township 2 North, Range 9 West to the Westerly prolongation of the North line of said Section 30;

Thence Easterly along said Westerly prolongation of the North line of said Section 30 and continuing Easterly along the North line of Section 29 to the Northeast corner of said Section 29;

Thence Southerly along the East line of said Section 29 and continuing Southerly along the East line of Section 32, Township 2 North, Range 9 West, and thence continuing Southerly along the East line of Section 5, Township 1 North, Range 9 West to the Southeast corner of said Section 5;

Thence Westerly along the South line of said Section 5 to the Southwest corner of said Section 5, said point being also the Northwest corner of Section 8;

Thence Southerly along the West line of said Section 8 and continuing Southerly along the West line of Section 17, to the Southwest corner of said Section 17, said corner being also the Northwest corner of Section 20;

Thence Easterly along the North line of Sections 20 and 21 to the Northwest corner of Section 22, said corner being also the Southwest corner of Section 15;

Thence Northerly along the West line of said Section 15 to the Northwest corner of the South half of said Section 15;

Thence Easterly along the North line of said South half of Section 15 to the Northeast corner of said South half of Section 15;

Thence Southerly along the East line of Section 15 and continuing Southerly along the East line of Section 22 to the Southeast corner of said Section 22, said point being also the Southwest corner of Section 23;

Thence Easterly along the South line of Sections 23 and 24 to the East line of the West half of said Section 24;

Thence Northerly along said East line of the West half of Section 24 to the North line thereof;

Thence Easterly along said North line of Section 24 to the Northeast corner thereof, said point also being the Northwest corner of Section 19, Township 1 North, Range 8 West;

Thence continuing Easterly along the North line of Section 19 and Section 20 of said Township 1 North, Range 8 West to the Northeast corner of said Section 20;

Thence Southerly along the East line of Sections 20, 29 and 32 of said Township 1 North, Range 8 West to the Southeast corner of said Section 32;

Thence Westerly along the South line of Section 32 to the Northwest corner of the East half of Section 5, Township 1 South, Range 8 West;

Thence Southerly along the West line of the East half of said Section 5 to the South line of said Section 5;

Thence West to the East line of the Northerly prolongation of Range 9 West;

Thence South 67° 30' West to an intersection with the Northerly prolongation of the West line of Section 27, Township 1 South, Range 9 West;

Thence Southerly along the Northerly prolongation of said West line of Section 27 and continuing Southerly along the West line of Section 27 to the Southwest corner of said Section 27, said point being also the Southeast corner of Section 28;

Thence Westerly along the South line and Westerly projection of the South line of said Section 28 to the Northerly prolongation of the West line of Range 9 West;

Thence Southerly along said prolongation of the West line of Range 9 West to the Westerly prolongation of the North line of Township 2 South;

Thence Westerly along said Westerly prolongation of the North line of Township 2 South, a distance of 8,500 feet;

Thence South a distance of 4,500 feet;

Thence West a distance of 10,700 feet;

Thence South 29° West to an intersection with the Northerly prolongation of the West line of Section 20, Township 2 South, Range 10 West;

Thence Southerly along said Northerly prolongation of the West line of said Section 20 and continuing Southerly along the West line of Section 20 to the Southwest corner of said Section 20;

Thence South a distance of 2,000 feet;

Thence West a distance of two miles, more or less, to an intersection with the East line of Section 26, Township 2 South, Range 11 West;

Thence Northerly along said East line of Section 26 and continuing Northerly along the East line of Section 23, Township 2 South, Range 11 West to the Northeast corner of said Section 23;

Thence Westerly along the North line of said Section 23 to the Northwest corner thereof, said point being also the Southeast corner of Section 15, Township 2 South, Range 11 West;

Thence Northerly and Westerly along the East and North lines, respectively, of said Section 15, Township 2 South, Range 11 West, to the Northwest corner thereof;

Thence continuing Westerly along the Westerly prolongation of said North line of Section 15, Township 2 South, Range 11 West to an intersection with a line parallel to and one mile East of the West line of Range 11 West;

Thence Northerly along said parallel line to an intersection with the Northerly boundary of the City of Pico Rivera as said City of Pico Rivera existed on July 17, 1970;

Thence Westerly along said City boundary to an intersection with the East line of Range 12 West;

Thence Northerly along said East line of Range 12 West to the North line of Township 2 South;

Thence Westerly along the North line of Township 2 South to an intersection with the Southerly prolongation of the East line of the West half of Section 26, Township 1 South, Range 12 West;

Thence Northerly along said Southerly prolongation of said East line of the West half of said Section 26 to the Southeast corner of said West half;

Thence Westerly along the South line of Sections 26, 27 and 28, Township 1 South, Range 12 West, to the Southeast corner of Section 29, Township 1 South, Range 12 West;

Thence Northerly along the East line of said Section 29 to the Northeast corner of the South half of said Section 29;

Thence Westerly along the North line of the South half of said Section 29 to the Northwest corner thereof;

Thence Northerly along the West line of Sections 29, 20, 17 and 8, Township 1 South, Range 12 West;

Thence continuing Northerly along the Northerly prolongation of the West line of Section 8, Township 1 South, Range 12 West to an intersection with the North line of Township 1 South;

Thence Easterly along said North line of Township 1 South to the Northeast corner of Section 3, Township 1 South, Range 12 West;

Thence North 64° 30′ East to an intersection with the West line of Section 23, Township 1 North, Range 11 West;

Thence Northerly along the West line of said Section 23 to the Northwest corner thereof, said point being the Southwest corner of Section 14, Township 1 North, Range 11 West and said point being also the point of beginning.

Exhibit "C"

TABLE SHOWING BASE ANNUAL DIVERSION RIGHTS OF CERTAIN DIVERTERS

	Base Annual Diversion Right Acre-Feet
Covell, Ralph (Successor to Rittenhouse, Catherine and Rittenhouse, James)	2.12
Maddock, A. G.	3.40
Rittenhouse, Catherine (Transferred to Covell, Ralph)	0
Rittenhouse, James (Transferred to Covell, Ralph)	0
Ruebhausen, Arline (Held in common with Ruebhausen, Victor) (Transferred to City of Glendale)	0
Ruebhausen, Victor (See Ruebhausen, Arline, above)	0
TOTAL	5.52

Exhibit "D"

TABLE
SHOWING PRESCRIPTIVE PUMPING RIGHTS
AND PUMPER'S SHARE OF EACH PUMPER
AS OF JUNE, 1988

Pumper	Prescriptive Pumping Right Acre-feet	Pumper's Share Percent (%)
Adams Ranch Mutual Water Company	100.00	0.05060
A & E Plastik Pak Co., Inc. (Transferred to Industry Properties, Ltd.)	0	0
Alhambra, City of	8,812.05	4.45876
Amarillo Mutual Water Company	709.00	0.35874
Anchor Plating Co., Inc. (Successor to Bodger & Sons) (Transferred to Crown City Plating Co.)	0	0
Anderson, Ray L. and Helen T., Trustees (Successor to Covina-Valley Unified School District)	50.16	0.02538
Andrade, Marcario and Consuelo; and Andrade, Robert and Jayne (Successor to J. F. Isbell Estate, Inc.)	8.36	0.00423
Arcardia, City of	9,252.00	4.68137
(Successor to First National Finance Corporation)	60.90	0.03081
(Transferred to City of Monrovia)	951.00	0.48119
	8,361.90	4.23099
Associated Southern Investment Company (Transferred to Southern California Edison Company)	0	0
AZ-Two, Inc. (Lessee of Southwestern Portland Cement Co.)	0	0
Azusa, City	3,655.99	1.84988
Azusa-Western Inc. (Transferred to Southwestern Portland Cement Co.)	0	0
Bahnsen & Beckman Ind., Inc. (Transferred to Woodland, Richard)	0	0

Pumper	Prescriptive Pumping Right Acre-feet	Pumper's Share %
Bahnsen, Betty M. (Transferred to Dawes, Mary Kay)	0	0
Baldwin Park County Water District (See Valley County Water District)	-	-
Banks, Gale C. (Successor to Doyle, Mr. and Mrs.; and Madruga, Mr. and Mrs.)	50.00	0.02530
Base Line Water Company	430.20	0.21767
Beverly Acres Mutual Water Company	93.00	0.04706
Birenbaum, Max (Held in common with Birenbaum, Sylvia; Schneiderman, Alan; Schneiderman, Lydia; Wigodsky, Bernard; Wigodsky, Estera) (Transferred to City of Whittier)	0	0
Birenbaum, Sylvia (See Birenbaum, Max)	-	-
Blue Diamond Concrete Materials Div., The Flintkote Company (Transferred to Sully-Miller Contracting Co.)	0	0
Bodger & Sons DBA Bodger Seeds Ltd. (Transferred to Anchor Plating Co., Inc.)	0	0
Botello Water Company	0	0
Burbank Development Company	50.65	0.02563
Cadway, Inc. (Successor to:		
Corcoran, Jack S. and R. L.)	100.00	0.05060
Corcoran, Jack S. and R. L.)	100.00	0.05060
	200.00	0.10120
Cal Fin (Transferred to Suburban Water Systems)	0	0
California-American Water Company (San Marino System)	7,868.70	3.98144
California Country Club	0	0

Pumper	Prescriptive Pumping Right Acre-feet	Pumper's Share %
California Domestic Water Company	11,024.82	5.57839
(Successor to:		
Cantrill Mutual Water Company	42.50	0.02150
Industry Properties, Ltd.	73.50	0.03719
Modern Accent Corporation	256.86	0.12997
Fisher, Russell)	19.00	0.00961
	11,416.68	5.77666
California Materials Company	0	0
Cantrill Mutual Water Company (Transferred to California Domestic Water Co.)	0	0
Cedar Avenue Mutual Water Company	121.10	0.06127
Champion Mutual Water Company	147.68	0.07472
Chronis, Christine (See Polopolus, et al)	-	-
Clayton Manufacturing Company	511.80	0.25896
Collison, E. O.	0	0
Comby, Erma M. (See Wilmott, Erma M.)	-	-
Conrock Company		
(Formerly Consolidated Rock Products Co.)	1,465.35	0.74144
(Successor to Manning Bros. Rock & Sand Co.)	328.00	0.16596
	1,793.35	0.90740
Consolidated Rock Products Co. (See Conrock Company)	-	-
Corcoran, Jack S.		
(Held in common with Corcoran, R. L.)		
(Transferred to:	747.00	0.37797
Cadway, Inc.	100.00	0.05060
Cadway, Inc.)	100.00	0.05060
	547.00	0.27677
Corcoran, R. L. (See Corcoran, Jack S.)	-	-
County Sanitation District No. 18 of Los Angeles County	4.50	0.00228

Pumper	Prescriptive Pumping Right Acre-feet	Pumper's Share %
Covell, et al. (Successor to Rittenhouse, Catherine and Rittenhouse, James) (Held in common with Jobe, Darr; Goedert, Lillian E.; Goedert, Marion W.; Lakin, Kendall R.; Lakin, Kelly R.; Snyder, Harry)	111.05	0.05619
Covina, City of	2,507.89	1.26895
(Transferred to Covina Irrigating Company)	1,734.00	0.87737
(Transferred to Covina Irrigating Company)	300.00	0.15179
	473.89	0.23979
Covina-Valley Unified School District (Transferred to Anderson, Ray)	0	0
Crevolin, A. J.	2.25	0.00114
Crocker National Bank, Executor of the Estate of A. V. Handorf (Transferred to Modern Accent Corp.)	0	0
Cross Water Company (Transferred to City of Industry)	0	0
Crown City Plating Company	190.00	0.09614
(Successor to Anchor Plating Co., Inc.)	10.00	0.00506
	200.00	0.10120
Davidson Optronics, Inc.	22.00	0.01113
Dawes, Mary Kay (Successor to Bahnsen, Betty M.)	441.90	0.22359
Del Rio Mutual Water Company	199.00	0.10069
Denton, Kathryn W., Trustee for San Jose Ranch Company (Transferred to White, June G., Trustee of the June G. White Share of the Garnier Trust)	0	0
Doyle, Mr. and Mrs.; and Madruga, Mr. and Mrs. (Successor to Sawpit Farms, Ltd.) (Transferred to Banks, Gale C.)	0	0
Driftwood Dairy	163.80	0.08288
Duhalde, L. (Transferred to El Monte Union High School District)	0	0

Pumper	Prescriptive Pumping Right Acre-feet	Pumper's Share %
Dunning, George (Held in common with Dunning, Vera H.) (Successor to Vera H. Dunning)	324.00	0.16394
Dunning, Vera H. (Transferred to George Dunning)	-	-
East Pasadena Water Company, Ltd.	1,407.69	0.71227
Eckis, Rollin (Successor to Sawpit Farms, Ltd.) (Transferred to City of Monrovia)	0	0
El Encanto Properties (Transferred to La Puente Valley County Water District)	0	0
El Monte, City of	2,784.23	1.40878
El Monte Cemetary Association	18.50	0.00936
El Monte Union High School District (Successor to Duhalde, L.) (Transferred to City of Whittier)	0	0
Everett, Mrs. Alda B. (Held in common with Everett, W. B., Executor of the Estate of I. Worth Everett)	0	0
Everett, W. B., Executor of the Estate of I. Worth Everett (See Everett, Mrs. Alda B.)	-	-
Faix, Inc. (Successor to Frank F. Pellissier & Sons, Inc.) (Transferred to Faix, Ltd.)	0	0
Faix, Ltd. (Successor to Faix, Inc.)	6,490.00	3.28384
First National Finance Corporation (Transferred to City of Arcadia)	0	0
Fisher, Russell (Held in common with Hauch, Edward and Warren, Clyde) (Transferred to California Domestic Water Company)	0	0

Pumper	Prescriptive Pumping Right Acre-feet	Pumper's Share %
Frank F. Pellissier & Sons, Inc. (Transferred to Faix, Inc.)	0	0
Fruit Street Water Company (Transferred to: Gifford, Brooks, Jr. City of La Verne)	0	0
Gifford, Brooks, Jr. (Successor to: Fruit Street Water Co., Mission Gardens Mutual Water Company) (Transferred to City of Whittier)	0	0
Gilkerson, Frank B. (Transferred to Jobe, Darr)	-	-
Glendora Unified High School District (Transferred to City of Glendora)	0	0
Goedert, Lillian E. (See Covell, et al)	-	-
Goedert, Marion W. (See Covell, et al)	-	-
Graham, William (Transferred to Darr Jobe)	-	-
Green, Walter	71.70	0.03628
Grizzle, Lissa B. (Held in common with Grizzle, Mervin A.; Wilson, Harold R.; Wilson, Sarah C.) (Transferred to City of Whittier)	0	0
Grizzle, Mervin A. (See Grizzle, Lissa B.)	0	0
Hansen, Alice	0.75	0.00038
Hartley, David	0	0
Hauch, Edward (See Fisher, Russell)	0	0
Hemlock Mutual Water Company	166.00	0.08399

Pumper	Prescriptive Pumping Right Acre-feet	Pumper's Share %
Hollenbeck Street Water Company (Transferred to Suburban Water Systems)	0	0
Hunter, Lloyd F. (Successor to R. Wade)	4.40	0.00223
Hydro-Conduit Corporation	0	0
Industry Waterworks System, City of (Successor to Cross Water Company)	1,103.00	0.55810
Industry Properties, Ltd. (Successor to A & E Plastik Pak Co., Inc.) (Transferred to California Domestic Water Co.)	0	0
J. F. Isbell Estate, Inc. (Transferred to Andrade, Macario and Consuelo; and Andrade, Robert and Jayne)	0	0
Jerris, Helen (See Polopolus, et al)	-	-
Jobe, Darr (See Covell, et al)	-	-
Kirklen Family Trust (Formerly Kirklen, Dawn L.)		
(Held in common with Kirklen, William R.)	375.00	0.18974
(Successor to San Dimas-La Verne Recreational Facilities Authority)	62.50	0.03162
	437.50	0.22136
Kirklen, Dawn L. (See Kirklen Family Trust)	-	-
Kirklen, William R. (See Kirklen, Dawn L.)	-	-
Kiyan, Hideo (Held in common with Kiyan, Hiro)	30.00	0.01518
Kiyan, Hiro (See Kiyan, Hideo)	-	-
Knight, Kathryn M. (Successor to William Knight)	227.88	0.11530
Knight, William (Transferred to Kathryn M. Knight)	0	0

Pumper	Prescriptive Pumping Right Acre-feet	Pumper's Share %
Lakin, Kelly R. (See Covell, et al)	-	-
Lakin, Kendall R. (See Covell, et al)	-	-
Landeros, John	0.75	0.00038
La Grande Source Water Company (Transferred to Suburban Water Systems)	0	0
Lang, Frank (Transferred to San Dimas-La Verne Recreational Facilities Authority)	0	0
La Puente Cooperative Water Company (Transferred to Suburban Water Systems)	0	0
La Puente Valley County Water District (Successor to El Encanto Properties)	1,097.00 33.40 1,130.40	0.55507 0.01690 0.57197
La Verne, City of (Successor to Fruit Street Water Co.)	250.00 105.71 355.71	0.12650 0.05349 0.17999
Lee, Paul M. and Ruth A.; Nasmyth, Virrginia; Nasmyth, John	0	0
Little John Dairy	0	0
Livingston-Graham, Inc.	1,824.40	0.92312
Los Flores Mutual Water Company (Transferred to City of Monterey Park)	0	0
Loucks, David	3.00	0.00152
Manning Bros. Rock & Sand Co. (Transferred to Conrock Company)	0	0
Maple Water Company	118.50	0.05996
Martinez, Frances Mercy (Held in common with Martinez, Jaime)	0.75	0.00038
Martinez, Jaime (See Martinez, Frances Mercy)	-	-
Massey-Ferguson Company	0	0

Pumper	Prescriptive Pumping Right Acre-feet	Pumper's Share %
Miller Brewing Company (Successor to:	111.01	0.05617
Maechtlen, Estate of J. J.	151.50	0.07666
Phillips, Alice B., et al)	50.00	0.02530
	312.51	0.15813
Mission Gardens Mutual Water Company (Transferred to Gifford, Brooks, Jr.)	0	0
Modern Accent Corporation (Successor to Crocker National Bank, Executor of the Estate of A. V. Handorf) (Transferred to California Domestic Water Co.)	0	0
Monterey Park, City of	6,677.48	3.37870
(Successor to Los Flores Mutual Water Co.)	26.60	0.01346
	6,704.08	3.39216
Murphy Ranch Mutual Water Company (Transferred to Southwest Suburban Water)	0	0
Namimatsu Farms (Transferred to California Cities Water Company)	0	0
Nick Tomovich & Sons	0.02	0.00001
No. 17 Walnut Place Mutual Water Co. (Transferred to San Gabriel Valley Water Company)	0	0
Orange Production Credit Association	0	0
Owl Rock Products Co.	715.60	0.36208
Pacific Rock & Gravel Co. (Transferred to: City of Whittier Rose Hills Memorial Park Association)	0	0
Park Water Company (Transferred to Valley County Water District)	0	0
Penn, Margaret (See Polopolus, et al)	-	-
Pico County Water District	0.75	0.00038
Polopolus, John (See Polopolus, et al)	-	-

Pumper	Prescriptive Pumping Right Acre-feet	Pumper's Share %
Polopolus, et al (Successor to Polopolus, Steve) (Held in common with Chronis, Christine; Jerris, Helen; Penn, Margaret; Polopolus, John)	22.50	0.01138
Polopolus, Steve (Transferred to Polopolus, et al)	-	-
Rados, Alexander (Held in common with Rados, Stephen and Rados, Walter)	43.00	0.02176
Rados, Stephen (See Rados, Alexander)	-	-
Rados, Walter (See Rados, Alexander)	-	-
Richwood Mutual Water Company	192.60	0.09745
Rincon Ditch Company	628.00	0.31776
Rincon Irrigation Company	314.00	0.15888
Rittenhouse, Catherine (Transferred to Covell, Ralph)	0	0
Rittenhouse, James (Transferred to Covell, Ralph)	0	0
Rose Hills Memorial Park Association (Successor to Pacific Rock & Gravel Co.)	594.00 200.00 794.00	0.30055 0.10120 0.40175
Rosemead Development, Ltd. (Successor to Thompson, Earl W.)	1.00	0.00051
Rurban Homes Mutual Water Company	217.76	0.11018
Ruth, Roy	0.75	0.00038
San Dimas-La Verne Recreational Facilities Authority (Successor to Lang, Frank) (Transferred to Kirklen, Dawn L. and William R.)	0	0
San Gabriel Country Club	286.10	0.14476
San Gabriel County Water District	4,250.00	2.15044

Pumper	Prescriptive Pumping Right Acre-feet	Pumper's Share %
San Gabriel Valley Municipal Water District	0	0
San Gabriel Valley Water Company	16,659.00	8.42920
(Successor to:		
Vallecito Water Co.	2,867.00	1.45066
No. 17 Walnut Place Mutual Water Co.)	21.50	0.01088
	19,547.50	9.89074
Sawpit Farms, Limited (Transferred to: Eckis, Rollin Doyle and Madruga)	0	0
Schneiderman, Alan (See Birenbaum, Max)	-	-
Schneiderman, Lydia (See Birenbaum, Max)	-	-
Security Pacific National Bank, Co-Trustee for the Estate of Winston F. Stoody (See Stoody, Virginia A.) (Transferred to City of Whittier)	0	0
Sierra Madre, City of	0	0
Sloan Ranches	129.60	0.06558
Smith, Charles	0	0
Snyder, Harry (See Covell, et al)	-	-
Sonoco Products Company	311.60	0.15766
South Covina Water Service	992.30	0.50209
Southern California Edison Company	155.25	0.07855
(Successor to: Associated Southern Investment Company)	16.50	0.00835
	171.75	0.08690
Southern California Water Company, San Gabriel Valley District	5,773.00	2.92105
South Pasadena, City of	3,567.70	1.80520
Southwest Suburban Water (See Suburban Water Systems)	-	-

Pumper	Prescriptive Pumping Right Acre-feet	Pumper's Share %
Southwestern Portland Cement Company (Successor to Azusa Western, Inc.)	742.00	0.37544
Speedway 605, Inc.	0	0
Standard Oil Company of California	2.00	0.00101
Sterling Mutual Water Company	120.00	0.06072
Stoody, Virginia A., Co-Trustee for the Estate of Winston F. Stoody (See Security Pacific National Bank, Co-Trustee)	-	-
Suburban Water Systems (Formerly Southwest Suburban Water) (Successor to:	20,462.47	10.35370
Hollenbeck Street Water Company	646.39	0.32706
La Grande Source Water Company	1,078.00	0.54545
La Puente Cooperative Water Co.	1,210.90	0.61270
Valencia Valley Water Company	651.50	0.32965
Victoria Mutual Water Company	469.60	0.23761
Cal Fin	118.10	0.05976
Murphy Ranch Mutual Water Co.	223.23	0.11295
	24,860.19	12.57888
Sully-Miller Contracting Company (Successor to Blue Diamond Concrete Materials Division, The Flintkote Co.)	1,399.33	0.70804
Sunny Slope Water Company	2,228.72	1.12770
Taylor Herb Garden (Transferred to Covina Irrigating Company)	0	0
Texaco, Inc.	50.00	0.02530
Thompson, Earl W. (Held in common with Thompson, Mary) (Transferred to Rosemead Development, Ltd.)	0	0
Thompson, Mary (See Thompson, Earl W.)	-	-
Tyler Nursery	3.21	0.00162
United Concrete Pipe Corporation (See U. S. Pipe & Foundry Company)	-	-

Pumper	Prescriptive Pumping Right Acre-feet	Pumper's Share %
U. S. Pipe & Foundry Company (Formerly United Concrete Pipe Corporation)	376.00	0.19025
Valencia Heights Water Company	861.00	0.43565
Valencia Valley Water Company (Transferred to Suburban Water Systems)	0	0
Vallecito Water Company (Transferred to San Gabriel Valley Water Company)	0	0
Valley County Water District (Formerly Baldwin Park County Water District) (Successor to Park Water Company)	5,775.00 184.01 5,959.01	2.92206 0.09311 3.01517
Valley Crating Company	0	0
Valley View Mutual Water Company	616.00	0.31169
Via, H. (See Via, H., Trust of)	-	-
Via, H., Trust of (Formerly Via, H.)	46.20	0.02338
Victoria Mutual Water Company (Transferred to Suburban Water Systems)	0	0
Wade, R. (Transferred to Lloyd F. Hunter)	0	0
Ward Duck Company	1,217.40	0.61599
Warren, Clyde (See Fisher, Russell)	-	-
W. E. Hall Company	0.20	0.00010
White, June G., Trustee of the June G. White Share of the Garnier Trust (Successor to Denton, Kathryn W., Trustee for the San Jose Ranch Company)	185.50	0.09386

Pumper	Prescriptive Pumping Right Acre-feet	Pumper's Share %
Whittier, City of	7,620.23	3.85572
(Successor to:		
Grizzle, Lissa B.	184.00	0.09310
Pacific Rock and Gravel Co.)	208.00	0.10524
Security Pacific National Bank,		
Co-Trustee for the Estate of Winston F. Stoody	38.70	0.01958
El Monte Union High School District	16.20	0.00820
Gifford, Brooks, Jr.	198.25	0.10031
Birenbaum, Max)	6.00	0.00304
	8,271.38	4.18519
Wigodsky, Bernard (See Birenbaum, Max)	-	-
Wigodsky, Estera (See Birenbaum, Max)	-	-
Wilmott, Erma M. (Formerly Comby, Erma M.)	0.75	0.00038
Wilson, Harold R. (See Grizzle, Lissa B.)	-	-
Wilson, Sarah C. (See Grizzle, Lissa B.)	-	-
Woodland, Frederick G.	-	-
Woodland, Richard (Successor to: Bahnsen and Beckman Ind., Inc.)	840.50	0.42528
Totals for Exhibit "D"	156,800.68	78.83276
Totals from Exhibit "E"	41 833.75 ~~38,026.25~~	21.16724 ~~19.54431~~
GRAND TOTALS	197,634.43	100.00000

TABLE
SHOWING PRODUCTION RIGHTS
OF EACH
INTEGRATED PRODUCER
AS OF JUNE 1988

Party	Diversion Component Acre-feet	Prescriptive Pumping Component Acre-feet	Pumping Component Share Percent (%)
Azusa Agricultural Water Company	1,000.00	1,732.20	0.87647
Azusa Foot-Hill Citrus Water Company (Transfered to Monrovia Nursery Company)	0	0	0
Azusa Valley Water Company	2,422.00	8,274.00	4.18652
California-American Water Company (Duarte System)	1,672.00	3,649.00	1.84634
California Cities Water Company (See Southern California Water Company, San Dimas District)	-	-	-
Covina Irrigating Company	2,514.00	4,140.00	2.09478
(Successor to:			
City of Covina,		1,734.00	0.87737
City of Covina, and		300.00	0.15179
Taylor Herb Garden)		6.00	0.00304
	2,514.00	6,180.00	3.12698
Glendora, City of	17.00	8,258.00	4.17842
(Successor to:			
Maechtlen, Estate of J. J.,		150.00	0.07590
Maechtlen, Trust of P. A.,		50.00	0.02530
Ruebhausen, Arline, and	18.34		
Glendora Unified High School District)		9.00	0.05009
	35.34	8,557.00	4.32971
Los Angeles, County of	310.00	3,721.30	1.88292
Maechtlen, Estate of J. J.	0	301.50	0.15256
(Transferred to:			
City of Glendora		-150.00	-0.07590
Miller Brewing Company)		-151.50	-0.07666
	0	0	0

Party	Diversion Componet Acre-feet	Prescriptive Pumping Component Acre-feet	Pumping Component Share %
Maechtlen, Estate of J. J.	1.49	0	0
Maechtlen, Trust of P. A.	0.50	100.50	0.05085
(Transferred to:			
City of Glendora		-50.00	-0.02530
Alice B. Phillips, et al)	-0.50	-50.50	-0.02555
	0	0	0
The Metropolitan Water District of Southern California	9.59	165.00	0.08349
Monrovia, City of	1,098.00	5,042.22	2.55129
(Sucessor to:			
Eckis, Rollin		123.00	0.06224
City of Arcadia)		951.00	0.48119
	1,098.00	6,116.22	3.09472
Monrovia, Nursery Company	239.50	0	0
(Successor to:			
Azusa Foot-Hill Citrus Co.)	718.50	0	
Phillips, Alice B., et al			
(Successor to:			
Maechtlen, Trust of P. A.)	0.50	50.50	0.02530
(Transferred to:			
Miller Brewing Company)		-50.00	-0.02530
	0.50	0.50	0.00025
Southern California Water Company (San Dimas Dist.)	500.00	3,242.53	1.64076
(Formerly California Cities Water Company)			
(Successor to:			
Namimatsu Farms)		196.00	0.09917
	500.00	3,438.53	1.73984
TOTAL for Exhibit "E"	10,520.92	41,833.75	21.16724

Exhibit "F"

TABLE SHOWING
SPECIAL CATAGORY RIGHTS

PARTY	Nature of Right
The Metropolitan Water District of Southern California	Morris Reservoir Storage and Withdrawal (a) A right to divert, store and use San Gabriel River Water, pursuant to Permit No. 7174. (b) Prior and paramount right to divert 72 acre-feet annually to offset Morris Reservoir evaporation and seepage losses and to provide the water supply necessary for presently existing incidential Morris Dam facilities.
Los Angeles County Flood Control District (Now Los Angeles County Department of Public Works)	Puddingstone Reservoir Prior Prescriptive right to divert water from San Dimas Wash for storage in Puddingstone Reservoir in quantities sufficient to offset annual evaporation and seepage losses of the reservoir at approximate elevation 942.

Exhibit "G"

TABLE SHOWING
NON-CONSUMPTIVE USERS

Party	Nature of Right
Covina Irrigating Company Azusa Valley Water Company Azusa Agricultural Water Co. Azusa Foot-Hill Citrus Co. Monrovia Nursery Company	"Committee-of-Nine" Spreading Right To continue to divert water from the San Gabriel River pursuant to the 1888 Settlement, and to spread in spreading grounds within the Basin all water thus diverted without the right to recapture water in excess of said parties' rights as adjudicated in Exhibit "E".
California-American Water Company (Duarte System)	Spreading Right To continue to divert water from the San Gabriel River pursuant to the 1888 Settlement, and to continue to divert water from Fish Canyon and to spread said waters in its spreading grounds in the Basin without the right to recapture water in excess of said party's rights as adjudicated in Exhibit "E".
City of Glendora	Spreading Right To continue to spread the water of Big and Little Dalton Washes, pursuant to License No. 2592 without the right to recapture water in excess of said party's rights as adjudicated in Exhibit "E".
San Gabriel Valley Protective Association	Spreading Right To continue to spread San Gabriel River water pursuant to License Nos. 9991 and 12,209, without the right to recapture said water.
California Cities Water Company	Spreading Right To continue to spread waters from San Dimas Wash without the right to recapture water in excess of said party's rights as adjudicated in Exhibit "E".
Los Angeles County Flood Control District	Temporary storage of storm flow for regulatory purposes; Spreading and conservation for general benefit in streambeds, reservoirs and spreading grounds without the right to recapture said water. Maintenance and operation of dams and other flood control works.

EXHIBIT "H"

WATERMASTER OPERATING CRITERIA

1. Basin Storage Capacity. The highest water level at the end of a water year during the past 40 years was reached at the Key Well on September 30, 1944 (elevation 316). The State of California, Department of Water Resources, estimates that as of that date, the quantity of fresh water in storage in the Basin was approximately 8,600,000 acre-feet. It is also estimated by said Department that by September 30, 1960, the quantity of fresh water in storage had decreased to approximately 7,900,000 acre-feet (elevation 237) at the Key Well).

The lowest water level at the end of a water year during the past 40 years was reached at the Key Well on September 30, 1965 (elevation 209). It is estimated that the quantity of fresh water in storage in the Basin on that date was approximately 7,700,000 acre-feet.

Thus, the maximum utilization of Basin storage was approximately 900,000 acre-feet, occurring between September 30, 1944, and September 30, 1965 (between elevations 316 and 209 at the Key Well). This is not to say that more than 900,000 acre-feet of storage space below the September 30, 1944 water levels cannot be utilized. However, it demonstrates that pumpers have deepened their wells and lowered their pumps so that such 900,000 acre-feet of storage can be safely and economically utilized.

The storage capacity of the Basin between elevations of 200 and 250 at the Key Well represents a usable volume of approximately 400,000 acre-feet of water.

2. <u>Operating Safe Yield and Spreading.</u> Watermaster in determining Operating Safe Yield and the importation of Replacement Water shall be guided by water level elevations in the Basin. He shall give recognition to, and base his operations on, the following general objectives insofar as practicable:

(a) The replenishment of ground water from sources of supplemental water should not cause excessively high levels of ground water and such replenishment should not cause undue waste of local water supplies.

(b) Certain areas within the Basin are not at the present time capable of being recharged with supplemental water. Efforts should be made to provide protection to such areas from excessive ground water lowering either through the "in lieu" provisions of the Judgment or by other means.

(c) Watermaster shall consider and evaluate the long-term consequences on ground water quality, as well as quantity, in determining and establishing Operating Safe Yield. Recognition shall be given to the enhancement of ground water quality insofar as practicable, especially in the area immediately upstream of Whittier Narrows where degradation of water quality may occur when water levels at the Key Well are maintained at or below elevation 200.

(d) Watermaster shall take into consideration the comparative costs of supplemental and Make-up Water in determining the savings on a present value basis of temporary or permanent lowering or raising of water levels and other economic data and analyses indicating both the short-term and long-term propriety of adjusting Operating Safe Yield in order to derive optimum water levels during any period. Watermaster shall utilize the provisions in the Long Beach Judgment which will result in the least cost of delivering Make-up Water.

3. Replacement Water -- Sources and Recharge Criteria. The following criteria shall control purchase of Replacement Water and Recharge of the Basin by Watermaster.

(a) Responsible Agency From Which to Purchase. Watermaster, in determining the Responsible Agency from which to purchase supplemental water for replacement purposes, shall be governed by the following:

(1) Place of Use of Water which is used primarily within the Basin or by cities within San Gabriel District in areas within or outside the Basin shall control in determining the Responsible Agency. For purposes of this subparagraph, water supplied through a municipal water system which lies chiefly within the Basin shall be deemed entirely used within the Basin; and

(2) Place of production of water shall control in determining the Responsible Agency as to water exported from the Basin, except as to use within San Gabriel District.

Any Responsible Agency may, at the request of Watermaster, waive its right to act as the source for such supplemental water, in which case Watermaster shall be free to purchase such water from the remaining Responsible Agencies which are the most beneficial and appropriate sources; provided, however, that a Responsible Agency shall not authorize any sale of water in violation of the California Constitution.

(b) <u>Water Quality.</u> Watermaster shall purchase the best quality of supplemental water available for replenishment of the Basin, pursuant to subsection (a) hereof.

(c) <u>Reclaimed Water.</u> It is recognized that the technology and economic and physical necessity for utilization of reclaimed water is increasing. The purchase of reclaimed water in accordance with the Long Beach Judgment to satisfy the Make-up Obligation is expressly authorized. At the same time, water quality problems involved in the reuse of water within the Basin pose serious questions of increased costs and other problems to the pumpers, their customers and all water users. Accordingly, Watermaster is authorized to gather information, make and review studies, and make recommendations on the feasibility of the use of reclaimed water for replacement purposes; provided that no reclaimed water shall be recharged in the Basin by Watermaster without the prior approval of the court, after notice to all parties and hearing thereon.

4. <u>Replacement Assessment Rates.</u> The Replacement Assessment rates shall be in an amount calculated to allow Watermaster to purchase one acre-foot of supplemental water for each acre-foot of excess Production to which such Assessment applies.

EXHIBIT "J"

PUENTE NARROWS AGREEMENT

THIS AGREEMENT is made and entered into as of the 8th day of May, 1972, by and between PUENTE BASIN WATER AGENCY, herein called "Puente Agency", and UPPER SAN GABRIEL VALLEY MUNICIPAL WATER DISTRICT, herein called "Upper District".

A. RECITALS

1. Puente Agency. Puente Agency is a joint powers agency composed of Walnut Valley Water District, herein called "Walnut District", and Rowland Area County Water District, herein called "Rowland District". Puente Agency is formed for the purpose of developing and implementing a ground water basin management program for Puente Basin. Pursuant to said purpose, said Agency is acting as a representative of its member districts and of the water users and water right claimants therein in the defense and maintenance of their water rights within Puente Basin.

2. Upper District. Upper District is a municipal water district overlying a major portion of the Main San Gabriel Basin. Upper District is plaintiff in the San Gabriel Basin Case, wherein it seeks to adjudicate rights and implement a basin management plan for the Main San Gabriel Basin.

3. Puente Basin is a ground water basin tributary to the Main San Gabriel Basin. Said area was included within the scope of the San Gabriel Basin Case and substantially

all water rights claimants within Puente Basin were joined as defendants therein. The surface contribution to the Main San Gabriel Basin from Puente Basin is by way of the paved flood control channel of San Jose Creek, which passes through Puente Basin from the Pomona Valley area. Subsurface outflow is relatively limited and moves from the Puente Basin to the Main San Gabriel Basin through Puente Narrows.

4. Intent of Agreement. Puente Agency is prepared to assure Upper District that no activity within Puente Basin will hereafter be undertaken which will (1) interfere with surface flows in San Jose Creek, or (2) impair the subsurface flow from Puente Basin to the Main San Gabriel Basin. Walnut District and Rowland District, by operation of law and by express assumption endorsed hereon, assume the covenants of this agreement as a joint and several obligation. Based upon such assurances and the covenants hereinafter contained in support thereof, Upper District consents to the dismissal of all Puente Basin parties from the San Gabriel Basin Case. By reason of said dismissals, Puente Agency will be free to formulate a separate water management program for Puente Basin.

B. DEFINITIONS AND EXHIBITS

5. Definitions. As used in this Agreement, the following terms shall have the meanings herein set forth:

(a) Annual or Year refers to the fiscal year July 1 through June 30.

(b) Base Underflow. The underflow through

Puente Narrows which Puente Agency agrees to maintain, and on which accrued debits and credits shall be calculated.

(c) Make-up Payment. Make-up payments shall be an amount of money payable to the Watermaster appointed in the San Gabriel Basin Case, sufficient to allow said Watermaster to purchase replacement water on account of any accumulated deficit as provided in Paragraph 9 hereof.

(d) Puente Narrows. The subsurface geologic constriction at the downstream boundary of Puente Basin, located as shown on Appendix "B".

(e) Main San Gabriel Basin, the ground water basin shown and defined as such in Exhibit "A" to the Judgment in the San Gabriel Basin Case.

(f) San Gabriel Basin Case. Upper San Gabriel Valley Municipal Water District v. City of Alhambra, et al., L. A. Sup. Ct. No. 924128, filed January 2, 1968.

6. Appendices. Attached hereto and by this reference made a part hereof are the following appendices:

"A" -- Location Map of Puente Basin, showing major geographic, geologic, and hydrologic features.

"B" -- Map of Cross-Section Through Puente Narrows, showing major physical features and location of key wells.

"C" -- Engineering Criteria, being a description of a method of measurement of subsurface outflow to be utilized for Watermaster purposes.

C. COVENANTS

7. Watermaster. There is hereby created a two member Watermaster service to which each of the parties to this agreement shall select one consulting engineer. The respective representatives on said Watermaster shall serve at the pleasure of the governing body of each appointing party and each party shall bear its own Watermaster expense.

a. Organization. Watermaster shall perform the duties specified herein on an informal basis, by unanimous agreement. In the event the two representatives are unable to agree upon any finding or decision, they shall select a third member to act, pursuant to the applicable laws of the State of California. Thereafter, until said issue is resolved, said three shall sit formally as a board of arbitration. Upon resolution of the issue in dispute, the third member shall cease to function further.

b. Availability of Information. Each party hereto shall, for itself and its residents and water users, use its best efforts to furnish all appropriate information to the Watermaster in order that the required determination can be made.

c. Cooperation With Other Watermasters. Watermaster hereunder shall cooperate and coordinate activities with the Watermasters appointed in the San Gabriel Basin Case and in Long Beach v. San Gabriel Valley Water Company, et al.

d. Determination of Underflow. Watermaster shall annually determine the amount of underflow from Puente Basin to the San Gabriel Basin, pursuant to Engineering Criteria.

e. Perpetual Accounting. Watermaster shall maintain a perpetual account of accumulated base underflow, accumulated subsurface flow, any deficiencies by reason of interference with surface flows, and the offsetting credit for any make-up payments. Said account shall annually show the accumulated credit or debit in the obligation of Puente Agency to Upper District.

f. Report. Watermaster findings shall be incorporated in a brief written report to be filed with the parties and with the Watermaster in the San Gabriel Basin Case. Said report shall contain a statement of the perpetual account heretofore specified.

8. Base Underflow. On the basis of a study and review of historic underflow from Puente Basin to the Main San Gabriel Basin, adjusted for the effect of the paved flood control channel and other relevant considerations, it is

mutually agreed by the parties that the base underflow is and shall be 580 acre feet per year, calculated pursuant to Engineering Criteria.

9. Puente Agency's Obligation. Puente Agency covenants, agrees and assumes the following obligation hereunder:

a. Noninterference with Surface Flow. Neither Puente Agency nor any persons or entities within the corporate boundaries of Walnut District or Rowland District will divert or otherwise interfere with or utilize natural surface runoff now or hereafter flowing in the storm channel of San Jose Creek; provided, however, that this covenant shall not prevent the use, under Watermaster supervision, of said storm channel by the Puente Agency or Walnut District or Rowland District for transmission within Puente Agency of supplemental or reclaimed water owned by said entities and introduced into said channel solely for transmission purposes. In the event any unauthorized use of surface flow in said channel is made contrary to the covenant herein provided, Puente Agency shall compensate Upper District by utilizing any accumulated credit or by make-up payment in the same manner as is provided for deficiencies in subsurface outflow from Puente Basin.

b. Subsurface Outflow. To the extent that the accumulated subsurface outflow falls below the accumulated base underflow and the result thereof is an accumulated deficit in the Watermaster's annual accounting, Puente Agency agrees to provide make-up payments during the next year in an amount not less than one-third of the accumulated deficit.

c. Purchase of Reclaimed Water. To the extent that Puente Agency or Walnut District or Rowland District may hereafter purchase reclaimed water from the facilities of Sanitation District 21 of Los Angeles County, such purchaser shall use its best efforts to obtain waters originating within San Gabriel River Watershed.

10. Puente Basin Parties Dismissal. In consideration of the assumption of the obligation hereinabove provided by Puente Agency, Upper District consents to entry of dismissals as to all Puente Basin parties in San Gabriel Basin Case. This agreement shall be submitted for specific approval by the Court and a finding that it shall operate as full satisfaction of any and all claims by the parties within Main San Gabriel Basin against Puente Basin parties by reason of historic surface and subsurface flow.

IN WITNESS WHEREOF the parties hereto have caused this Agreement to be executed as of the day and date first above written.

Approved as to form:
CLAYSON, STARK, ROTHROCK & MANN

By ______________________
Attorneys for Puente Agency

PUENTE BASIN AGENCY

By ______________________
EDMUND M. BIEDERMAN
President

Approved as to form:

By ______________________
Attorney for Upper District

UPPER SAN GABRIEL VALLEY MUNICIPAL WATER DISTRICT

By ______________________
Howard H. Hawkins
President

The foregoing agreement is approved and accepted, and the same is acknowledged as the joint and several obligation of the undersigned.

Approved as to form:

____
Attorney for Walnut District

WALNUT VALLEY WATER DISTRICT

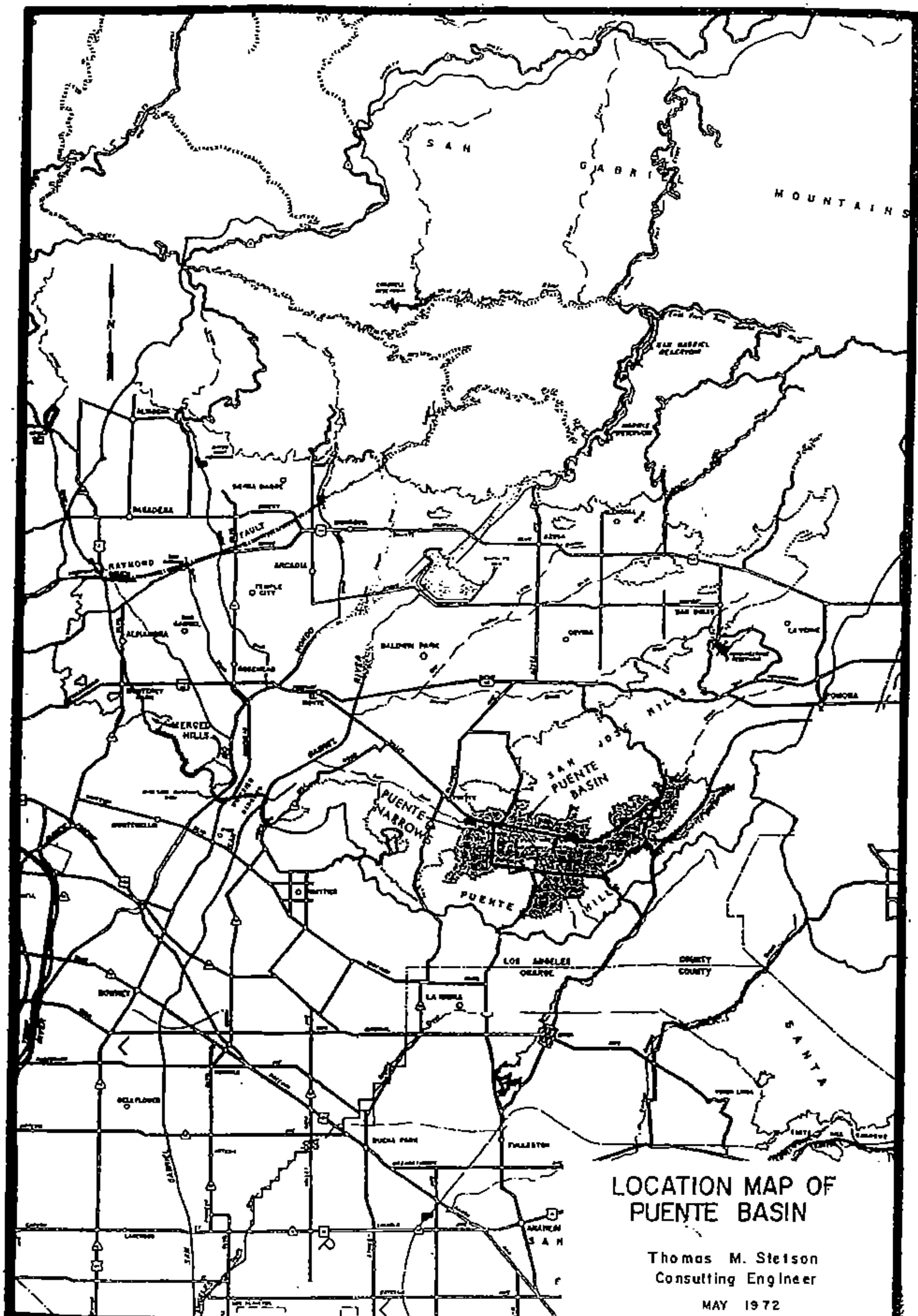
By ______________________
J. P. BOURDET
Vice President

Approved as to form:

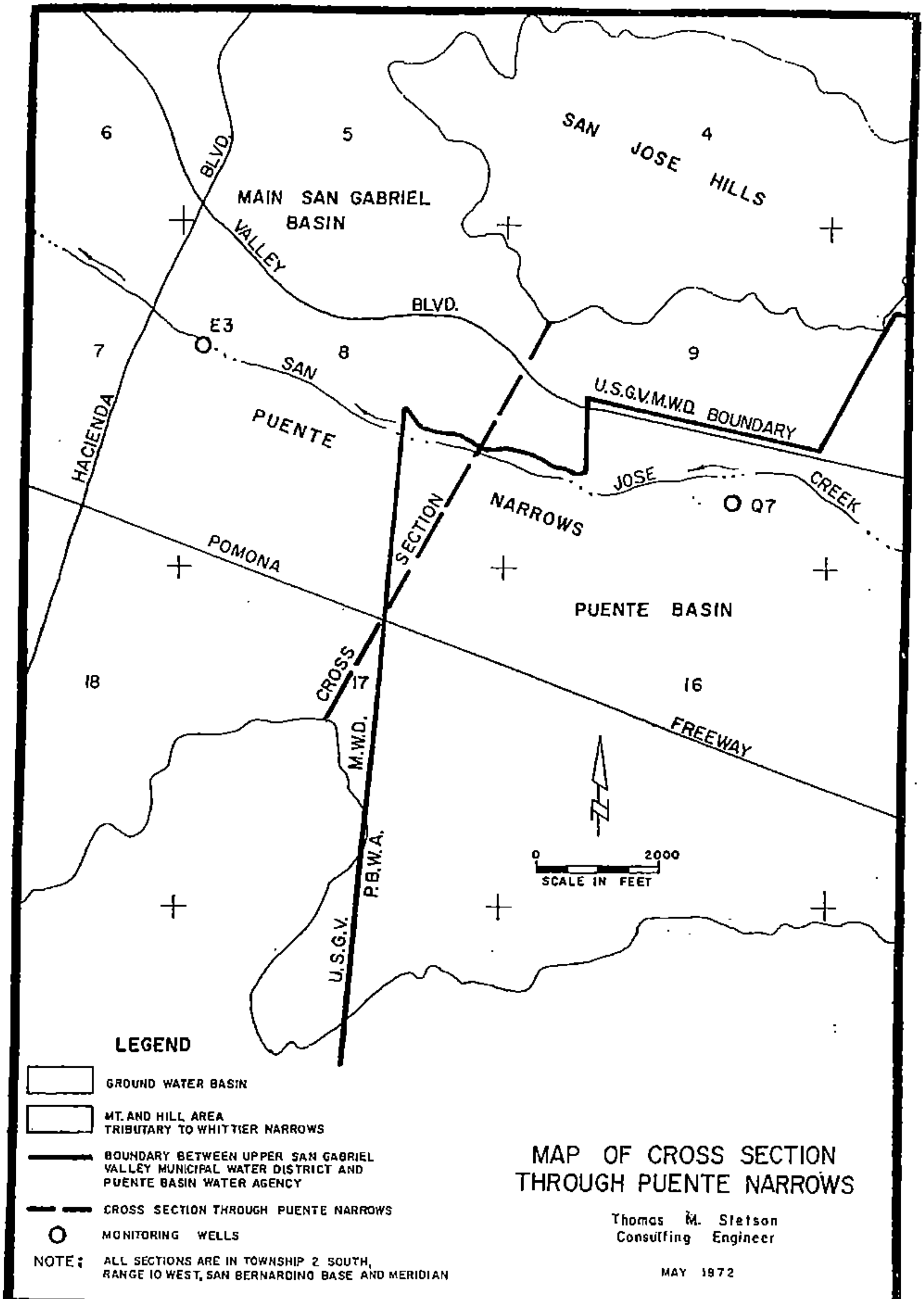
____
Attorneys for Rowland District

ROWLAND AREA COUNTY WATER DISTRICT

By ______________________
President
Wm. A. Simmons



APPENDIX "A"
EXHIBIT "J"



APPENDIX "B"
EXHIBIT "J"

ENGINEERING CRITERIA

APPENDIX "C"

1. Monitoring Wells. The wells designated as State Wells No. 2S/10W-9Q7 and 2S/10W-8E3 and Los Angeles County Flood Control District Nos. 3079M and 3048B, respectively, shall be used to measure applicable ground water elevations. In the event either monitoring well should fail or become unrepresentative, a substitute well shall be selected or drilled by Watermaster. The cost of drilling a replacement well shall be the obligation of the Puente Agency.

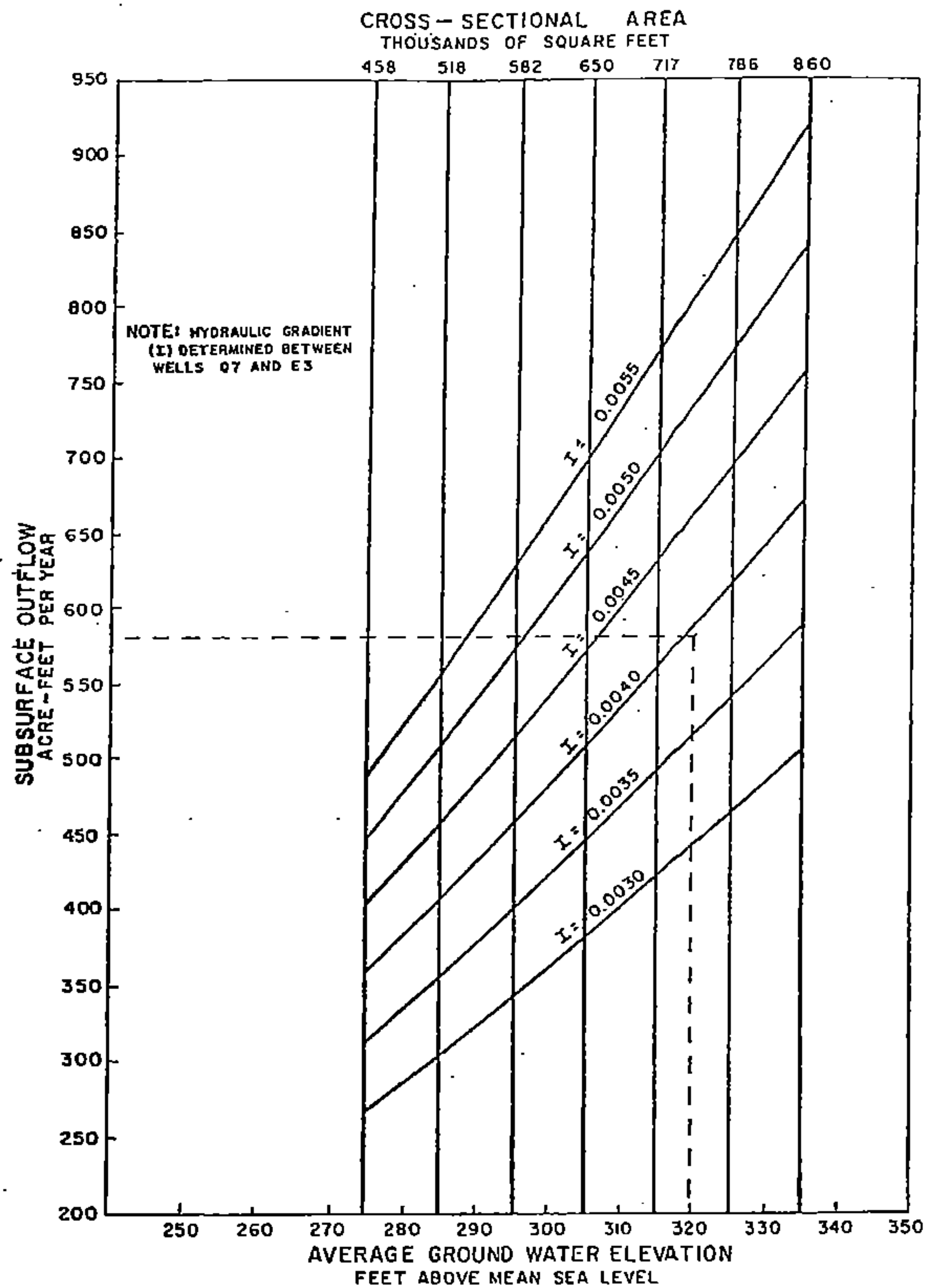
2. Measurement. Each monitoring well shall be measured and the ground water elevation determined semi-annually on or about April 1 and October 1 of each year. Prior to each measurement, the pump shall be turned off for a sufficient period to insure that the water table has recovered to a static or near equilibrium condition.

3. Hydraulic Gradient. The hydraulic gradient, or slope of the water surface through Puente Narrows, shall be calculated between the monitoring wells as the difference in water surface elevation divided by the distance, approximately 9,000 feet, between the wells. The hydraulic gradient shall be determined for the spring and fall and the average hydraulic gradient calculated for the year.

4. Ground Water Elevation at Puente Narrows Cross Section. The ground water elevation at the Puente Narrows

cross section midway between the monitoring wells shall be the average of the ground water elevation at the two wells. This shall be determined for the spring and fall and the average annual ground water elevation calculated for the year.

5. <u>Determination of Underflow</u>. The chart attached is a photo-reduction of a full scale chart on file with the Watermaster. By applying the appropriate average annual hydraulic gradient (I) to the average annual ground water elevation at the Puente Narrows cross section (involving the appropriate cross-sectional area [A]), it is possible to read on the vertical scale the annual acre feet of underflow.



RELATIONSHIP OF AVERAGE GROUND WATER ELEVATION AT PUENTE NARROWS AND APPLICABLE CROSS-SECTIONAL AREA WITH SUBSURFACE OUTFLOW THROUGH PUENTE NARROWS FOR VARIOUS HYDRAULIC GRADIENTS

Thomas M. Stetson
Consulting Engineer
MAY 1972

EXHIBIT "K"

OVERLYING RIGHTS

I. NATURE OF OVERLYING RIGHT

An "Overlying Right" is the right to Produce water from the Main San Gabriel Basin for use on the overlying lands hereinafter described. Such rights are exercisable without quantitative limit only on said overlying land and cannot be separately conveyed or transferred apart therefrom. The exerciser of such right is assessable by Watermaster as provided in Paragraph 21 of the Amended Judgment herein (prior Paragraph 14.5 of the Judgment herein) and is subject to the other provisions of said Paragraph.

II. OVERLYING LANDS (Description)

The overlying lands to which Overlying Rights are appurtenant are described as follows:

"Those portions of Lots 1 and 2 of the lands formerly owned by W.A. Church, in the Rancho San Francisquito, in the City of Irwindale, County of Los Angeles, State of California, as shown on recorder's filed map No. 509, in the office of the County Recorder of said County, lying northeasterly of the northeasterly line and its southeasterly prolongation of Tract 1888, as shown on map recorded in Book 21 page 183 of Maps, in the office of the County Recorder of said County.

"EXCEPT the portions thereof lying northerly and northwesterly of the center line of Arrow Highway described 'Sixth' and the center line of Live Oak Avenue described 'Third' in a final decree of condemnation, a certified copy of which was recorded August 18, 1933 as Instrument No. 354, in Book 12289, Page 277, Official Records.

"ALSO EXCEPT that portion of said land described in the final decree of condemnation entered in Los Angeles County Superior Court Case No. 805008, a certified copy of which was recorded September 21, 1964, as Instrument No. 3730, in Book D-2634, Page 648, Official Records."

III. PRODUCERS ENTITLED TO EXERCISE OVERLYING RIGHTS AND THEIR RESPECTIVE CONSUMPTIVE USE PORTIONS

The persons entitled to exercise Overlying Rights are both the owners of Overlying Rights and persons and entities licensed by such owners to exercise such Overlying Rights. The persons entitled to exercise Overlying Rights and their respective Consumptive Use portions are as follows:

OWNER PRODUCERS	CONSUMPTIVE USE PORTION
BROOKS GIFFORD, SR. BROOKS GIFFORD, JR. PAUL MNOIAN JOHN MGRDICHIAN J. EARL GARRETT	3.5 acre-feet per year
Present User: Nu-Way Industries	
PRODUCERS UNDER LICENSE	
A. WILLIAM C. THOMAS and EVELYN F. THOMAS, husband and wife, and MALCOLM K. GATHERER and JACQUELINE GATHERER, husband and wife, doing business by and through B & B REDI-I-MIX CONCRETE, INC., a corporation	45.6 acre-feet per year
B. PRE-STRESS CRANE RIGGING & TRUCK CO., INC., a corporation	1.0 acre-foot per year
Present Users: Pre-Stress Crane Rigging & Truck Co., Inc., a corporation	
Total	50.1 acre-feet per year

IV. ANNUAL GROSS AMOUNT OF PRODUCTION FROM WHICH CONSUMPTIVE USE PORTIONS WERE DERIVED

183.65 acre-feet

Exhibit "L"

LIST OF PRODUCERS AND THEIR DESIGNEES
June, 1989

Producer Name	Designee
A	
Adams Ranch Mutual Water Company	Goji Iwakiri
Alhambra, City of	T. E. Shollenberger
Amarillo Mutual Water Company	Ester Guadagnolo
Anderson, Ray	Ray Anderson
Andrade, Macario, et al.	Macario R. Andrade
Arcadia, City of	Eldon Davidson
AZ-Two, Inc.	R. S. Chamberlain
Azusa, City of	William H. Redcay
Azusa Ag. Water Company	Robert E. Talley
Azusa Valley Water Company	Edward Heck
B	
Baldwin Park County Water District (See Valley County Water District)	-
Banks, Gale C.	Gale C. Banks
Base Line Water Company	Everett W. Hughes, Jr.
Beverly Acres Mutual Water User's Assn. (Formerly Beverly Acres Mutual Water Co.)	Eloise A. Moore
Burbank Development Company	Darrell A. Wright
C	
Cadway, Inc.	P. Geoffrey Nunn
California-American Water Company (San Marino System)	Andrew A. Krueger
California-American Water Company (Duarte System)	Andrew A. Krueger
California Country Club	Henri F. Pellissier
California Domestic Water Company	P. Geoffrey Nunn
Cedar Avenue Mutual Water Company	Austin L. Knapp

Producer Name	Designee
Champion Mutual Water Company	Margaret Bauwens
Chevron, USA, Inc.	Ms. Margo Bart
Clayton Manufacturing Company	Don Jones
Conrock Company	Gene R.Block
Corcoran Brothers	Ray Corcoran
County Sanitation District No. 18	Charles W. Curry
Covell, et al.	Darr Jobe
Covell, Ralph	Ralph Covell
Covina, City of	Wayne B. Dowdey
Covina Irrigating Company	William R. Temple
Crevolin, A. J.	A. J. Crevolin
Crown City Plating Company	N. G. Gardner
D	
Davidson Optronics, Inc.	James McBride
Dawes, Mary Kay	Mary Kay Dawes
Del Rio Mutual Water Company	Gonzalo Galindo
Driftwood Dairy	James E. Dolan
Dunning, George	George Dunning
E	
East Pasadena Water Company	Robert D. Mraz
El Monte, City of	Robert J. Pinniger
El Monte Cemetery Association	Linn E. Magoffin
F	
Faix, Ltd.	Henri F. Pellissier
G	
Glendora, City of	Arthur E. Cook
Green, Walter	Dr. Walter Green
H	
Hansen, Alice	Alice Hansen

Producer Name	Designee
Hartley, David	David Hartley
Hemlock Mutual Water Company	Bud Selander
Hunter, Lloyd F.	Lloyd F. Hunter
I	
Industry Waterworks System, City of	Mary L. Jaureguy
K	
Kiyan Farm Kiyan, Hideo	Mrs. Hideo Kiyan
Kirklen Family Trust	Dawn Kirklen
Knight, Kathryn M.	William J. Knight
L	
Landeros, John	John Landeros
La Puente Valley County Water District	Mary L. Jaureguy
La Verne, City of	N. Kathleen Hamm
Livingston-Graham	Gary O. Tompkins
Los Angeles, County of	Robert L. Larson
Loucks, David	David Loucks
M	
Maddock, A. G.	Ranney Draper, Esq.
Maechtlen, Trust of J. J.	Jack F. Maechtlen
Maple Water Company, Inc.	Charles King
Martinez, Francis Mercy	Francis Mercy Martinez
Metropolitan Water District of Southern California	Fred Vendig, Esq.
Miller Brewing Company	Dennis B. Puffer
Mnoian, Paul, et al.	Mal Gatherer
Monrovia, City of	Robert K. Sandwick
Monrovia Nursery	Miles R. Rosedale
Monterey Park, City of	Nels Palm

Producer Name	Designee
N	
Nick Tomovich & Sons	Nick Tomovich
O	
Owl Rock Products Company	Peter L. Chiu
P	
Phillips, Alice B., et al.	Jack F. Maechtlen
Pico County Water District	Robert P. Fuller
Polopolus, et al.	Christine Chronis
R	
Rados Brothers	Alexander S. Rados
Richwood Mutual Water Company	Bonnie Pool
Rincon Ditch Company	K. E. Nungesser
Rincon Irrigation Company	K. E. Nungesser
Rose Hills Memorial Park Association	Allan D. Smith
Rosemead Development, Ltd.	John W. Lloyd
Rurban Homes Mutual Water Company	George W. Bucey
Ruth, Roy	Roy Ruth
S	
San Dimas - La Verne Recreational Facilities Authority	R. F. Griszka
San Gabriel Country Club	Fran Wolfe
San Gabriel County Water District	Philip G. Crocker
San Gabriel Valley Municipal Water District	Bob Stallings
San Gabriel Valley Water Company	Robert H. Nicholson, Jr.
Sloan Ranches	Larry R. Sloan
Sonoco Products Company	Elaine Corboy
South Covina Water Service	Anton C. Garnier
Southern California Edison Company	S. R. Shermoen

Producer Name	Designee
Southern California Water Company -San Dimas District	J. F. Young
Southern California Water Company -San Gabriel Valley District	J. F. Young
South Pasadena, City of	John Bernardi
Southwestern Portland Cement Company	Dale W. Heineck
Standard Oil Company of California	John A. Wild
Sterling Mutual Water Company	Bennie L. Prowett
Suburban Water Systems	Anton C. Garnier
Sully-Miller Contracting Company	R. R. Munro
Sunny Slope Water Company	Michael J. Hart
T	
Taylor Herb Garden	Paul S. Taylor
Texaco, Inc.	E. O. Wakefield
Tyler Nursery	James K. Mitsumori, Esq.
U	
United Concrete Pipe Corporation	Doyle H. Wadley
United Rock Products Corporation	William S. Capps, Esq.
V	
Valencia Heights Water Company	Herman Weskamp
Valley County Water District (Formerly Baldwin Park County Water District)	Stanley D. Yarbrough
Valley View Mutual Water Company	Robert T. Navarre
Via, H., Trust of	Marverna Parton
W	
Ward Duck Company	Richard J. Woodland
W. E. Hall Company	Thomas S. Bunn, Jr., Esq.
White, June G., Trustee	June G. Lovelady
Whittier, City of	Neil Hudson
Wilmott, Erma M.	Erma M. Wilmott

Exhibit "M"

WATERMASTER MEMBERS

FOR CALENDAR YEAR 1973

ROBERT T. BALCH (Producer Member), Chairman

LINN E. MAGOFFIN (Producer Member), Vice Chairman

RICHARD L. ROWLAND (Producer Member), Secretary

BOYD KERN (Public Member), Treasurer

WALKER HANNON (Producer Member)

HOWARD H. HAWKINS (Public Member)

M. E. MOSLEY (Producer Member)

CONRAD T. REIBOLD (Public Member)

HARRY C. WILLS (Producer Member)

STAFF

Carl Fossette, Assistant Secretary-Assistant Treasurer
Ralph B. Helm, Attorney
Thomas M. Stetson, Engineer

FOR CALENDAR YEAR 1974

ROBERT T. BALCH (Producer Member), Chairman

LINN E. MAGOFFIN (Producer Member), Vice Chairman

RICHARD L. ROWLAND (Producer Member), Secretary

BOYD KERN (Public Member), Treasurer

WALKER HANNON (Producer Member)

BURTON E. JONES (Public Member)

M. E. MOSLEY (Producer Member)

CONRAD T. REIBOLD (Public Member)

HARRY C. WILLS (Producer Member)

STAFF

Carl Fossette, Assistant Secretary-Assistant Treasurer
Ralph B. Helm, Attorney
Thomas M. Stetson, Engineer

FOR CALENDAR YEAR 1975

ROBERT T. BALCH (Producer Member), Chairman

LINN E. MAGOFFIN (Producer Member), Vice Chairman

HARRY C. WILLS (Producer Member), Secretary

BOYD KERN (Public Member), Treasurer

WALKER HANNON (Producer Member)

BURTON E. JONES (Public Member)

D. J. LAUGHLIN (Producer Member)

M. E. MOSLEY (Producer Member)

CONRAD T. REIBOLD (Public Member)

STAFF

Carl Fossette, Assistant Secretary-Assistant Treasurer
Ralph B. Helm, Attorney
Thomas M. Stetson, Engineer

FOR CALENDAR YEAR 1976

ROBERT T. BALCH (Producer Member), Chairman

LINN E. MAGOFFIN (Producer Member), Vice Chairman

HARRY C. WILLS (Producer Member), Secretary

BOYD KERN (Public Member), Treasurer

WALKER HANNON (Producer Member)

BURTON E. JONES (Public Member)

D. J. LAUGHLIN (Producer Member)

M. E. MOSLEY (Producer Member)

CONRAD T. REIBOLD (Public Member)

STAFF

Jane M. Bray, Assistant Secretary-Assistant Treasurer
Ralph B. Helm, Attorney
Thomas M. Stetson, Engineer

FOR CALENDAR YEAR 1977

ROBERT T. BALCH (Producer Member), Chairman

LINN E. MAGOFFIN (Producer Member), Vice Chairman

HARRY C. WILLS (Producer Member), Secretary

CONRAD T. REIBOLD (Public Member), Treasurer

WALKER HANNON (Producer Member)

BURTON E. JONES (Public Member)

BOYD KERN (Public Member)

D. J. LAUGHLIN (Producer Member)

R. H. NICHOLSON, JR. (Producer Member)

STAFF

Jane M. Bray, Assistant Secretary-Assistant Treasurer)
Ralph B. Helm, Attorney
Thomas M. Stetson, Engineer

FOR CALENDAR YEAR 1978

ROBERT T. BALCH (Producer Member), Chairman

LINN E. MAGOFFIN (Producer Member), Vice Chairman

D. J. LAUGHLIN (Producer Member), Secretary

CONRAD T. REIBOLD (Public Member), Treasurer

WALKER HANNON (Producer Member)

BURTON E. JONES (Public Member)

L. E. MOELLER (Producer Member)

R. H. NICHOLSON, JR. (Producer Member)

WILLIAM M. WHITESIDE (Public Member)

STAFF

Jane M. Bray, Assistant Secrretary-Assistant Treasurer
Ralph B. Helm, Attorney
Thomas M. Stetson, Engineer

FOR CALENDAR YEAR 1979

LINN E. MAGOFFIN (Producer Member), Chairman

D. J. LAUGHLIN (Producer Member), Vice Chairman

R. H. NICHOLSON, JR. (Producer Member), Secretary

CONRAD T. REIBOLD (Public Member), Treasurer

WALKER HANNON (Producer Member)

BURTON E. JONES (Public Member)

L. E. MOELLER (Producer Member)

WILLIAM M. WHITESIDE (Public Member)

STAFF

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Ralph B. Helm, Attorney
Thomas M. Stetson, Engineer

FOR CALENDAR YEAR 1980

LINN E. MAGOFFIN (Producer Member), Chairman

R. H. NICHOLSON, JR. (Producer Member), Vice Chairman

WILLIAM M. WHITESIDE (Pulic Member), Secretary

CONRAD T. REIBOLD (Public Member), Treasurer

ROBERT T. BALCH (Producer Member)

ROBERT G. BERLIEN (Producer Member)

ANTON C. GARNIER (Producer Member)

TRAVIS L. MANNING (Public Member)

L. E. MOELLER (Producer Member)

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Ralph B. Helm, Attorney
Thomas M. Stetson. Engineer

FOR CALENDAR YEAR 1981

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CONRAD T. REIBOLD (Public Member), Treasurer

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ANTON C. GARNIER (Producer Member)

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L. E. MOELLER (Producer Member)

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Ralph B. Helm, Attorney
Thomas M. Stetson, Engineer

FOR CALENDAR YEAR 1982

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WILLIAM M. WHITESIDE (Public Member), Secretary

CONRAD T. REIBOLD (Public Member), Treasurer

ROBERT T. BALCH (Producer Member)

ROBERT G. BERLIEN (Producer Member)

ANTON C. GARNIER (Producer Member)

L. E. MOELLER (Producer Member)

ALFRED F. WITTIG (Public Member)

STAFF

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Ralph B. Helm, Attorney
Thomas M. Stetson, Engineer

FOR CALENDAR YEAR 1983

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ROBERT G. BERLIEN (Producer Member), Secretary

CONRAD T. REIBOLD (Public Member), Treasurer

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Ralph B. Helm, Attorney
Thomas M. Stetson, Engineer

FOR CALENDAR YEAR 1984

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R. H. NICHOLSON, JR. (Producer Member), Vice Chairman

ROBERT G. BERLIEN (Producer Member), Secretary

CONRAD T. REIBOLD (Public Member), Treasurer

ROBERT T. BALCH (Producer Member)

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ANTON C. GARNIER (Producer Member)

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ALFRED R. WITTIG (Public Member)

STAFF

Jane M. Bray, Assistant Secretary-Assistant Treasurer
Ralph B. Helm, Attorney
Thomas M. Stetson, Engineer

FOR CALENDAR YEAR 1985

LINN E. MAGOFFIN (Producer Member), Chairman

R. H. NICHOLSON, JR. (Producer Member), Vice Chairman

ROBERT G. BERLIEN (Producer Member), Secretary

CONRAD T. REIBOLD (Public Member), Treasurer

ROBERT T. BALCH (Producr Member)

DONALD F. CLARK (Public Member)

ANTON C. GARNIER (Producer Member)

L. E. MOELLER (Producer Member)

ALFRED R. WITTIG (Public Member)

STAFF

Jane M. Bray, Assistant Secretary-Assistant Treasurer
Ralph B. Helm, Attorney
Thomas M. Stetson, Engineer

FOR CALENDAR YEAR 1986

LINN E. MAGOFFIN (Producer Member), Chairman

R. H. NICHOLSON, JR. (Producer Member), Vice Chairman

ROBERT G. BERLIEN (Producer Member), Secretary

CONRAD T. REIBOLD (Public Member), Treasurer

ROBERT T. BALCH (Producer Member)

DONALD F. CLARK (Public Member)

L. E. MOELLER (Producer Member)

REGINOLD A. STONE (Producer Member)

ALFRED R. WITTIG (Public Member)

STAFF

Jane M. Bray, Assistant Secretary-Assistant Treasurer
Ralph B. Helm, Attorney
Thomas M. Stetson, Engineer

FOR CALENDAR YEAR 1987

LINN E. MAGOFFIN (Producer Member), Chairman

REGINALD A. STONE (Producer Member), Vice Chairman

L. E. MOELLER (Producer Member), Secretary

ALFRED R. WITTIG (Public Member), Treasurer

ROBERT T. BALCH (Producer Member)

GERALD J. BLACK (Producer Member)

DONALD F. CLARK (Public Member)

EDWARD R. HECK (Producer Member)

JOHN E. MAULDING (Public Member)

STAFF

Robert G. Berlien, Assistant Secretary-Assistant Treasurer
Ralph B. Helm, Attorney
Thomas M. Stetson, Engineer

FOR CALENDAR YEAR 1988

LINN E. MAGOFFIN (Producer Member), Chairman

REGINALD A. STONE (Producer Member), Vice Chairman

L. E. MOELLER (Producer Member), Secretary

ALFRED R. WITTIG (Public Member), Treasurer

ROBERT T. BALCH (Producer Member)

GERALD J. BLACK (Producer Member)

DONALD F. CLARK (Public Member)

EDWARD R. HECK (Producer Member)

JOHN E. MAULDING (Public Member)

STAFF

Robert G. Berlien, Assistant Secretary-Assistant Treasurer
Ralph B. Helm, Attorney
Thomas M. Stetson, Engineer

FOR CALENDAR YEAR 1989

LINN E. MAGOFFIN (Producer Member), Chairman

REGINALD A. STONE (Producer Member), Vice Chairman

GERALD G. BLACK (Producer Member), Secretary

ALFRED R. WITTIG (Public Member), Treasurer

ROBERT T. BALCH (Producer Member) *

DONALD F. CLARK (Public Member)

EDWARD R. HECK (Producer Member)

BURTON E. JONES (Public Member)

NELS PALM (Producer Member) **

THOMAS E. SCHOLLENBERGER (Producer Member)

STAFF

Robert G. Berlien, Assistant Secretary-Assistant Treasurer
Ralph B. Helm, Attorney
Thomas M. Stetson, Engineer

* DECEASED APRIL 25, 1989

** Appointed August 24, 1989, for the balance of the calendar year term, to replace deceased member, Robert T. Balch.

Ralph B. Helm - Bar No. 022004
4605 Lankershim Boulevard, #214
North Hollywood, CA 91602

Telephone (818) 769-2002

Attorney for Watermaster - Petitioner

SUPERIOR COURT OF CALIFORNIA, COUNTY OF LOS ANGELES

UPPER SAN GABRIEL VALLEY MUNICIPAL WATER DISTRICT, Plaintiff, vs. CITY OF ALHAMBRA, et al., Defendants.	No. 924129 ORDER AMENDING JUDGMENT TO EXPAND WATERMASTER'S POWERS TO INCLUDE MAINTENANCE, IMPROVEMENT, AND CONTROL OF BASIN WATER QUALITY WITH ALLOWABLE FUNDING THROUGH IN-LIEU ASSESSMENTS Hearing: August 7, 1990 Department 38, 9:15 A. M.

The Petition of the Main San Gabriel Basin Watermaster (Watermaster) for Amendment to Judgment herein to expand its powers to include maintenance, improvement, and control of Basin water quality by controlling pumping in the Basin, with allowable funding for associated costs to be paid through its In-Lieu Assessments, was continued on July 31, 1990, to August 7, 1990, when it duly and regularly came on for hearing, at 9:15 o'clock A. M. in Department 38 of the above entitled Court, the Honorable FLORENCE T. PICKARD, Assigned Judge Presiding. Ralph B. Helm appeared as Attorney for Watermaster - Petitioner; Wayne K. Lemieux appeared for Defendant, San Gabriel Valley Municipal Water District, in support of the Petition; Fred Vendig, General

Counsel, Karen L. Tachiki, Assistant General Counsel, and Victor E. Gleason, Senior Deputy General Counsel, by Victor E. Gleason, appeared for Defendant, The Metropolitan Water District of Southern California, in support of the Petition; Timothy J. Ryan appeared for Defendant, San Gabriel Valley Water Company, in opposition to the Petition; Lagerlof, Senecal, Drescher & Swift, by H. Jess Senecal, appeared for Defendants, Calmat Company, Livingston-Graham, Owl Rock Products, AZ-Two, Inc., and Sully-Miller Contracting Company, in opposition to the Petition; Ira Reiner, Los Angeles County District Attorney, by Jan Chatten-Brown, Special Assistant to the District Attorney, appeared in opposition to the Petition; and Sarah F. Bates and Laurens H. Silver, by Sarah F. Bates, appeared on behalf of Amicus Curiae Sierra Club, in opposition to the Petition.

The Court acknowledged receipt and consideration of: letters in support of the Petition by the California Regional Water Quality Control Board - Los Angeles Region and by the State Water Resources Control Board; a copy of a letter addressed to the Attorney for Petitioner, from the US Environmental Protection Agency - Region IX, by Mark J. Klaiman, Assistant Regional Counsel, regarding several matters of federal law which EPA believed might ultimately affect the subject Petition; a letter in opposition to the Petition by East Valleys Organization; and a FAX communication to the Court, in opposition to the Petition, from Congressman Esteban E. Torres, which was not communicated to nor seen by the parties.

Members of the public, present in Court, were invited to, and did, present oral testimony during the hearing.

Under date of December 10, 1990 the Court entered its Intended Decision Re Amendment To Judgment and, by minute order duly entered and mailed to Counsel for Petitioner, ordered copies thereof mailed forthwith to all appearing parties, including those appearing as friends of the court, and to all other affected parties on the case's current mailing list.

A Proof Of Service by mail on December 13, 1990, Of Intended Decision Re Amendment To Judgment, as ordered, has been filed with the Court.

Opposition to Petitioner's Proposed Order were filed by Amicus Curiae Sierra Club, Amicus Curiae Los Angeles District Attorney, and by Producer Parties Calmat Co., Livingston-Graham, Owl Rock Products Company, AZ-Two, Inc., and Sully-Miller Contracting Company.

Proof being made to the satisfaction of the Court and good cause appearing:

IT IS, HEREBY, ORDERED:

1. That the Amended Judgment herein be further amended by amending Subsection (j) of Section 10 thereof, Definitions, and Section 40 thereof, Division F, Physical Solution, to read as follows:

"10 (j) <u>In-Lieu Water Cost</u> - - The differential between a particular Producer's cost of Watermaster directed produced, treated, blended, substituted, or Supplemental Water delivered or substituted to, for, or taken by, such Producer in-lieu of his cost of otherwise normally Producing a like amount of Ground Water from the Basin.

"40. <u>Watermaster Control.</u> (Prior Judgment Section 32)

In order to develop an adequate and effective program of Basin management, it is essential that Watermaster have broad discretion in the making of Basin management decisions within the ambit hereinafter set forth. The maintenance, improvement, and control of the water quality and quantity of the Basin, withdrawal and replenishment of supplies of the Basin and Relevant Watershed, and the utilization of the water resources thereof, must be subject to procedures established by Watermaster in implementation of the Physical Solution provisions of this Judgment. Both the quantity and quality of said water resource are thereby preserved and its beneficial utilization maximized.

"(a) Watermaster shall develop an adequate and effective program of Basin management. The maintenance, improvement, and control of the water quality and quantity of the Basin, withdrawal and replenishment of supplies of the Basin and Relevant Watershed, and the utilization of the water resources thereof, must be subject to procedures established by Watermaster in implementation of the Physical Solution provisions of this Judgment. All Watermaster programs and procedures shall be adopted only after a duly noticed public hearing pursuant to Sections 37 and 40 of the Amended Judgment herein.

"(b) Watermaster shall have the power to control pumping in the Basin by water Producers therein for Basin cleanup and water quality control so that specific well production can be directed as to a lesser amount, to total cessation, as to an increased amount, and even to require pumping in a new location in the

Basin. Watermaster's right to regulate pumping activities of Producers shall be subordinate to any conflicting Basin cleanup plan established by the EPA or other public governmental agency with responsibility for ground water management or clean up.

"(c) Watermaster may act individually or participate with others to carry on technical and other necessary investigations of all kinds and collect data necessary to carry out the herein stated purposes. It may engage in contractual relations with the EPA or other agencies in furtherance of the clean up of the Basin and enter into contracts with agencies of the United States, the State of California, or any political subdivision, municipality, or district thereof, to the extent allowed under applicable federal or state statutes. Any cooperative agreement between the Watermaster and EPA shall require the approval of the appropriate Agency(s) of the State of California.

"(d) For regulation and control of pumping activity in the Basin, Watermaster shall adopt Rules and Regulations and programs to promote, manage and accomplish clean up of the Basin and its waters, including, but not limited to, measures to confine, move, and remove contaminants and pollutants. Such Rules and Regulations and programs shall be adopted only after a duly Noticed Public Hearing by Watermaster and shall be subject to Court review pursuant to Section 37 of the Amended Judgment herein.

"(e) Watermaster shall determine whether funds from local, regional, state or federal agencies are available for regulating pumping and the various costs associated with, or arising from such activities. If no public funds are available from local, regional, state, or federal agencies, the costs shall be obtained and paid by way of an In-Lieu Assessment by Watermaster pursuant to Section 10 (j) of the Amended Judgment herein. Provided such In-Lieu Assessments become necessary, the costs shall be borne by all Basin Producers.

"(f) Watermaster is a Court empowered entity with limited powers, created pursuant to the Court's Physical Solution Jurisdiction under Article X, Section 2 of the California Constitution. None of the Powers granted herein to Watermaster shall be construed as designating Watermaster a political subdivision of the State of California or authorizing Watermaster to act as 'lead agency' to administer the federal Superfund for clean up of the Basin."

2. This Amended Judgment shall continue in full force and effect as hereby Ordered and Amended.

Dated: January 29, 1991.

/s/Florence T. Pickard
FLORENCE T. PICKARD
Judge of the Superior Court,
Specially Assigned

Appendix G

Summary of Population Based on Census Data

Appendix G-1: Census Tracts within the South San Gabriel System

County	Subregion	City	Census Tract	Percentage of Tract in System
Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	433602	4%
Los Angeles	San Gabriel Valley Assoc. of Cities	San Gabriel city	481401	4%
Los Angeles	San Gabriel Valley Assoc. of Cities	San Gabriel city	482301	61%
Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	482303	88%
Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	482304	100%
Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	482401	25%
Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	482402	60%
Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	482502	100%
Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	482503	100%
Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	482521	100%
Los Angeles	San Gabriel Valley Assoc. of Cities	Unincorporated	482521	45%
Los Angeles	San Gabriel Valley Assoc. of Cities	Monterey Park city	482600	4%

Table G-2: Population, Household and Employment Projections for South San Gabriel System

Census Tract	County	Subregion	City	Population 2005	2010	2015	2020	2025	2030	2035	Percentage of Tract in System
433602	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	2,992	3,064	3,109	3,159	3,206	3,252	3,296	4%
481401	Los Angeles	San Gabriel Valley Assoc. of Cities	San Gabriel city	6,382	6,411	6,649	6,782	6,932	7,076	7,221	4%
482301	Los Angeles	San Gabriel Valley Assoc. of Cities	San Gabriel city	5,525	5,560	5,850	6,016	6,204	6,385	6,565	61%
482303	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	6,141	6,276	6,361	6,456	6,547	6,634	6,718	88%
482304	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	4,142	4,232	4,289	4,352	4,413	4,473	4,530	100%
482401	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	4,178	4,278	4,342	4,411	4,477	4,540	4,601	25%
482402	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	5,519	5,637	5,713	5,796	5,876	5,953	6,026	60%
482502	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	3,638	3,713	3,761	3,816	3,868	3,919	3,967	100%
482503	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	4,603	4,697	4,757	4,824	4,889	4,952	5,012	100%
482521	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	122	127	132	137	142	146	150	100%
482521	Los Angeles	San Gabriel Valley Assoc. of Cities	Unincorporated	6,064	6,475	6,944	7,412	7,864	8,303	8,723	45%
482600	Los Angeles	San Gabriel Valley Assoc. of Cities	Monterey Park city	7,202	7,684	8,127	8,517	8,872	9,186	9,504	4%
Total Population Based on SCAG				29,021	29,729	30,452	31,127	31,795	32,439	33,060	
SCAG Growth Rate						2%	2%	2%	2%	2%	

Census Tract	County	Subregion	City	Households 2005	2010	2015	2020	2025	2030	2035	Percentage of Tract in System
433602	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	724	746	765	786	802	818	831	0%
481401	Los Angeles	San Gabriel Valley Assoc. of Cities	San Gabriel city	1,877	1,886	1,989	2,055	2,107	2,157	2,196	0%
482301	Los Angeles	San Gabriel Valley Assoc. of Cities	San Gabriel city	1,333	1,340	1,422	1,476	1,518	1,558	1,590	0%
482303	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	1,473	1,517	1,559	1,603	1,638	1,671	1,699	0%
482304	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	1,006	1,030	1,053	1,077	1,096	1,114	1,129	0%
482401	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	947	974	999	1,026	1,046	1,066	1,083	0%
482402	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	1,488	1,531	1,571	1,614	1,647	1,680	1,706	0%
482502	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	830	850	868	887	903	917	930	0%
482503	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	1,028	1,053	1,076	1,100	1,119	1,138	1,153	0%
482521	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	11	11	11	11	12	12	12	0%
482521	Los Angeles	San Gabriel Valley Assoc. of Cities	Unincorporated	1,486	1,588	1,723	1,865	1,976	2,084	2,172	0%
482600	Los Angeles	San Gabriel Valley Assoc. of Cities	Monterey Park city	2,283	2,325	2,392	2,429	2,455	2,484	2,504	0%
Total Population Based on SCAG				6,976	7,169	7,419	7,659	7,849	8,031	8,180	
SCAG Growth Rate						3%	3%	2%	2%	2%	

Census Tract	County	Subregion	City	Employment 2005	2010	2015	2020	2025	2030	2035	Percentage of Tract in System
433602	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	4,464	4,535	4,592	4,627	4,669	4,713	4,756	0%
481401	Los Angeles	San Gabriel Valley Assoc. of Cities	San Gabriel city	1,730	1,754	1,774	1,787	1,802	1,819	1,834	0%
482301	Los Angeles	San Gabriel Valley Assoc. of Cities	San Gabriel city	280	351	408	443	484	529	571	0%
482303	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	419	422	425	427	429	431	434	0%
482304	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	671	691	708	718	731	744	757	0%
482401	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	540	558	573	582	593	605	617	0%
482402	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	1,613	1,714	1,793	1,841	1,898	1,958	2,016	0%
482502	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	551	563	572	578	585	592	599	0%
482503	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	989	1,000	1,008	1,013	1,020	1,027	1,033	0%
482521	Los Angeles	San Gabriel Valley Assoc. of Cities	Rosemead city	295	312	325	334	345	357	368	0%
482521	Los Angeles	San Gabriel Valley Assoc. of Cities	Unincorporated	322	345	361	370	380	390	400	0%
482600	Los Angeles	San Gabriel Valley Assoc. of Cities	Monterey Park city	449	485	507	525	548	567	585	0%
Total Population Based on SCAG				4,559	4,745	4,892	4,983	5,092	5,207	5,318	
SCAG Growth Rate						3%	2%	2%	2%	2%	

Appendix H

Documentation of submittal to Library, Cities and Counties

September 1, 2011

City of Monterey Park
Ray Hamada
Planning Manager
320 West Newmark Avenue
Monterey Park, CA 91754

Dear: Ray Hamada

RE: Golden State Water Company- 2010 Urban Water Management Plan

Golden State Water Company (GSWC) adopted the 2010 Urban Water Management Plan (UWMP) following a public hearing on August 18, 2011. The 2010 UWMP was adopted in accordance with the Urban Water Management Planning Act and filed with DWR and the California Sate Library.

Pursuant to Section 10644(a) of the California Water Code, GSWC is required to file a copy of the adopted 2010 UWMP with any city or county within which GSWC provided water. Enclosed for your files is one copy of GSWC's adopted 2010 UWMP. It is also on our website at www.gswater.com.

If you have any questions you can contact me at (916) 853-3612.

Sincerely,
GOLDEN STATE WATER COMPANY

Ernest A. Gisler
Planning Manager

Enclosure

Golden State
Water Company
A Subsidiary of American States Water Company

September 1, 2011

City of Rosemead
Bradford Johnson
Planning Director
8838 Valley Boulevard
Rosemead, CA 91770

Dear: Bradford Johnson

RE: Golden State Water Company- 2010 Urban Water Management Plan

Golden State Water Company (GSWC) adopted the 2010 Urban Water Management Plan (UWMP) following a public hearing on August 18, 2011. The 2010 UWMP was adopted in accordance with the Urban Water Management Planning Act and filed with DWR and the California Sate Library.

Pursuant to Section 10644(a) of the California Water Code, GSWC is required to file a copy of the adopted 2010 UWMP with any city or county within which GSWC provided water. Enclosed for your files is one copy of GSWC's adopted 2010 UWMP. It is also on our website at www.gswater.com.

If you have any questions you can contact me at (916) 853-3612.

Sincerely,
GOLDEN STATE WATER COMPANY

Ernest A. Gisler
Planning Manager

Enclosure

Golden State
Water Company
A Subsidiary of American States Water Company

September 1, 2011

City of San Gabriel
Carol Banet
Planning Manager
425 South Mission Drive
San Gabriel, CA 91776

Dear: Carol Banet

RE: Golden State Water Company- 2010 Urban Water Management Plan

Golden State Water Company (GSWC) adopted the 2010 Urban Water Management Plan (UWMP) following a public hearing on August 18, 2011. The 2010 UWMP was adopted in accordance with the Urban Water Management Planning Act and filed with DWR and the California Sate Library.

Pursuant to Section 10644(a) of the California Water Code, GSWC is required to file a copy of the adopted 2010 UWMP with any city or county within which GSWC provided water. Enclosed for your files is one copy of GSWC's adopted 2010 UWMP. It is also on our website at www.gswater.com.

If you have any questions you can contact me at (916) 853-3612.

Sincerely,
GOLDEN STATE WATER COMPANY

Ernest A. Gisler
Planning Manager

Enclosure

Golden State
Water Company
A Subsidiary of American States Water Company

September 1, 2011

County of Los Angeles
Richard Brudckner
Director Department of Regional Planning
320 West Temple Street
Los Angeles, CA 90012

Dear: Richard Brudckner

RE: Golden State Water Company- 2010 Urban Water Management Plan

Golden State Water Company (GSWC) adopted the 2010 Urban Water Management Plan (UWMP) following a public hearing on August 18, 2011. The 2010 UWMP was adopted in accordance with the Urban Water Management Planning Act and filed with DWR and the California Sate Library.

Pursuant to Section 10644(a) of the California Water Code, GSWC is required to file a copy of the adopted 2010 UWMP with any city or county within which GSWC provided water. Enclosed for your files is one copy of GSWC's adopted 2010 UWMP. It is also on our website at www.gswater.com.

If you have any questions you can contact me at (916) 853-3612.

Sincerely,
GOLDEN STATE WATER COMPANY

Ernest A. Gisler
Planning Manager

Enclosure

Appendix I

Documentation of Water Use Projections Submittal

Golden State
Water Company
A Subsidiary of American States Water Company

11 February 2011

Mr. Steve Sherman
Field Operations Superintendent
Covina Irrigating Company
146 E College Street
Covina, CA 91723

Subject: Golden State Water Company - Claremont, San Dimas, South Arcadia, and South San Gabriel System
2010 Urban Water Management Plan Preparation Notification and Supply Reliability Information Request

Dear Mr. Sherman:

Golden State Water Company (GSWC) is currently preparing its 2010 Urban Water Management Plan (UWMP) for the Claremont, San Dimas, South Arcadia, and South San Gabriel System as required by the Urban Water Management Planning Act (Act). Since Covina Irrigating Company is a wholesale water supplier to GSWC, water use projections through 2035 are enclosed (Table 1) pursuant to §10631(k) of the Act. We would like to request confirmation of the anticipated water supply reliability, water supply sources, and other information as described below. This information may be provided by either (a) providing a copy of your Draft UWMP if all requested information is included or, (b) completing the enclosed tables and providing any additional documents as required.

1. Supply projections to 2035 (Table 2)
2. Single Dry Year Reliability to 2035 (Table 3)
3. Normal, single dry, and multiple dry year reliability (Table 4)
4. Basis of water year data (Table 5)
5. Factors resulting in inconsistency of supply (Table 6)
6. Assumptions used to determine retail agency supply projections, including conservation.
7. Recycled water projections to the Claremont, San Dimas, South Arcadia, and South San Gabriel service area (if applicable) (Table 7)
8. Describe any regional desalination opportunities, if any for the Claremont, San Dimas, South Arcadia, and South San Gabriel system (if applicable)

We appreciate your timely attention to the information requested above and ask you provide a response no later than **18 February 2011**. Kennedy/Jenks Consultants is assisting GSWC with preparation of the 2010 UWMP and will be contacting you directly within the next week to follow up on this request. In the meantime, should you have any questions or concerns please feel free to contact me at (916) 853-3612.

Very truly yours,

GOLDEN STATE WATER COMPANY

Ernest Gisler
Planning Manager

Enclosures

cc: Sean Maguire, Kennedy/Jenks Consultants

Golden State
Water Company
A Subsidiary of American States Water Company

11 February 2011

Mr. Timothy C. Jochem
General Manager
Upper San Gabriel Valley Municipal Water District
11310 Valley Blvd.
El Monte, CA 91731

Subject: Golden State Water Company - South San Gabriel System
2010 Urban Water Management Plan Preparation Notification and Supply Reliability Information Request

Dear Mr. Jochem:

Golden State Water Company (GSWC) is currently preparing its 2010 Urban Water Management Plan (UWMP) for the South San Gabriel System as required by the Urban Water Management Planning Act (Act). Since Upper San Gabriel Valley Municipal Water District is a wholesale water supplier to GSWC, water use projections through 2035 are enclosed (Table 1) pursuant to §10631(k) of the Act. We would like to request confirmation of the anticipated water supply reliability, water supply sources, and other information as described below. This information may be provided by either (a) providing a copy of your Draft UWMP if all requested information is included or, (b) completing the enclosed tables and providing any additional documents as required.

1. Supply projections to 2035 (Table 2)
2. Single Dry Year Reliability to 2035 (Table 3)
3. Normal, single dry, and multiple dry year reliability (Table 4)
4. Basis of water year data (Table 5)
5. Factors resulting in inconsistency of supply (Table 6)
6. Assumptions used to determine retail agency supply projections, including conservation.
7. Recycled water projections to the South San Gabriel service area (if applicable) (Table 7)
8. Describe any regional desalination opportunities, if any for the South San Gabriel system (if applicable)

We appreciate your timely attention to the information requested above and ask you provide a response no later than **18 February 2011**. Kennedy/Jenks Consultants is assisting GSWC with preparation of the 2010 UWMP and will be contacting you directly within the next week to follow up on this request. In the meantime, should you have any questions or concerns please feel free to contact me at (916) 853-3612.

Very truly yours,

GOLDEN STATE WATER COMPANY

Ernest Gisler
Planning Manager

Enclosures

cc: Sean Maguire, Kennedy/Jenks Consultants

Appendix J

Urban Water Management Plan Checklist

Table I-2 Urban Water Management Plan checklist, organized by subject

No.	UWMP requirement [a]	Calif. Water Code reference	Additional clarification	UWMP location	Page Number
PLAN PREPARATION					
4	Coordinate the preparation of its plan with other appropriate agencies in the area, including other water suppliers that share a common source, water management agencies, and relevant public agencies, to the extent practicable.	10620(d)(2)		1.6	1-7
6	Notify, at least 60 days prior to the public hearing on the plan required by Section 10642, any city or county within which the supplier provides water that the urban water supplier will be reviewing the plan and considering amendments or changes to the plan. Any city or county receiving the notice may be consulted and provide comments.	10621(b)		1.6	1-7
7	Provide supporting documentation that the UWMP or any amendments to, or changes in, have been adopted as described in Section 10640 et seq.	10621(c)		1.6	1-7
54	Provide supporting documentation that the urban water management plan has been or will be provided to any city or county within which it provides water, no later than 60 days after the submission of this urban water management plan.	10635(b)		Appendix H	
55	Provide supporting documentation that the water supplier has encouraged active involvement of diverse social, cultural, and economic elements of the population within the service area prior to and during the preparation of the plan.	10642		1.6	1-7
56	Provide supporting documentation that the urban water supplier made the plan available for public inspection and held a public hearing about the plan. For public agencies, the hearing notice is to be provided pursuant to Section 6066 of the Government Code. The water supplier is to provide the time and place of the hearing to any city or county within which the supplier provides water. Privately-owned water suppliers shall provide an equivalent notice within its service area.	10642		Page vii	Vii
57	Provide supporting documentation that the plan has been adopted as prepared or modified.	10642		1.6	1-7
58	Provide supporting documentation as to how the water supplier plans to implement its plan.	10643		1.8	1-8

No.	UWMP requirement [a]	Calif. Water Code reference	Additional clarification	UWMP location	Page Number
59	Provide supporting documentation that, in addition to submittal to DWR, the urban water supplier has submitted this UWMP to the California State Library and any city or county within which the supplier provides water supplies a copy of its plan no later than 30 days after adoption. This also includes amendments or changes.	10644(a)		1.7 Appendix H	1-8
60	Provide supporting documentation that, not later than 30 days after filing a copy of its plan with the department, the urban water supplier has or will make the plan available for public review during normal business hours	10645		1.7	1-8
SYSTEM DESCRIPTION					
8	Describe the water supplier service area.	10631(a)		2.1	2-1
9	Describe the climate and other demographic factors of the service area of the supplier	10631(a)		2.2 & 2.4	2-1 & 2-10
10	Indicate the current population of the service area	10631(a)	Provide the most recent population data possible. Use the method described in “Baseline Daily Per Capita Water Use.” See Section M.	2.3	2-5
11	Provide population projections for 2015, 2020, 2025, and 2030, based on data from State, regional, or local service area population projections.	10631(a)	2035 and 2040 can also be provided to support consistency with Water Supply Assessments and Written Verification of Water Supply documents.	2.3.2	2-5
12	Describe other demographic factors affecting the supplier’s water management planning.	10631(a)		2.2 & 2.4	2-1 & 2-10
SYSTEM DEMANDS					
1	Provide baseline daily per capita water use, urban water use target, interim urban water use target, and compliance daily per capita water use, along with the bases for determining those estimates, including references to supporting data.	10608.20(e)		3.2	3-3

No.	UWMP requirement [a]	Calif. Water Code reference	Additional clarification	UWMP location	Page Number
2	*Wholesalers:* Include an assessment of present and proposed future measures, programs, and policies to help achieve the water use reductions. *Retailers:* Conduct at least one public hearing that includes general discussion of the urban retail water supplier's implementation plan for complying with the Water Conservation Bill of 2009.	10608.36 10608.26(a)	Retailers and wholesalers have slightly different requirements	4.6	4-8
3	Report progress in meeting urban water use targets using the standardized form.	10608.40		Not Applicable	
25	Quantify past, current, and projected water use, identifying the uses among water use sectors, for the following: (A) single-family residential, (B) multifamily, (C) commercial, (D) industrial, (E) institutional and governmental, (F) landscape, (G) sales to other agencies, (H) saline water intrusion barriers, groundwater recharge, conjunctive use, and (I) agriculture.	10631(e)(1)	Consider 'past' to be 2005, present to be 2010, and projected to be 2015, 2020, 2025, and 2030. Provide numbers for each category for each of these years.	3.3	3-8
33	Provide documentation that either the retail agency provided the wholesale agency with water use projections for at least 20 years, if the UWMP agency is a retail agency, OR, if a wholesale agency, it provided its urban retail customers with future planned and existing water source available to it from the wholesale agency during the required water-year types	10631(k)	Average year, single dry year, multiple dry years for 2015, 2020, 2025, and 2030.	3.7 Appendix I	3-15
34	Include projected water use for single-family and multifamily residential housing needed for lower income households, as identified in the housing element of any city, county, or city and county in the service area of the supplier.	10631.1(a)		3.8	3-16
SYSTEM SUPPLIES					
13	Identify and quantify the existing and planned sources of water available for 2015, 2020, 2025, and 2030.	10631(b)	The 'existing' water sources should be for the same year as the "current population" in line 10. 2035 and 2040 can also be provided.	4.1	4-2

No.	UWMP requirement [a]	Calif. Water Code reference	Additional clarification	UWMP location	Page Number
14	Indicate whether groundwater is an existing or planned source of water available to the supplier. If yes, then complete 15 through 21 of the UWMP Checklist. If no, then indicate “not applicable” in lines 15 through 21 under the UWMP location column.	10631(b)	Source classifications are: surface water, groundwater, recycled water, storm water, desalinated sea water, desalinated brackish groundwater, and other.	4.3	4-3
15	Indicate whether a groundwater management plan been adopted by the water supplier or if there is any other specific authorization for groundwater management. Include a copy of the plan or authorization.	10631(b)(1)		4.3	4-3
16	Describe the groundwater basin.	10631(b)(2)		4.3	4-3
17	Indicate whether the groundwater basin is adjudicated? Include a copy of the court order or decree.	10631(b)(2)		4.3 & Appendix F	4-3
18	Describe the amount of groundwater the urban water supplier has the legal right to pump under the order or decree. If the basin is not adjudicated, indicate “not applicable” in the UWMP location column.	10631(b)(2)		4.3	4-3
19	For groundwater basins that are not adjudicated, provide information as to whether DWR has identified the basin or basins as overdrafted or has projected that the basin will become overdrafted if present management conditions continue, in the most current official departmental bulletin that characterizes the condition of the groundwater basin, and a detailed description of the efforts being undertaken by the urban water supplier to eliminate the long-term overdraft condition. If the basin is adjudicated, indicate “not applicable” in the UWMP location column.	10631(b)(2)		Not Applicable	
20	Provide a detailed description and analysis of the location, amount, and sufficiency of groundwater pumped by the urban water supplier for the past five years	10631(b)(3)		4.3	4-3
21	Provide a detailed description and analysis of the amount and location of groundwater that is projected to be pumped.	10631(b)(4)	Provide projections for 2015, 2020, 2025, and 2030.	4.3	4-3
24	Describe the opportunities for exchanges or transfers of water on a short-term or long-term basis.	10631(d)		4.4	4-7

No.	UWMP requirement [a]	Calif. Water Code reference	Additional clarification	UWMP location	Page Number
30	Include a detailed description of all water supply projects and programs that may be undertaken by the water supplier to address water supply reliability in average, single-dry, and multiple-dry years, excluding demand management programs addressed in (f)(1). Include specific projects, describe water supply impacts, and provide a timeline for each project.	10631(h)		4.5	4-7
31	Describe desalinated water project opportunities for long-term supply, including, but not limited to, ocean water, brackish water, and groundwater.	10631(i)		4.7	4-9
44	Provide information on recycled water and its potential for use as a water source in the service area of the urban water supplier. Coordinate with local water, wastewater, groundwater, and planning agencies that operate within the supplier's service area.	10633		4.8	4-9
45	Describe the wastewater collection and treatment systems in the supplier's service area, including a quantification of the amount of wastewater collected and treated and the methods of wastewater disposal.	10633(a)		4.8.2	4-11
46	Describe the quantity of treated wastewater that meets recycled water standards, is being discharged, and is otherwise available for use in a recycled water project.	10633(b)		4.8.2	4-11
47	Describe the recycled water currently being used in the supplier's service area, including, but not limited to, the type, place, and quantity of use.	10633(c)		4.8.2	4-11
48	Describe and quantify the potential uses of recycled water, including, but not limited to, agricultural irrigation, landscape irrigation, wildlife habitat enhancement, wetlands, industrial reuse, groundwater recharge, indirect potable reuse, and other appropriate uses, and a determination with regard to the technical and economic feasibility of serving those uses.	10633(d)		4.8.3	4-12
49	The projected use of recycled water within the supplier's service area at the end of 5, 10, 15, and 20 years, and a description of the actual use of recycled water in comparison to uses previously projected.	10633(e)		4.8	4-9
50	Describe the actions, including financial incentives, which may be taken to encourage the use of recycled water, and the projected results of these actions in terms of acre-feet of recycled water used per year.	10633(f)		4.8.4	4-13

No.	UWMP requirement [a]	Calif. Water Code reference	Additional clarification	UWMP location	Page Number
51	Provide a plan for optimizing the use of recycled water in the supplier's service area, including actions to facilitate the installation of dual distribution systems, to promote recirculating uses, to facilitate the increased use of treated wastewater that meets recycled water standards, and to overcome any obstacles to achieving that increased use.	10633(g)		4.8.4	4-13
WATER SHORTAGE RELIABILITY AND WATER SHORTAGE CONTINGENCY PLANNING [b]					
5	Describe water management tools and options to maximize resources and minimize the need to import water from other regions.	10620(f)		1.10	1-10
22	Describe the reliability of the water supply and vulnerability to seasonal or climatic shortage and provide data for (A) an average water year, (B) a single dry water year, and (C) multiple dry water years.	10631(c)(1)		6.1	6-1
23	For any water source that may not be available at a consistent level of use - given specific legal, environmental, water quality, or climatic factors - describe plans to supplement or replace that source with alternative sources or water demand management measures, to the extent practicable.	10631(c)(2)		6.1.4	6-6
35	Provide an urban water shortage contingency analysis that specifies stages of action, including up to a 50-percent water supply reduction, and an outline of specific water supply conditions at each stage	10632(a)		8.1	8-1
36	Provide an estimate of the minimum water supply available during each of the next three water years based on the driest three-year historic sequence for the agency's water supply.	10632(b)		8.2	8-3
37	Identify actions to be undertaken by the urban water supplier to prepare for, and implement during, a catastrophic interruption of water supplies including, but not limited to, a regional power outage, an earthquake, or other disaster.	10632(c)		8.3	8-4
38	Identify additional, mandatory prohibitions against specific water use practices during water shortages, including, but not limited to, prohibiting the use of potable water for street cleaning.	10632(d)		8.4	8-6
39	Specify consumption reduction methods in the most restrictive stages. Each urban water supplier may use any type of consumption reduction methods in its water shortage contingency analysis that would reduce water use, are appropriate for its area, and have the ability to achieve a water use reduction consistent with up to a 50 percent reduction in water supply.	10632(e)		8.4	8-6
40	Indicated penalties or charges for excessive use, where applicable.	10632(f)		8.4	8-6

No.	UWMP requirement [a]	Calif. Water Code reference	Additional clarification	UWMP location	Page Number
41	Provide an analysis of the impacts of each of the actions and conditions described in subdivisions (a) to (f), inclusive, on the revenues and expenditures of the urban water supplier, and proposed measures to overcome those impacts, such as the development of reserves and rate adjustments.	10632(g)		8.5	8-8
42	Provide a draft water shortage contingency resolution or ordinance.	10632(h)		8.4 & Appendix D	8-6
43	Indicate a mechanism for determining actual reductions in water use pursuant to the urban water shortage contingency analysis.	10632(i)		8.6	8-10
52	Provide information, to the extent practicable, relating to the quality of existing sources of water available to the supplier over the same five-year increments, and the manner in which water quality affects water management strategies and supply reliability	10634	For years 2010, 2015, 2020, 2025, and 2030	5	5-1
53	Assess the water supply reliability during normal, dry, and multiple dry water years by comparing the total water supply sources available to the water supplier with the total projected water use over the next 20 years, in five-year increments, for a normal water year, a single dry water year, and multiple dry water years. Base the assessment on the information compiled under Section 10631, including available data from state, regional, or local agency population projections within the service area of the urban water supplier.	10635(a)		6.2 – 6.4	6-7
DEMAND MANAGEMENT MEASURES					
26	Describe how each water demand management measures is being implemented or scheduled for implementation. Use the list provided.	10631(f)(1)	Discuss each DMM, even if it is not currently or planned for implementation. Provide any appropriate schedules.	7.1	7-2
27	Describe the methods the supplier uses to evaluate the effectiveness of DMMs implemented or described in the UWMP.	10631(f)(3)		7.1	7-2
28	Provide an estimate, if available, of existing conservation savings on water use within the supplier's service area, and the effect of the savings on the ability to further reduce demand.	10631(f)(4)		7.2	7-4

No.	UWMP requirement [a]	Calif. Water Code reference	Additional clarification	UWMP location	Page Number
29	Evaluate each water demand management measure that is not currently being implemented or scheduled for implementation. The evaluation should include economic and non-economic factors, cost-benefit analysis, available funding, and the water suppliers' legal authority to implement the work.	10631(g)	See 10631(g) for additional wording.	7.2	7-4
32	Include the annual reports submitted to meet the Section 6.2 requirements, if a member of the CUWCC and signer of the December 10, 2008 MOU.	10631(j)	Signers of the MOU that submit the annual reports are deemed compliant with Items 28 and 29.	N/A	

a The UWMP Requirement descriptions are general summaries of what is provided in the legislation. Urban water suppliers should review the exact legislative wording prior to submitting its UWMP.

b The Subject classification is provided for clarification only. It is aligned with the organization presented in Part I of this guidebook. A water supplier is free to address the UWMP Requirement anywhere with its UWMP, but is urged to provide clarification to DWR to facilitate review.

Recycled Water Policy

1. *Preamble*

California is facing an unprecedented water crisis.

The collapse of the Bay-Delta ecosystem, climate change, and continuing population growth have combined with a severe drought on the Colorado River and failing levees in the Delta to create a new reality that challenges California's ability to provide the clean water needed for a healthy environment, a healthy population and a healthy economy, both now and in the future.

These challenges also present an unparalleled opportunity for California to move aggressively towards a sustainable water future. The State Water Resources Control Board (State Water Board) declares that we will achieve our mission to "preserve, enhance and restore the quality of California's water resources to the benefit of present and future generations." To achieve that mission, we support and encourage every region in California to develop a salt/nutrient management plan by 2014 that is sustainable on a long-term basis and that provides California with clean, abundant water. These plans shall be consistent with the Department of Water Resources' Bulletin 160, as appropriate, and shall be locally developed, locally controlled and recognize the variability of California's water supplies and the diversity of its waterways. We strongly encourage local and regional water agencies to move toward clean, abundant, local water for California by emphasizing appropriate water recycling, water conservation, and maintenance of supply infrastructure and the use of stormwater (including dry-weather urban runoff) in these plans; these sources of supply are drought-proof, reliable, and minimize our carbon footprint and can be sustained over the long-term.

We declare our independence from relying on the vagaries of annual precipitation and move towards sustainable management of surface waters and groundwater, together with enhanced water conservation, water reuse and the use of stormwater. To this end, we adopt the following goals for California:

- Increase the use of recycled water over 2002 levels by at least one million acre-feet per year (afy) by 2020 and by at least two million afy by 2030.
- Increase the use of stormwater over use in 2007 by at least 500,000 afy by 2020 and by at least one million afy by 2030.
- Increase the amount of water conserved in urban and industrial uses by comparison to 2007 by at least 20 percent by 2020.
- Included in these goals is the substitution of as much recycled water for potable water as possible by 2030.

The purpose of this Policy is to increase the use of recycled water from municipal wastewater sources that meets the definition in Water Code section 13050(n), in a manner that implements state and federal water quality laws. The State Water Board expects to develop additional policies to encourage the use of stormwater, encourage water conservation, encourage the conjunctive use of surface and groundwater, and improve the use of local water supplies.

When used in compliance with this Policy, Title 22 and all applicable state and federal water quality laws, the State Water Board finds that recycled water is safe for approved uses, and strongly supports recycled water as a safe alternative to potable water for such approved uses.

2. *Purpose of the Policy*

a. The purpose of this Policy is to provide direction to the Regional Water Quality Control Boards (Regional Water Boards), proponents of recycled water projects, and the public regarding the appropriate criteria to be used by the State Water Board and the Regional Water Boards in issuing permits for recycled water projects.

b. It is the intent of the State Water Board that all elements of this Policy are to be interpreted in a manner that fully implements state and federal water quality laws and regulations in order to enhance the environment and put the waters of the state to the fullest use of which they are capable.

c. This Policy describes permitting criteria that are intended to streamline the permitting of the vast majority of recycled water projects. The intent of this streamlined permit process is to expedite the implementation of recycled water projects in a manner that implements state and federal water quality laws while allowing the Regional Water Boards to focus their limited resources on projects that require substantial regulatory review due to unique site-specific conditions.

d. By prescribing permitting criteria that apply to the vast majority of recycled water projects, it is the State Water Board's intent to maximize consistency in the permitting of recycled water projects in California while also reserving to the Regional Water Boards sufficient authority and flexibility to address site-specific conditions.

e. The State Water Board will establish additional policies that are intended to assist the State of California in meeting the goals established in the preamble to this Policy for water conservation and the use of stormwater.

f. For purposes of this Policy, the term "permit" means an order adopted by a Regional Water Board or the State Water Board prescribing requirements for a recycled water project, including but not limited to water recycling requirements, master reclamation permits, and waste discharge requirements.

3. *Benefits of Recycled Water*

The State Water Board finds that the use of recycled water in accordance with this Policy, that is, which supports the sustainable use of groundwater and/or surface water, which is sufficiently treated so as not to adversely impact public health or the environment and which ideally substitutes for use of potable water, is presumed to have a beneficial impact. Other public agencies are encouraged to use this presumption in evaluating the impacts of recycled water projects on the environment as required by the California Environmental Quality Act (CEQA).

4. *Mandate for the Use of Recycled Water*

a. The State Water Board and Regional Water Boards will exercise the authority granted to them by the Legislature to the fullest extent possible to encourage the use of recycled water, consistent with state and federal water quality laws.

(1) The State Water Board hereby establishes a mandate to increase the use of recycled water in California by 200,000 afy by 2020 and by an additional 300,000 afy by 2030. These mandates shall be achieved through the cooperation and collaboration of the State Water Board, the Regional Water Boards, the environmental community, water purveyors and the operators of publicly owned treatment works. The State Water Board will evaluate progress toward these mandates biennially and review and revise as necessary the implementation provisions of this Policy in 2012 and 2016.

(2) Agencies producing recycled water that is available for reuse and not being put to beneficial use shall make that recycled water available to water purveyors for reuse on reasonable terms and conditions. Such terms and conditions may include payment by the water purveyor of a fair and reasonable share of the cost of the recycled water supply and facilities.

(3) The State Water Board hereby declares that, pursuant to Water Code sections 13550 *et seq*., it is a waste and unreasonable use of water for water agencies not to use recycled water when recycled water of adequate quality is available and is not being put to beneficial use, subject to the conditions established in sections 13550 *et seq*. The State Water Board shall exercise its authority pursuant to Water Code section 275 to the fullest extent possible to enforce the mandates of this subparagraph.

b. These mandates are contingent on the availability of sufficient capital funding for the construction of recycled water projects from private, local, state, and federal sources and assume that the Regional Water Boards will effectively implement regulatory streamlining in accordance with this Policy.

c. The water industry and the environmental community have agreed jointly to advocate for $1 billion in state and federal funds over the next five years to fund projects needed to meet the goals and mandates for the use of recycled water established in this Policy.

d. The State Water Board requests the California Department of Public Health (CDPH), the California Public Utilities Commission (CPUC), and the California Department of Water Resources (CDWR) to use their respective authorities to the fullest extent practicable to assist the State Water Board and the Regional Water Boards in increasing the use of recycled water in California.

5. *Roles of the State Water Board, Regional Water Boards, CDPH and CDWR*

The State Water Board recognizes that it shares jurisdiction over the use of recycled water with the Regional Water Boards and with CDPH. In addition, the State Water Board recognizes that CDWR and the CPUC have important roles to play in encouraging the use of recycled water. The State Water Board believes that it is important to clarify the respective roles of each of these agencies in connection with recycled water projects, as follows:

a. The State Water Board establishes general policies governing the permitting of recycled water projects consistent with its role of protecting water quality and sustaining water supplies. The State Water Board exercises general oversight over recycled water projects, including review of Regional Water Board permitting practices, and shall lead the effort to meet the recycled water use goals set forth in the Preamble to this Policy. The State Water Board is also charged by statute with developing a general permit for irrigation uses of recycled water.

b. The CDPH is charged with protection of public health and drinking water supplies and with the development of uniform water recycling criteria appropriate to particular uses of water. Regional Water Boards shall appropriately rely on the expertise of CDPH for the establishment of permit conditions needed to protect human health.

c. The Regional Water Boards are charged with protection of surface and groundwater resources and with the issuance of permits that implement CDPH recommendations, this Policy, and applicable law and will, pursuant to paragraph 4 of this Policy, use their authority to the fullest extent possible to encourage the use of recycled water.

d. CDWR is charged with reviewing and, every five years, updating the California Water Plan, including evaluating the quantity of recycled water presently being used and planning for the potential for future uses of recycled water. In undertaking these tasks, CDWR may appropriately rely on urban water management plans and may share the data from those plans with the State Water Board and the Regional Water Boards. CDWR also shares with the State Water Board the authority to allocate and distribute bond funding, which can provide incentives for the use of recycled water.

e. The CPUC is charged with approving rates and terms of service for the use of recycled water by investor-owned utilities.

6. *Salt/Nutrient Management Plans*

a. *Introduction.*

(1) Some groundwater basins in the state contain salts and nutrients that exceed or threaten to exceed water quality objectives established in the applicable Water Quality Control Plans (Basin Plans), and not all Basin Plans include adequate implementation procedures for achieving or ensuring compliance with the water quality objectives for salt or nutrients. These conditions can be caused by natural soils/conditions, discharges of waste, irrigation using surface water, groundwater or recycled water and water supply augmentation using surface or recycled water. Regulation of recycled water alone will not address these conditions.

(2) It is the intent of this Policy that salts and nutrients from all sources be managed on a basin-wide or watershed-wide basis in a manner that ensures attainment of water quality objectives and protection of beneficial uses. The State Water Board finds that the appropriate way to address salt and nutrient issues is through the development of regional or subregional salt and nutrient management plans rather than through imposing requirements solely on individual recycled water projects.

b. *Adoption of Salt/ Nutrient Management Plans.*

(1) The State Water Board recognizes that, pursuant to the letter dated December 19, 2008 and attached to the Resolution adopting this Policy, the local water and wastewater entities, together with local salt/nutrient contributing stakeholders, will fund locally driven and controlled, collaborative processes open to all stakeholders that will prepare salt and nutrient management plans for each basin/sub-basin in California, including compliance with CEQA and participation by Regional Water Board staff.

(a) It is the intent of this Policy for every groundwater basin/sub-basin in California to have a consistent salt/nutrient management plan. The degree of specificity within these plans and the length of these plans will be dependent on a variety of site-specific factors, including but not limited to size and complexity of a basin, source water quality, stormwater recharge, hydrogeology, and aquifer water quality. It is also the intent of the State Water Board that because stormwater is typically lower in nutrients and salts and can augment local water supplies, inclusion of a significant stormwater use and recharge component within the salt/nutrient management plans is critical to the long-term sustainable use of water in California. Inclusion of stormwater recharge is consistent with State Water Board Resolution No. 2005-06, which establishes sustainability as a core value for State Water Board programs and also assists in implementing Resolution No. 2008-30, which requires sustainable water resources management and is consistent with Objective 3.2 of the State Water Board Strategic Plan Update dated September 2, 2008.

(b) Salt and nutrient plans shall be tailored to address the water quality concerns in each basin/sub-basin and may include constituents other than salt and nutrients that impact water quality in the basin/sub-basin. Such plans shall address and implement provisions, as appropriate, for all sources of salt and/or nutrients to groundwater basins, including recycled water irrigation projects and groundwater recharge reuse projects.

(c) Such plans may be developed or funded pursuant to the provisions of Water Code sections 10750 *et seq.* or other appropriate authority.

(d) Salt and nutrient plans shall be completed and proposed to the Regional Water Board within five years from the date of this Policy unless a Regional Water Board finds that the stakeholders are making substantial progress towards completion of a plan. In no case shall the period for the completion of a plan exceed seven years.

(e) The requirements of this paragraph shall not apply to areas that have already completed a Regional Water Board approved salt and nutrient plan for a basin, sub-basin, or other regional planning area that is functionally equivalent to paragraph 6(b)3.

(f) The plans may, depending upon the local situation, address constituents other than salt and nutrients that adversely affect groundwater quality.

(2) Within one year of the receipt of a proposed salt and nutrient management plan, the Regional Water Boards shall consider for adoption revised implementation plans, consistent with Water Code section 13242, for those groundwater basins within their regions where water quality objectives for salts or nutrients are being, or are threatening to be, exceeded. The implementation plans shall be based on the salt and nutrient plans required by this Policy.

(3) Each salt and nutrient management plan shall include the following components:

(a) A basin/sub-basin wide monitoring plan that includes an appropriate network of monitoring locations. The scale of the basin/sub-basin monitoring plan is dependent upon the site-specific conditions and shall be adequate to provide a reasonable, cost-effective means of determining whether the concentrations of salt, nutrients, and other constituents of concern as identified in the salt and nutrient plans are consistent with applicable water quality objectives. Salts, nutrients, and the constituents identified in paragraph 6(b)(1)(f) shall be monitored. The frequency of monitoring shall be determined in the salt/nutrient management plan and approved by the Regional Water Board pursuant to paragraph 6(b)(2).

(i) The monitoring plan must be designed to determine water quality in the basin. The plan must focus on basin water quality near water supply wells and areas proximate to large water recycling projects, particularly groundwater recharge projects. Also, monitoring locations shall, where appropriate, target groundwater and surface waters where groundwater has connectivity with adjacent surface waters.

(ii) The preferred approach to monitoring plan development is to collect samples from existing wells if feasible as long as the existing wells are located appropriately to determine water quality throughout the most critical areas of the basin.

(iii) The monitoring plan shall identify those stakeholders responsible for conducting, compiling, and reporting the monitoring data. The data shall be reported to the Regional Water Board at least every three years.

(b) A provision for annual monitoring of Emerging Constituents/ Constituents of Emerging Concern (e.g., endocrine disrupters, personal care products or pharmaceuticals) (CECs) consistent with recommendations by CDPH and consistent with any actions by the State Water Board taken pursuant to paragraph 10(b) of this Policy.

(c) Water recycling and stormwater recharge/use goals and objectives.

(d) Salt and nutrient source identification, basin/sub-basin assimilative capacity and loading estimates, together with fate and transport of salts and nutrients.

(e) Implementation measures to manage salt and nutrient loading in the basin on a sustainable basis.

(f) An antidegradation analysis demonstrating that the projects included within the plan will, collectively, satisfy the requirements of Resolution No. 68-16.

(4) Nothing in this Policy shall prevent stakeholders from developing a plan that is more protective of water quality than applicable standards in the Basin Plan. No Regional Water Board, however, shall seek to modify Basin Plan objectives without full compliance with the process for such modification as established by existing law.

7. *Landscape Irrigation Projects*

a. *Control of incidental runoff.* Incidental runoff is defined as unintended small amounts (volume) of runoff from recycled water use areas, such as unintended, minimal over-spray from sprinklers that escapes the recycled water use area. Water leaving a recycled water use area is not considered incidental if it is part of the facility design, if it is due to excessive application, if it is due to intentional overflow or application, or if it is due to negligence. Incidental runoff may be regulated by waste discharge requirements or, where necessary, waste discharge requirements that serve as a National Pollutant Discharge Elimination System (NPDES) permit, including municipal separate storm water system permits, but regardless of the regulatory instrument, the project shall include, but is not limited to, the following practices:

(1) Implementation of an operations and management plan that may apply to multiple sites and provides for detection of leaks, (for example, from broken sprinkler heads), and correction either within 72 hours of learning of the runoff, or prior to the release of 1,000 gallons, whichever occurs first,

(2) Proper design and aim of sprinkler heads,

(3) Refraining from application during precipitation events, and

(4) Management of any ponds containing recycled water such that no discharge occurs unless the discharge is a result of a 25-year, 24-hour storm event or greater, and there is notification of the appropriate Regional Water Board Executive Officer of the discharge.

b. *Streamlined Permitting*

(1) The Regional Water Boards shall, absent unusual circumstances (i.e., unique, site-specific conditions such as where recycled water is proposed to be used for irrigation over high transmissivity soils over a shallow (5’ or less) high quality groundwater aquifer), permit recycled water projects that meet the criteria set forth in this Policy, consistent with the provisions of this paragraph.

(2) If the Regional Water Board determines that unusual circumstances apply, the Regional Water Board shall make a finding of unusual circumstances based on substantial evidence in the record, after public notice and hearing.

(3) Projects meeting the criteria set forth below and eligible for enrollment under requirements established in a general order shall be enrolled by the State or Regional Water Board within 60 days from the date on which an application is deemed complete by the State or Regional Water Board. For projects that are not enrolled in a general order, the Regional Water Board shall consider permit adoption within 120 days from the date on which the application is deemed complete by the Regional Water Board.

(4) Landscape irrigation projects that qualify for streamlined permitting shall not be required to include a project specific receiving water and groundwater monitoring component unless such project specific monitoring is required under the adopted salt/nutrient management plan. During the interim while the salt management plan is under development, a landscape irrigation project proponent can either perform project specific monitoring, or actively participate in the development and implementation of a salt/nutrient management plan, including basin/sub-basin monitoring. Permits or requirements for landscape irrigation projects shall include, in addition to any other appropriate recycled water monitoring requirements, recycled water monitoring for CECs on an annual basis and priority pollutants on a twice annual basis. Except as requested by CDPH, State and Regional Water Board monitoring requirements for CECs shall not take effect until 18 months after the effective date of this Policy. In addition, any permits shall include a permit reopener to allow incorporation of appropriate monitoring requirements for CECs after State Water Board action under paragraph 10(b)(2).

(5) It is the intent of the State Water Board that the general permit for landscape irrigation projects be consistent with the terms of this Policy.

c. *Criteria for streamlined permitting*. Irrigation projects using recycled water that meet the following criteria are eligible for streamlined permitting, and, if otherwise in compliance with applicable laws, shall be approved absent unusual circumstances:

(1) Compliance with the requirements for recycled water established in Title 22 of the California Code of Regulations, including the requirements for treatment and use area restrictions, together with any other recommendations by CDPH pursuant to Water Code section 13523.

(2) Application in amounts and at rates as needed for the landscape (i.e., at agronomic rates and not when the soil is saturated). Each irrigation project shall be subject to an operations and management plan, that may apply to multiple sites, provided to the Regional Water Board that specifies the agronomic rate(s) and describes a set of reasonably practicable measures to ensure compliance with this requirement, which may include the development of water budgets for use areas, site

supervisor training, periodic inspections, tiered rate structures, the use of smart controllers, or other appropriate measures.

(3) Compliance with any applicable salt and nutrient management plan.

(4) Appropriate use of fertilizers that takes into account the nutrient levels in the recycled water. Recycled water producers shall monitor and communicate to the users the nutrient levels in their recycled water.

8. *Recycled Water Groundwater Recharge Projects*

a. The State Water Board acknowledges that all recycled water groundwater recharge projects must be reviewed and permitted on a site-specific basis, and so such projects will require project-by-project review.

b. Approved groundwater recharge projects will meet the following criteria:

(1) Compliance with regulations adopted by CDPH for groundwater recharge projects or, in the interim until such regulations are approved, CDPH's recommendations pursuant to Water Code section 13523 for the project (e.g., level of treatment, retention time, setback distance, source control, monitoring program, etc.).

(2) Implementation of a monitoring program for constituents of concern and a monitoring program for CECs that is consistent with any actions by the State Water Board taken pursuant to paragraph 10(b) of this Policy and that takes into account site-specific conditions. Groundwater recharge projects shall include monitoring of recycled water for CECs on an annual basis and priority pollutants on a twice annual basis.

c. Nothing in this paragraph shall be construed to limit the authority of a Regional Water Board to protect designated beneficial uses, *provided* that any proposed limitations for the protection of public health may only be imposed following regular consultation by the Regional Water Board with CDPH, consistent with State Water Board Orders WQ 2005-0007 and 2006-0001.

d. Nothing in this Policy shall be construed to prevent a Regional Water Board from imposing additional requirements for a proposed recharge project that has a substantial adverse effect on the fate and transport of a contaminant plume or changes the geochemistry of an aquifer thereby causing the dissolution of constituents, such as arsenic, from the geologic formation into groundwater.

e. Projects that utilize surface spreading to recharge groundwater with recycled water treated by reverse osmosis shall be permitted by a Regional Water Board within one year of receipt of recommendations from CDPH. Furthermore, the Regional Water Board shall give a high priority to review and approval of such projects.

9. *Antidegradation*

a. The State Water Board adopted Resolution No. 68-16 as a policy statement to implement the Legislature's intent that waters of the state shall be regulated to achieve the highest water quality consistent with the maximum benefit to the people of the state.

b. Activities involving the disposal of waste that could impact high quality waters are required to implement best practicable treatment or control of the discharge necessary to ensure that pollution or nuisance will not occur, and the highest water quality consistent with the maximum benefit to the people of the state will be maintained.

c. Groundwater recharge with recycled water for later extraction and use in accordance with this Policy and state and federal water quality law is to the benefit of the people of the state of California. Nonetheless, the State Water Board finds that groundwater recharge projects using recycled water have the potential to lower water quality within a basin. The proponent of a groundwater recharge project must demonstrate compliance with Resolution No. 68-16. Until such time as a salt/nutrient management plan is in effect, such compliance may be demonstrated as follows:

(1) A project that utilizes less than 10 percent of the available assimilative capacity in a basin/sub-basin (or multiple projects utilizing less than 20 percent of the available assimilative capacity in a basin/sub-basin) need only conduct an antidegradation analysis verifying the use of the assimilative capacity. For those basins/sub-basins where the Regional Water Boards have not determined the baseline assimilative capacity, the baseline assimilative capacity shall be calculated by the initial project proponent, with review and approval by the Regional Water Board, until such time as the salt/nutrient plan is approved by the Regional Water Board and is in effect. For compliance with this subparagraph, the available assimilative capacity shall be calculated by comparing the mineral water quality objective with the average concentration of the basin/sub-basin, either over the most recent five years of data available or using a data set approved by the Regional Water Board Executive Officer. In determining whether the available assimilative capacity will be exceeded by the project or projects, the Regional Water Board shall calculate the impacts of the project or projects over at least a ten year time frame.

(2) In the event a project or multiple projects utilize more than the fraction of the assimilative capacity designated in subparagraph (1), then a Regional Water Board-deemed acceptable antidegradation analysis shall be performed to comply with Resolution No. 68-16. The project proponent shall provide sufficient information for the Regional Water Board to make this determination. An example of an approved method is the method used by the State Water Board in connection with Resolution No. 2004-0060 and the Regional Water Board in connection with Resolution No. R8-2004-0001. An integrated approach (using surface water, groundwater, recycled water, stormwater, pollution prevention, water conservation, etc.) to the implementation of Resolution No. 68-16 is encouraged.

d. Landscape irrigation with recycled water in accordance with this Policy is to the benefit of the people of the State of California. Nonetheless, the State Water Board finds that the use of water for irrigation may, regardless of its source, collectively affect groundwater quality over time. The State Water Board intends to address these impacts in part through the development of salt/nutrient management plans described in paragraph 6.

(1) A project that meets the criteria for a streamlined irrigation permit and is within a basin where a salt/nutrient management plan satisfying the provisions of paragraph 6(b) is in place may be approved without further antidegradation analysis, provided that the project is consistent with that plan.

(2) A project that meets the criteria for a streamlined irrigation permit and is within a basin where a salt/nutrient management plan satisfying the provisions of paragraph 6(b) is being prepared may be approved by the Regional Water Board by demonstrating through a salt/nutrient mass balance or similar analysis that the project uses less than 10 percent of the available assimilative capacity as estimated by the project proponent in a basin/sub-basin (or multiple projects using less than 20 percent of the available assimilative capacity as estimated by the project proponent in a groundwater basin).

10. *Emerging Constituents/Chemicals of Emerging Concern*

a. *General Provisions*

(1) Regulatory requirements for recycled water shall be based on the best available peer-reviewed science. In addition, all uses of recycled water must meet conditions set by CDPH.

(2) Knowledge of risks will change over time and recycled water projects must meet legally applicable criteria. However, when standards change, projects should be allowed time to comply through a compliance schedule.

(3) The state of knowledge regarding CECs is incomplete. There needs to be additional research and development of analytical methods and surrogates to determine potential environmental and public health impacts. Agencies should minimize the likelihood of CECs impacting human health and the environment by means of source control and/or pollution prevention programs.

(4) Regulating most CECs will require significant work to develop test methods and more specific determinations as to how and at what level CECs impact public health or our environment.

b. *Research Program.* The State Water Board, in consultation with CDPH and within 90 days of the adoption of this Policy, shall convene a "blue-ribbon" advisory panel to guide future actions relating to constituents of emerging concern.

(1) The panel shall be actively managed by the State Water Board and shall be composed of at least the following: one human health toxicologist, one environmental toxicologist, one epidemiologist, one biochemist, one civil engineer familiar with the design and construction of recycled water treatment facilities, and one chemist familiar with the design and operation of advanced laboratory methods for the detection of emerging constituents. Each of these panelists shall have extensive experience as a principal investigator in their respective areas of expertise.

(2) The panel shall review the scientific literature and, within one year from its appointment, shall submit a report to the State Water Board and CDPH describing the current state of scientific knowledge regarding the risks of emerging constituents to public health and the environment. Within six months of receipt of the panel's report the State Water Board, in coordination with CDPH, shall hold a public hearing to consider recommendations from staff and shall endorse the recommendations, as appropriate, after making any necessary modifications. The panel or a similarly constituted panel shall update this report every five years.

(3) Each report shall recommend actions that the State of California should take to improve our understanding of emerging constituents and, as may be appropriate, to protect public health and the environment.

(4) The panel report shall answer the following questions: What are the appropriate constituents to be monitored in recycled water, including analytical methods and method detection limits? What is the known toxicological information for the above constituents? Would the above lists change based on level of treatment and use? If so, how? What are possible indicators that represent a suite of CECs? What levels of CECs should trigger enhanced monitoring of CECs in recycled water, groundwater and/or surface waters?

c. *Permit Provisions.* Permits for recycled water projects shall be consistent both with any CDPH recommendations to protect public health and with any actions by the State Water Board taken pursuant to paragraph 10(b)(2).

11. *Incentives for the Use of Recycled Water*

a. *Funding*

The State Water Board will request CDWR to provide funding ($20M) for the development of salt and nutrient management plans during the next three years (i.e., before FY 2010/2011). The State Water Board will also request CDWR to provide priority funding for projects that have major recycling components; particularly those that decrease demand on potable water supplies. The State Water Board will also request priority funding for stormwater recharge projects that augment local water supplies. The State Water Board shall promote the use of the State Revolving Fund (SRF) for water purveyor, stormwater agencies, and water recyclers to use for water reuse and stormwater use and recharge projects.

b. *Stormwater*

The State Water Board strongly encourages all water purveyors to provide financial incentives for water recycling and stormwater recharge and reuse projects. The State Water Board also encourages the Regional Water Boards to require less stringent monitoring and regulatory requirements for stormwater treatment and use projects than for projects involving untreated stormwater discharges.

c. TMDLs

Water recycling reduces mass loadings from municipal wastewater sources to impaired waters. As such, waste load allocations shall be assigned as appropriate by the Regional Water Boards in a manner that provides an incentive for greater water recycling.

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CAPITAL IMPLEMENTATION MASTER PLAN FOR RECYCLED WATER SYSTEMS

FINAL REPORT
June 2009

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WEST BASIN MUNICIPAL WATER DISTRICT

CAPITAL IMPLEMENTATION MASTER PLAN FOR RECYCLED WATER SYSTEMS

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LIST OF ABBREVIATIONS

Abbreviation	Description
AACE	Association for the Advancement of Cost Engineering
AAD	average annual demand
ADD	average day demand
af	acre-feet
afy	acre feet per year
AOP	advanced oxidation processes
aSAR	adjusted sodium adsorption ratio
B	barrier
Carollo	Carollo Engineers, a Professional Corporation
CBOD	carbonaceous biochemical oxygen demand
CC	construction cost
CC+C	construction cost plus contingency
CCTV	closed circuit television
CIMIS	California Irrigation Management Information System
CIMP	Capital Implementation Master Plan
CIP	Capital Improvement Program
Cl	chloride
CMF	Continuous Microfiltration
CMLC	cement mortar lined and coated
CNF	Chevron Nitrification Facility
CRWRF	Carson Regional Water Recycling Treatment Facility
CSUDH	California State University Dominguez Hills
CT value	the product of total chlorine residual and modal contact time measured at the same point
DCS	distributed control system
DIP	ductile iron pipe
EC	electrical conductivity
ELWRF	Edward C. Little Water Reclamation Facility
EMWRF	ExxonMobil Water Recycling Facility
ENR	Engineering and News Record
EPS	extended period simulation
ET	evapotranspiration
FM	force main
fps	feet per second
frp	fiber reinforced plastic
ft	feet
ft/kft	foot per 1,000 feet
FY	fiscal year
GIS	Geographic Information Systems

Abbreviation	Description
gpd/ac	gallons per day per acre
gpm	gallons per minute
HCO_3	bicarbonate
HDPE	high-density polyethylene
HP	horsepower
HPBF	high pressure boiler feed
HSEFM	Hyperion Secondary Effluent Force Main
HSEPS	Hyperion Secondary Effluent Pump Station
HWWTP	Hyperion Wastewater Treatment Plant
IIMM	International Infrastructure Management Manual, Edition 2006
IN	industrial
IR	irrigation
JWPCP	Joint Water Pollution Control Plant
K_d	density factor
K_{mc}	microclimate factor
K_s	species factor
LACDPW	Los Angeles County Department of Public Works
LACSD	Los Angeles County Sanitation District
LADWP	Los Angeles Department of Water and Power
LF	leaching fraction
LPBF	low pressure boiler feed
MCL	maximum contaminant level
MDD	Maximum Day Demand
MF	Microfiltration
MFP	Mobile Facility Plant
Mg	magnesium
MG	million gallons
mg/L	milligrams per liter.
mgd	million gallons per day
MinDD	minimum day demands
MMD	maximum month demand
MPN	most probable number
MU	mixed use
MWD	Metropolitan Water District of Southern California
N	total nitrogen
Na	sodium
NH_3	ammonia
NO_3	nitrate
NPDES	National Pollutant Discharge Elimination System

Abbreviation	Description
O&M	Operations and Maintenance
OD	outer diameter
PS	pump station
psi	pounds per square inch
PVC	polyvinyl chloride
RO	reverse osmosis
RPM	revolutions per minute
SAR	sodium absorption ratio
SCADA	supervisory control and data acquisition
SDR	Standard Dimension Ratio
SE	secondary effluent
sf	square feet
TDS	total dissolved solids
TOC	total organic carbon
UV	ultraviolet
WBMWD	West Basin Municipal Water District
WDF	water demand factor
West Basin	West Basin Municipal Water District
WSPG	Water Surface Pressure Gradient (software package)

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**Table 3.4 Potential Customers
Capital Implementation Master Plan
West Basin Municipal Water District**

Customer Name	Database ID(1)	Usage Type Code(2)	Likelihood of Service	Anticipated Year of Service	Estimated Future Demand(3) (afy)	Seasonal Peaking Factor
Arthur Lee Johnson Memorial Park	P106	IR	20%	2018	33	2.5
Thornburg Park	P107	IR	20%	2018	4	2.5
Gardena High School	P108	IR	20%	2018	27	2.5
Serra High School	P109	IR	20%	2018	18	2.5
Vermont Medians	P114	IR	20%	2018	24	2.5
LAUSD - Peary Jr High	P44	IR	20%	2018	20	2.5
Calas Park	P89	IR	20%	2018	20	2.5
Caltrans I-405/190th St.	P93	IR	20%	2018	14	1.5
General Scott Park	P94	IR	20%	2020	14	2.5
Dominguez Hills Golf Course	P75	IR	10%	2012	25	2.5
Stephen M White Middle School	P80	IR	10%	2013	29	2.5
Caltrans I-405/Figueroa St.	P81	IR	10%	2013	28	1.5
Caltrans I-405/Edgar St.	P84	IR	10%	2013	23	1.5
LACMTA	P34	IN	10%	2017	30	1.3
Prime Wheel	P35	IN	10%	2018	27	1.3
Carson High School	P98	IR	10%	2018	41	2.5
One Hundred Fifty Third Street E	P110	IR	10%	2020	3	2.5
Crescendo Charter School	P111	IR	10%	2020	1	2.5
Roosevelt Cemetery	P112	IR	10%	2020	93	2.5
C Star Nursery	P113	IR	10%	2020	14	2.5
Rosecrans Recreation Center	P115	IR	10%	2020	24	2.5
Moneta Nursery	P116	IR	10%	2020	8	2.5

CAPITAL IMPROVEMENT PROGRAM

This chapter presents the recommended capital improvement program (CIP) for the West Basin Municipal Water District's (West Basin) distribution systems. The CIP summarizes the recommended improvements, cost estimates, and the allocation of project cost for the recommended improvements to the distribution systems, and establishes phasing of projects through the planning horizon. The purpose of this CIP is to provide West Basin with a guideline for the planning and budgeting of future improvements to its distribution systems and facilities. The CIP is based on the evaluation of the West Basin's distribution systems, and on the recommended projects described in previous chapters.

This chapter is divided into three subsections. First, the recommended projects are summarized for each of the ten distribution systems and the five treatment plants (four existing and one proposed). Secondly, the phasing of recommendation is presented by planning period from fiscal year (FY) 2008/2009 through FY 2029/2030 (FY29/30). This chapter is concluded with a summary of the entire CIP by presenting summaries of the estimated project improvement cost by planning year and facility type. It should be noted that all cost presented in this chapter are based on 2009 dollars, with the exception of the escalated CIP at the end of this chapter.

The reasons for replacements, upgrades, and/or new facilities and other details for each of the projects recommended in this CIP can be found in Chapters 7 and 8.

Where applicable, it is assumed that West Basin projects will be designed for certification in accordance with the Leadership in Energy and Environmental Design (LEED) Green Building Rating System. However, specific decisions on incorporation of green building technology will need to be made and refined at the preliminary design level.

9.1 PROJECT SUMMARY BY SYSTEM/FACILITY

This section summarizes the recommended projects discussed in Chapter 7 (Existing System Analysis) and Chapter 8 (Future System Analysis) for each of the ten distribution systems and the five treatment plants. The ten distribution systems, in the order presented, are:

- Hyperion Secondary Effluent Pumping Station (HSEPS) System
- Title 22 Distribution System
- West Coast Barrier System
- Chevron High Pressure Boiler Feed (CHPBF) System
- Chevron Low Pressure Boiler Feed (CLPBF) System

- Chevron Nitrified Water System
- ELWRF Brine Line
- bp Reverse Osmosis System (bp-RO)
- bp Nitrified Water System (bp-N)
- CRWRF Brine Line

The five treatment plants, including four existing and one proposed plant, are:

- Edward L. Little Water Reclamation Facility (ELWRF)
- Carson Regional Water Reclamation Facility (CRWRF)
- ExxonMobil Water Reclamation Facility (EMWRF)
- Chevron Nitrified Facility (CNF)
- New Treatment Plant (NTP)

As discussed in Chapter 8, this NTP would treat secondary effluent from the Los Angeles County Sanitation District's Joint Water Pollution Control Plant (JWPCP).

In addition, there are three types of recurring projects that are related to ongoing improvements at the treatment plants, such as membrane replacements, electrical upgrades, mechanical equipment, etc. These three types of recurring projects are:

- Replacement and rehabilitation projects identified in the Condition Assessment TM (Carollo 2009)
- Membrane replacements, assumed to take place every five years, as detailed in Section 8.4.2.
- Recapitalization projects identified by United Water (United Water 2009).

In this section, these recurring projects have been organized by treatment plant (Sections 9.1.13 through 9.1.17) and are phased as "mult", meaning multiple planning phases. In Section 9.2, the costs of these projects are organized by planning phase. The cost breakdown by treatment plant and planning phases can be found in the master CIP list presented at the end of this chapter (Table 9.37).

9.1.1 Hyperion Secondary Effluent Pumping System

Table 9.1 presents the list of recommended improvements to the HSEPS facility and distribution system.

As presented in Table 9.1, the total anticipated cost for improvements at the HSEPS is approximately $83.3 million (M). The most costly improvements are additional pumping capacity to support future demands and the pipeline to parallel the Hyperion Secondary Effluent Force Main (HSEFM) for Scenario 7 demands.

Table 9.1 Project Summary for HSEPS
Capital Implementation Master Plan
West Basin Municipal Water District

ID	Phase	Project Description	Capital Cost$^{(1)}$
HPS-01	FY10/11	Add 23 mgd of additional pumping capacity, to bring firm capacity to 74 mgd of firm capacity. (Phase I of II; total project assumes 7 pumps, 7,000 hp total)	$14,700,000
HPS-03	FY10/11	Secondary Power Connection for Backup Power	$2,520,000
HPS-04	FY10/11	PS Building	$560,000
HPS-05	FY11/12	Add 23 mgd of additional pumping capacity, to bring firm capacity to 97 mgd of firm capacity. (Phase II of II; total project assumes 7 pumps, 7,000 hp total)	$14,700,000
HPS-06	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$725,000
HPS-07	FY20-25	Add 38 mgd of additional firm pumping capacity, to bring total firm capacity to 135 mgd. (For LADWP Westside, Kenneth Hahn, LADWP Harbor Expansion) (Assumes 3 pumps, 3,000 hp increase)	$27,300,000
HPS-08	FY20-25	Parallel HSEFM w/ 36"	$22,815,000
Total			**$83,320,000**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

The additional pumping capacity is split into two initial phases to supply Scenario 5B demands through 2020 and a single post-2020 phase, to accommodate supplies to meet the additional demands for customers of Scenario 7B. Further details on HSEPS capacity requirements can be found in Chapter 4 and Chapter 8.

Consistent with the *HSEPS Expansion Study* (CDM 2004), a secondary power connection is recommended due to limited space and nearby connection availability.

The rehabilitation and replacement project is an aggregation of expected remaining life of existing equipment at the HSEPS as determined by the condition assessment. More information about the condition assessment can be found in the Condition Assessment Technical Memorandum (Carollo 2009), which can be found in Appendix F.

9.1.2 Title 22 Distribution System

Table 9.2 presents the list of recommended improvements to the Title 22 distribution system.

Table 9.2	Project Summary for Title 22 Distribution System Capital Implementation Master Plan West Basin Municipal Water District		
ID	**Phase**	**Project Description**	**Capital Cost[1]**
T22-01	FY12/13	Caltrans Inglewood Lateral	$260,000
T22-02	FY11/12	El Segundo Lateral (Boeing, Kilroy Airport)	$1,500,000
T22-02A	FY09/10	Mariposa Lateral (Mattel, Hilton, Marriot)	$750,000
T22-04	FY10/11	Virco-Torrance Lateral	$340,000
T22-06	FY09/10	Carson Mall Lateral(2)	$2,500,000
T22-07	FY11/12	Redondo Beach Lateral (Pete's Nursery)	$660,000
T22-08	FY11/12	Mills Park Lateral	$245,000
T22-09	FY09/10	Anza Lateral Phase II(2)	$3,500,000
T22-10	FY09/10	Anza PS (4-500 gpm pumps)(2)	$2,000,000
T22-11	FY12/13	Chlorination Stations (Phase I)	$1,960,000
T22-12	FY13/14	Main Street Carson Lateral	$17,075,000
T22-13	FY10/11	Dominguez Street Lateral(2)	$4,500,000
T22-14	FY14/15	Caltrans Gardena Lateral	$985,000
T22-15	FY15-20	Palos Verdes - Lateral 6B	$27,290,000
T22-16	FY15-20	Palos Verdes PS (4-1,250 gpm pumps)	$4,900,000
T22-17	FY15-20	Increase Title 22 product water storage by 5.0 MG	$10,500,000
T22-18A	FY15-20	Gardena Lateral - Normandie Ave	$3,635,000
T22-18B	FY15-20	Gardena Lateral - Normandie and Vermont	$6,170,000
T22-18C	FY15-20	Gardena Lateral - Van Ness	$4,480,000
T22-19	FY09/10	Dyehouse Lateral(2)	$3,000,000
T22-20	FY09/10	Dyehouse PS (3-250 gpm pumps)(2)	$1,500,000
T22-21	FY15-20	Chlorination Stations (Phase II)	$1,960,000
T22-22	FY15-20	Hawthorne Lateral (Solec)	$1,595,000
T22-23	FY15-20	Title-22 PS Discharge Pipeline Modification	$465,000
T22-24	FY20-25	Anza Lateral Break Tank	$4,200,000
T22-25	FY25-30	LA Westside Lateral	$40,005,000
T22-26	FY25-30	Inglewood/LA Westside PS (assumes 4-8,500 gpm pumps)	$28,025,000
Total			**$174,000,000**

Notes:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.
(2) Cost estimates provided by West Basin staff from preliminary design estimates.

Improvements related to treatment of Title 22 product water are included in the summaries of recommendations for ELWRF and NTP. Figure 9.1 shows each of the recommended distribution system improvements, with IDs corresponding to the IDs shown in Table 9.2. As presented in Table 9.2, the recommended improvements for the Title 22 distribution system are approximately $174.0M.

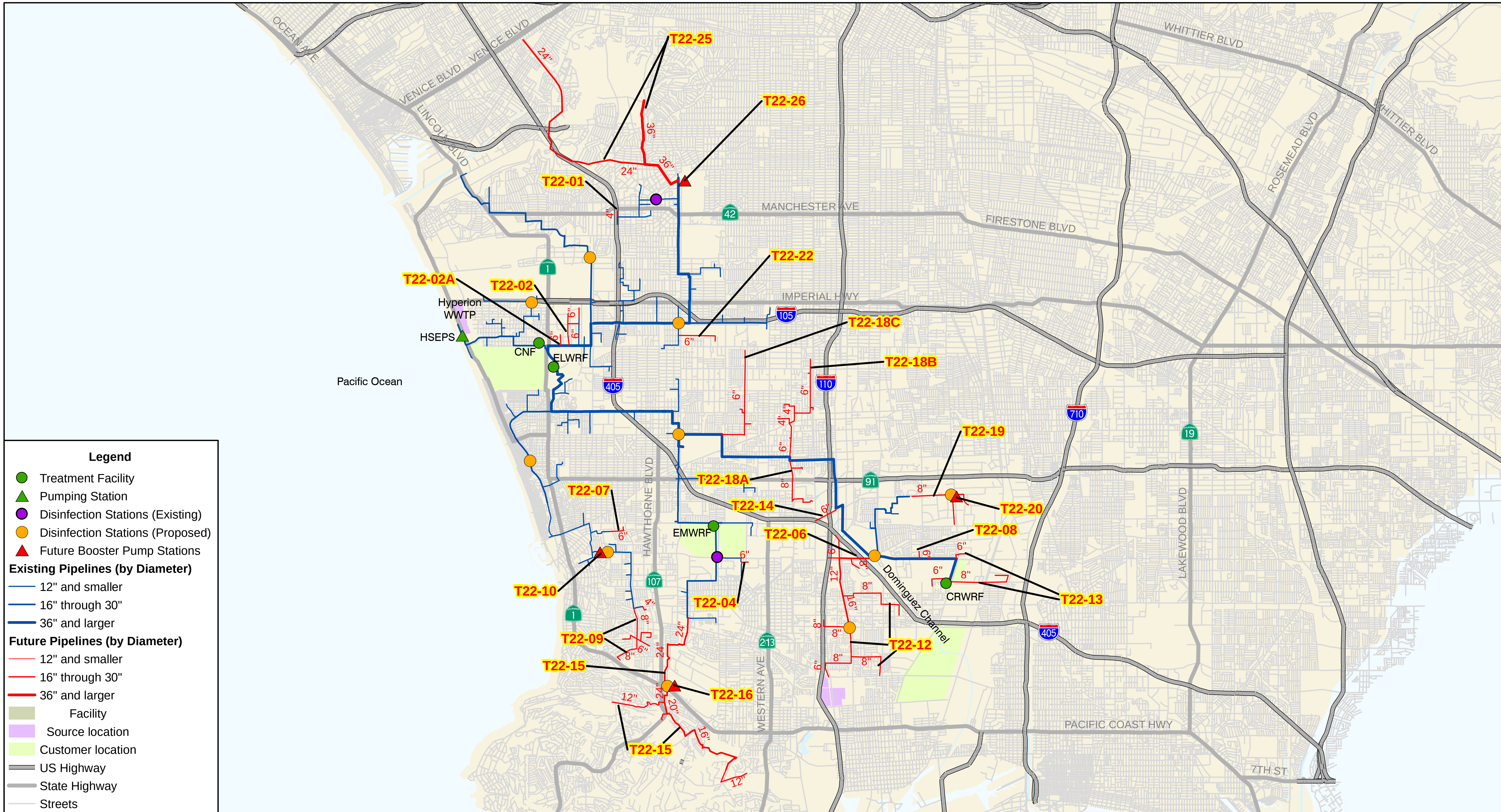

Figure 9.1
Title 22 CIP Projects

West Basin Municipal Water District
Capital Implementation Master Plan For Recycled Water Systems

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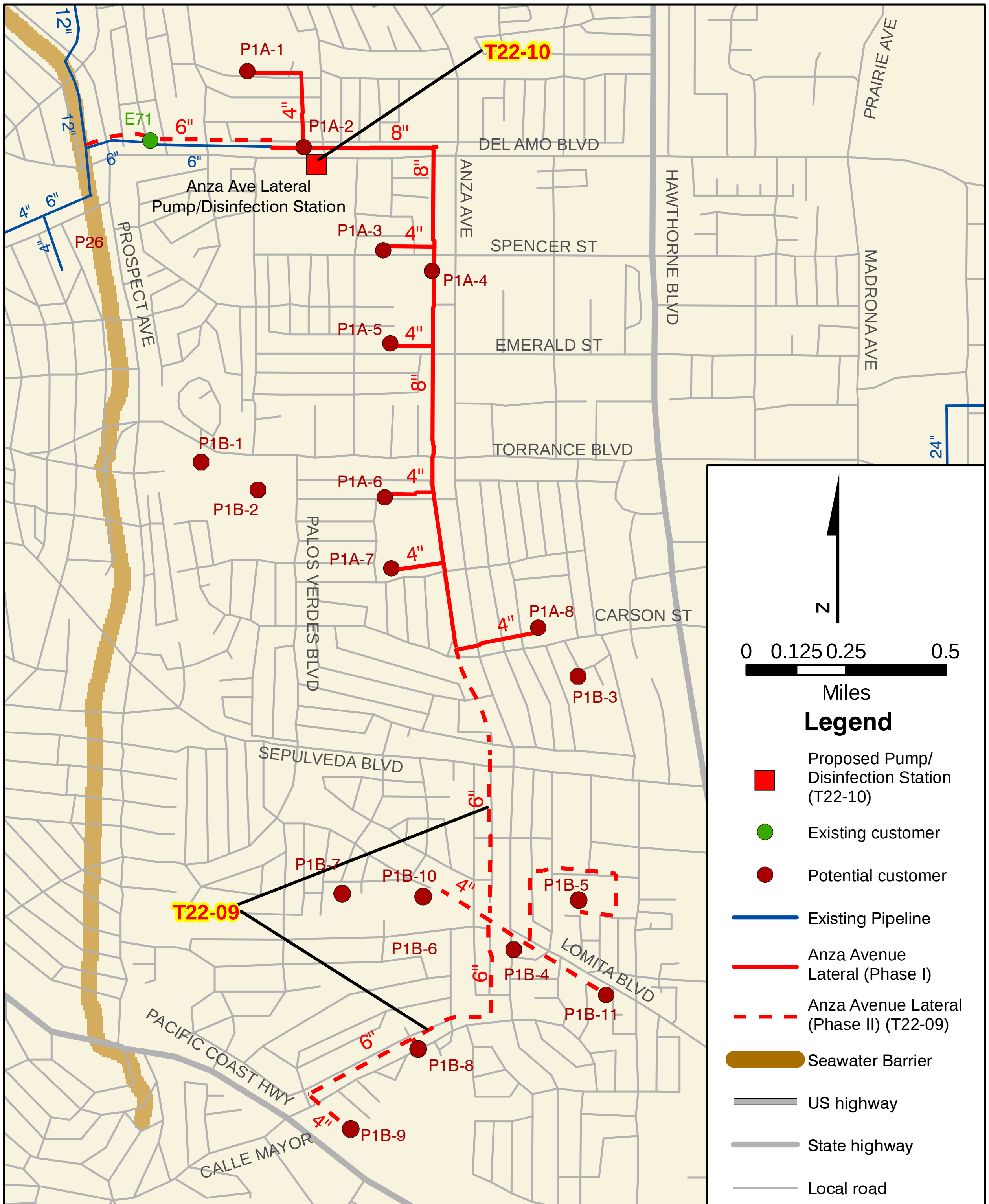
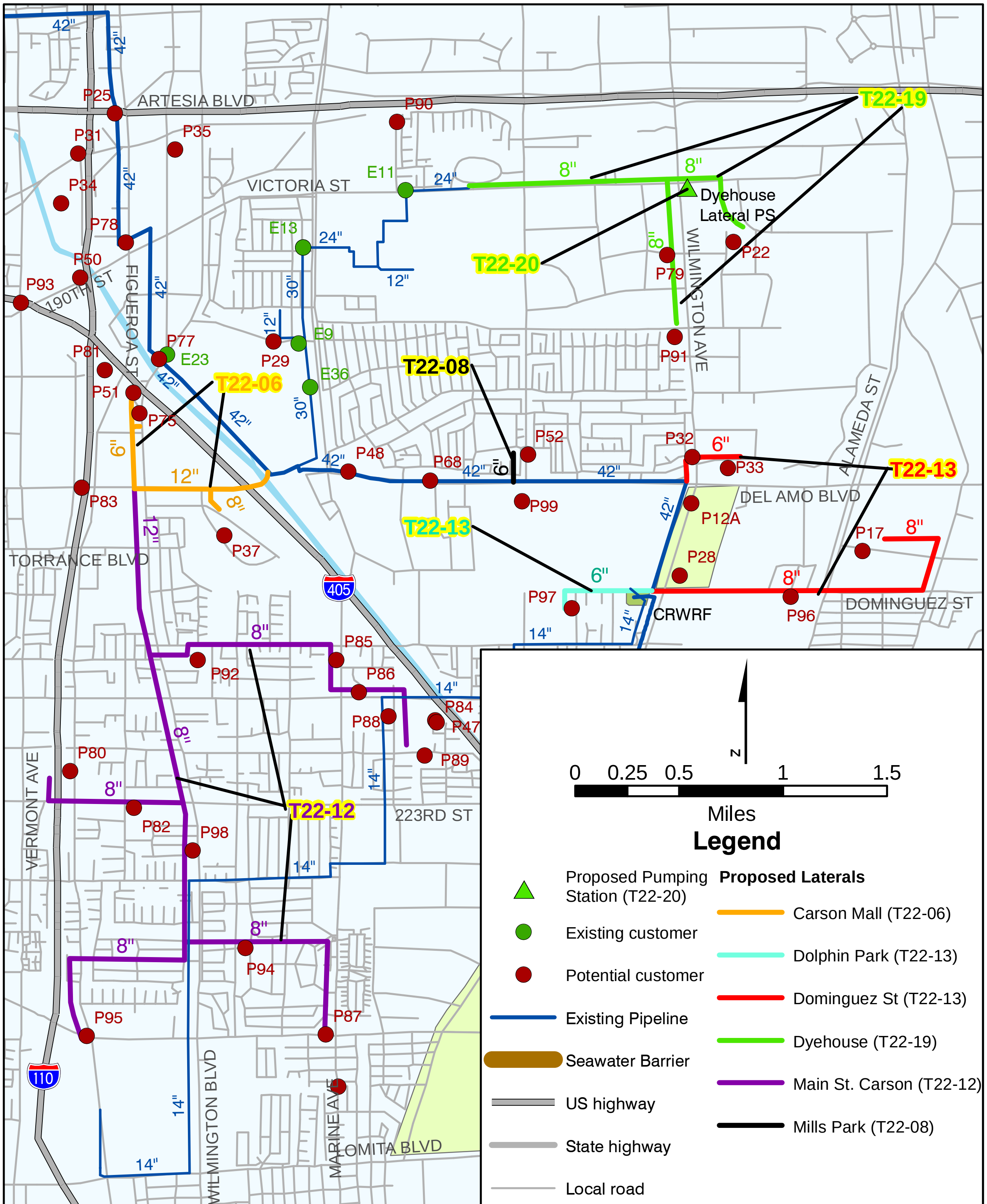


carollo in association with AKM SPI

Figure 9.1A
Anza Avenue Lateral

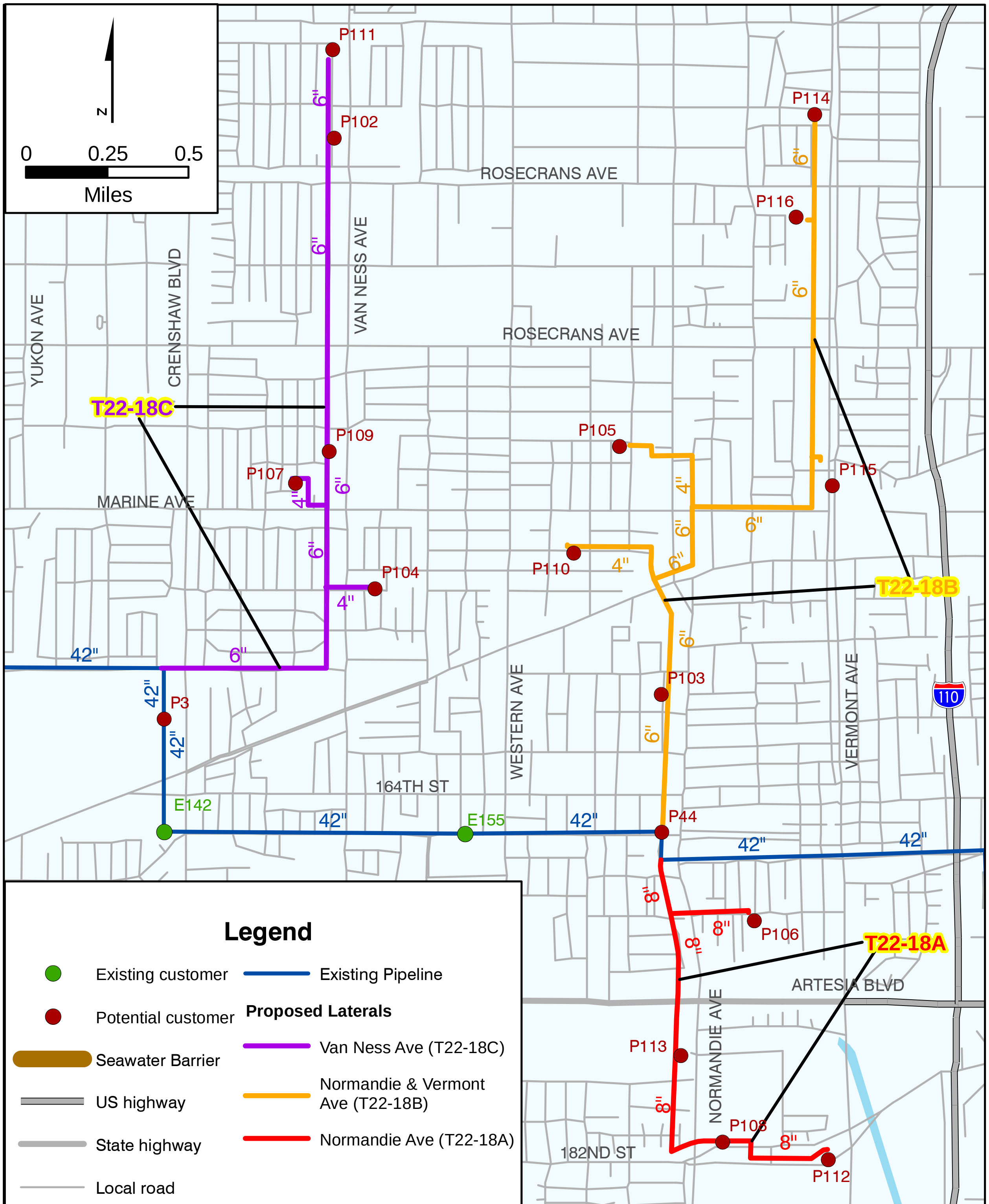
West Basin Municipal Water District
Capital Implementation Master Plan For Recycled Water Systems



carollo in association with AKM SPI

Figure 9.1B
City of Carson - Potential Recycled Water Customer Sites

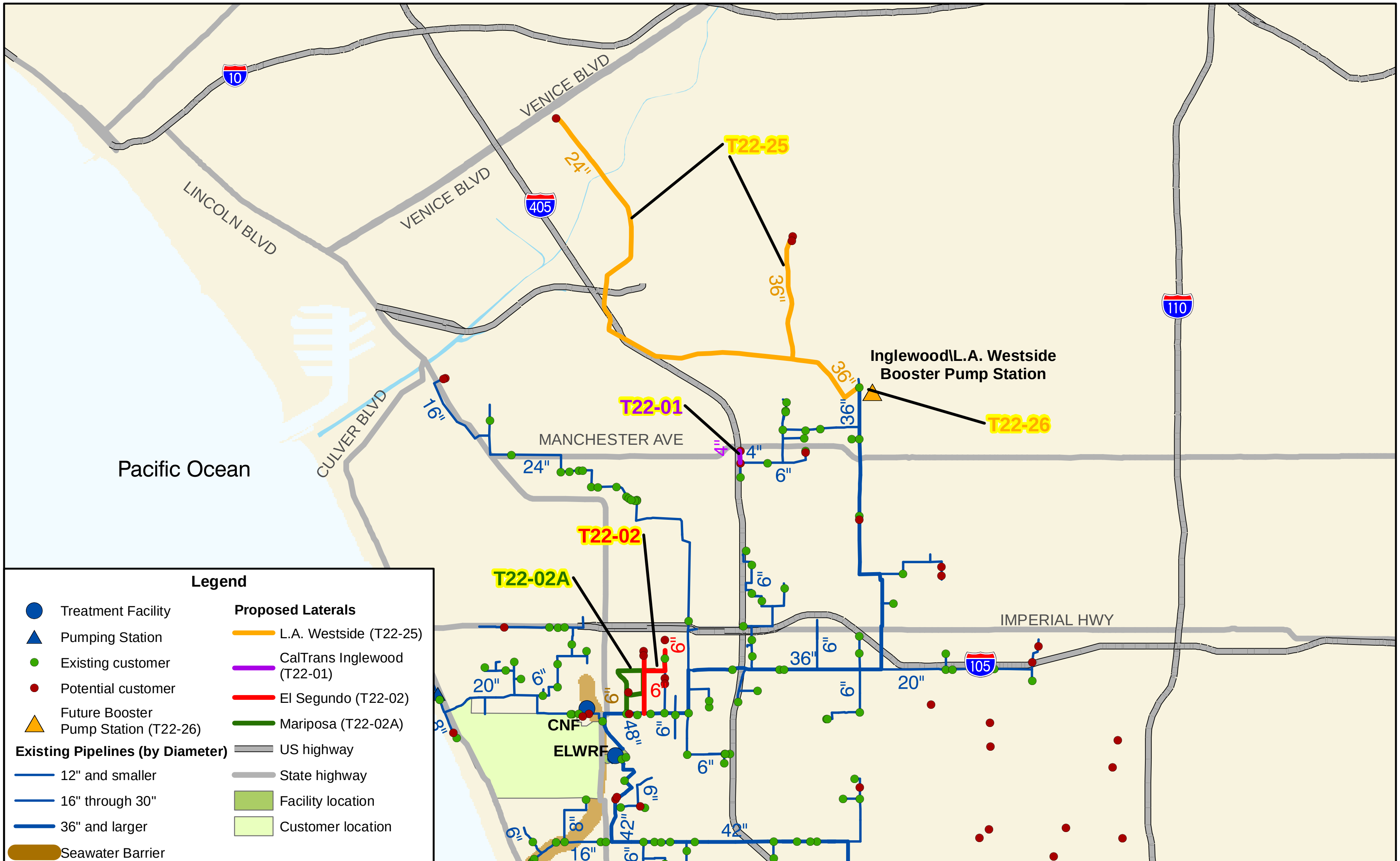
West Basin Municipal Water District
Capital Implementation Master Plan For Recycled Water Systems



carollo
in association with

Figure 9.1C
City of Gardena -
Potential Recycled
Water Customer Sites

West Basin Municipal Water District
Capital Implementation Master Plan For Recycled Water Systems



in association with

West Basin Municipal Water District
Capital Implementation Master Plan For Recycled Water Systems

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Miles

Figure 9.1D
LA Westside and
El Segundo Laterals

For all pipeline alignments, it is recommended that West Basin evaluate alternative alignments during preliminary design. As indicated in Table 9.2, cost estimates for several projects were provided by West Basin based on preliminary design and funding of specific laterals and were not estimated as a part of this study.

Special construction markups were applied to several of the Title 22 distribution system pipelines, as detailed in Table 9.4. The special construction markups were applied utilizing GIS layers for railroad, freeway, and arterial streets to determine which pipeline segments were anticipated to carry a larger cost of construction than anticipated by the developed unit costs. For railroad and freeway crossings, the markups account for assumed jack and bore construction techniques, while for arterial streets, higher markups account for increased cost of temporary traffic control. Where pipeline segments were not easily delineated into segments applicable for application of special construction markups, 500 feet was assumed for the construction markup (i.e., if the pipeline segment is 5,000 feet long, but crosses a freeway, the construction markup is applied to 500 feet of the segment length rather than the entire pipeline length).

It should be noted that the locations of the ten proposed disinfection stations shown on Figure 9.1 need to be verified and further evaluated based on water quality data obtained from field measurements. For budgetary purposes the ten recommended stations were divided into two groups, Phase I (T22-11) and Phase II (T22-21). The prioritization of these stations would need to be evaluated by comparing field measurements of existing and historical chlorine residual levels. It is also recommended that a study be conducted to evaluate if the installation of pig-launching and retrieval ports at strategic locations in the distribution system could replace and/or increase the effectiveness of these proposed disinfection stations. This study is included in the list of recommended studies found in Table 9.35.

For each of the laterals recommended for the Title 22 distribution system, demands served by the lateral are presented in Table 9.3. The projected average annual demands reflect Scenarios 7A and 7B.

A detailed breakdown of pipeline sizes for each lateral is presented in Table 9.4. The lengths in Table 9.4 are grouped into individual projects listed in Table 9.2 and Table 9.37. Special construction considerations indicate portions of the project to which are apply additional markups to account for advanced construction techniques or additional traffic control.

Table 9.3	Demands Associated with Title 22 Laterals Capital Implementation Master Plan West Basin Municipal Water District	
ID	**Project Description**	**Average Annual Demand (afy)**
T22-01	Caltrans Inglewood Lateral	10.0
T22-02	El Segundo Lateral (Boeing, Kilroy Airport)	200.0
T22-02A	Mariposa Lateral (Mattel, Hilton, Marriot)	15.0
T22-04	Virco-Torrance Lateral	10.0
T22-06	Carson Mall Lateral	110.0
T22-07	Redondo Beach Lateral (Pete's Nursery)	25.0
T22-08	Mills Park Lateral	10.0
T22-09	Anza Lateral Phase II	80.0
T22-10	Anza PS (4-500 gpm pumps)	
T22-12	Main Street Carson Lateral	275.0
T22-13	Dominguez Street Lateral	260.0
T22-14	Caltrans Gardena Lateral	25.0
T22-15	Palos Verdes - Lateral 6B	670.0
T22-16	Palos Verdes PS (4-1,250 gpm pumps)	
T22-18A	Gardena Lateral - Normandie Ave	165.0
T22-18B	Gardena Lateral - Normandie and Vermont	70.0
T22-18C	Gardena Lateral - Van Ness	55.0
T22-19	Dyehouse Lateral	220.0
T22-20	Dyehouse PS (3-250 gpm pumps)	
T22-22	Hawthorne Lateral (Solec)	175.0
T22-25	LA Westside Lateral	5,500.0

Table 9.4	Details of Title 22 Laterals Capital Implementation Master Plan West Basin Municipal Water District			
ID	**Project Description**	**Diameter**	**Special Const[1]**	**Length[2] (ft)**
T22-14	Caltrans Gardena Lateral	8	-	215
		6		3,025
T22-01	Caltrans Inglewood Lateral	4	ART	771
T22-06	Carson Mall Lateral	6	-	1,259
		6	ART	1,623
		6	FWY	1,344
		16	-	1,555
		16	FWY	2,597
		8	-	1,508

Table 9.4	Details of Title 22 Laterals Capital Implementation Master Plan West Basin Municipal Water District			
ID	**Project Description**	**Diameter**	**Special Const**[(1)]	**Length**[(2)] **(ft)**
T22-19	Dyehouse Lateral	8	-	11,638
T22-02	El Segundo Lateral (Boeing, Kilroy Airport)	6	-	546
T22-02A	Mariposa Lateral (Mattel, Hilton, Marriot)	6	-	1,400
T22-02	El Segundo Lateral (Boeing, Kilroy Airport)	6	-	5,802
T22-22	Hawthorne Lateral (Solec)	6	-	5,055
T22-15	Palos Verdes - Lateral 6B	24	-	13,048
		20	-	1,417
		16	-	14,232
		12	-	13,642
T22-07	Redondo Beach Lateral (Pete's Nursery)	6	-	2,092
T22-04	Virco-Torrance Lateral	6	-	1,072
T22-08	Mills Park Lateral	6	-	864
T22-12	Main Street Carson Lateral	16	ART	8,452
		8	-	13,538
		8	ART	3,500
		6	-	9,156
		6	ART	2,195
T22-13	Dominguez Street Lateral	6	-	5,073
		8	-	5,887
		8	RR	3,322
T22-18B	Gardena Lateral - Normandie and Vermont	6	-	11,908
		6	ART	2,243
		4	-	5,072
T22-18A	Gardena Lateral - Normandie Ave	8	-	8,235
		8	ART	915
T22-18C	Gardena Lateral - Van Ness	6	-	12,784
		4	-	1,742
T22-25	LA Westside Lateral	24	-	25,802
		36	-	12,721
		36	FWY	1,000
		36	RR	500
T22-09	Anza Lateral Phase II	8	-	8,002
		6	-	7,167
		4	-	698
Total				**234,618**

Notes:

1. Special Construction Markup Abbreviations: ART – Arterial Street requiring extensive temporary traffic control or alternate construction hours (125% of unit cost for distance of crossing or distance along street); RR – Railroad Crossing requiring jack and bore or alternate trenchless construction techniques (200% of unit cost for distance of crossing).FWY – Freeway Crossing requiring jack and bore or alternate trenchless construction techniques (200% of unit cost for distance of crossing).
2. Totals may not line up with Table 9.37 due to rounding.

As shown in Table 9.4, the total length of new Title 22 laterals is estimated at 235,000 lineal feet or 44 miles.

9.1.3 West Coast Barrier System

Table 9.5 presents the list of recommended improvements to the West Coast Barrier distribution system and treatment processes.

Table 9.5 Project Summary for West Coast Barrier System
Capital Implementation Master Plan
West Basin Municipal Water District

ID	Phase	Project Description	Capital Cost
BW-01	FY10/11	ELWRF Phase V Expansion - Increase treatment capacity of Barrier treatment by 5.0 mgd, from 12.5 mgd to 17.5 mgd.	$31,800,000
BW-02	FY10/11	Add VFDs to product water pumps	$700,000(1)
BW-04	FY10/11	Modify site piping at ELWRF, replacing 20-inch discharge piping and meter with 27-inch discharge piping and meter.	$175,000(1)
Total			**$32,675,000**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As presented in Table 9.5, the total anticipated cost for the recommended improvements for the West Coast Barrier System are approximately $32.7 M. The most costly project of the projects proposed for the West Coast Barrier Water System is the Phase V Treatment Expansion Project (BW-01).

For BW-01, the cost estimate shown is from the ELWRF Phase V Expansion Feasibility Study (HDR 2008) and was not estimated as a part of this study. Costs for expansion of the Barrier product water pump station are assumed to be included in the capital cost shown. This project is anticipated to be completed as a part of the ELWRF Phase V Expansion.

9.1.4 Chevron High Pressure Boiler Feed System

Table 9.6 presents the list of recommended improvements to the Chevron HPBF distribution system and treatment processes.

Table 9.6 Project Summary for CHPBF System
Capital Implementation Master Plan
West Basin Municipal Water District

ID	Phase	Project Description	Capital Cost
CH-01	FY10/11	ELWRF Phase V Expansion - Increase treatment capacity of Industrial RO Ultra treatment for HPBF by 0.5 mgd, from 2.6 mgd to 3.1 mgd (to meet MMD of 2,153 gpm).	$2,650,000
CH-02	FY10/11	Replace existing pumps with 2-2,400 gpm pumps (to meet MDD of 2,395 gpm).	$700,000[(1)]
Total			**$3,350,000**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As presented in Table 9.6, the total anticipated cost for improvements for the CHPBF is approximately $3.4M. The most costly component is the additional treatment capacity. Phasing of these improvements is coordinated with the ELWRF Phase V Expansion.

The cost estimate for CH-01 was provided by West Basin staff and is based on cost estimates prepared during ELWRF Phase V Expansion Feasibility Study phase.

9.1.5 Chevron Low Pressure Boiler Feed System

Table 9.7 presents the list of recommended improvements to the Chevron LPBF distribution system and treatment processes, excluding improvements to the system for the addition of the El Segundo Power Plant, which are addressed in Section 9.1.6.

Table 9.7 Project Summary for CLPBF System
Capital Implementation Master Plan
West Basin Municipal Water District

ID	Phase	Project Description	Capital Cost
CL-01	FY10/11	ELWRF Phase V Expansion - Increase treatment capacity of Industrial RO treatment for LPBF by 0.4 mgd, from 1.7 mgd to 2.1 mgd (to meet MMD of 1,218 gpm).	$1,050,000
CL-02	FY10/11	Replace existing pumps with 3-1,250 gpm pumps (to meet MDD of 2,039 gpm).	$1,050,000[(1)]
Total			**$2,100,000**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As presented in Table 9.7, the total anticipated cost for improvements at the CLPBF is approximately $2.1 M. The most costly component is the additional treatment capacity. Phasing of these improvements is coordinated with the ELWRF Phase V Expansion.

The cost estimate for CL-01 was provided by West Basin staff and is based on cost estimates prepared during ELWRF Phase V Expansion Feasibility Study phase.

Figure 9.2 shows locations of each of the recommended improvements from Table 9.7.

9.1.6 El Segundo Power Plant Boiler Feed System

Table 9.8 presents the list of recommended improvements to the El Segundo Power Plant Boiler Feed System distribution system. Pump station costs are included with upgrades to the Chevron Low Pressure Boiler Feed System, found in Table 9.7.

Table 9.8 Project Summary for ESPP System
Capital Implementation Master Plan
West Basin Municipal Water District

ID	Phase	Project Description	Capital Cost(1)
ESPP-01	FY15-20	Add to treatment capacity of Industrial RO treatment for ESPP of 0.5 mgd (to meet MMD of 325 gpm).	$1,900,000
ESPP-02	FY15-20	El Segundo Power Plant Pipeline from Chevron to El Segundo Power Plant	$3,895,000
ESPP-03	FY15-20	PRV at Chevron	$80,000
Total			**$5,875,000**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As presented in Table 9.8, the total anticipated cost for improvements to serve El Segundo Power Plant is approximately $5.9 M. The most costly component is the pipeline from the CLPBF system to the El Segundo Power Plant.

For ESPP-01, the cost estimate shown is from the ELWRF Phase V Expansion Study and was not estimated as a part of this study. Figure 9.2 shows locations of each of the recommended improvements from Table 9.8.

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Figure 9.2
Chevron LPBF & ESPP
CIP Projects

West Basin Municipal Water District
Capital Implementation Master Plan For Recycled Water Systems

9.1.7 Chevron Nitrified Water System

Table 9.9 presents the list of recommended improvements to the Chevron Nitrified Water distribution system. Recommended improvements for treatment, backup power, and replacement equipment for the Chevron Nitrification Facility are included in Table 9.18.

**Table 9.9 Project Summary for Chevron Nitrified Water System
Capital Implementation Master Plan
West Basin Municipal Water District**

ID	Phase	Project Description	Capital Cost(1)
CN-01	FY10/11	Replace existing pumps with 4-1,800 gpm pumps (to meet peak demand of 5,164 gpm).	$1,575,000
Total			**$1,575,000**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As presented in Table 9.9, the total anticipated cost for improvements at the CNS is approximately $1.6M. The only recommendation for this distribution system is upgrade of the pump station. Phasing of this improvement is coordinated with the ELWRF Phase V Expansion. It should be noted that the improvements associated with the Chevron Nitrification Facility are listed in Section 9.1.16.

9.1.8 ELWRF Brine Line

Table 9.10 presents the list of recommended improvements to the ELWRF Brine Line system. Recommended improvements for treatment, backup power, and replacement equipment for this system are included in the ELWRF improvement list in Table 9.15.

**Table 9.10 Project Summary for ELWRF Brine Line
Capital Implementation Master Plan
West Basin Municipal Water District**

ID	Phase	Project Description	Capital Cost(1)
EBRN-01	FY10/11	Install pinch valves/reducers	$630,000
EBRN-02	FY11/12	Install access ports for cleaning	$1,885,000
Total			**$2,515,000**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As presented in Table 9.10, the total anticipated cost for improvements in the ELWRF Brine Line system is approximately $2.5 M.

9.1.9 bp Reverse Osmosis System

Table 9.11 presents the list of recommended improvements to the bp RO system.

Table 9.11 Project Summary for bp Reverse Osmosis System
Capital Implementation Master Plan
West Basin Municipal Water District

ID	Phase	Project Description	Capital Cost(1)
BPRO-01	FY11/12	Treat SE from JWPCP w/ MF/RO to serve growth in bp RO System	$73,080,000
BPRO-02	FY11/12	New Pipeline from NTP to bp for conveyance of Industrial RO Water.	$8,705,000
BPRO-03	FY11/12	New pump station at NTP to serve bp Industrial RO (assumes 4-2,100 gpm pumps, in PS w/ BPN-04)	$4,200,000
Total			**$85,985,000**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As presented in Table 9.11, the total anticipated cost for improvements in the bp RO system is approximately $86.0 M. The most costly component is the treatment associated with supplying Industrial RO water at the JWPCP. It is important to note that under supply alternative Option 1, discussed in Section 8.4, this cost would be partially encountered through expansion of the conventional Title 22 treatment processes at ELWRF, but the MF/RO treatment at JWPCP incorporates both SE treatment and Industrial RO treatment into one process. Phasing of these improvements are coordinated with the CRWRF Phase II Expansion.

9.1.10 bp Nitrified Water System

Table 9.12 presents the list of recommended improvements to the bp Nitrified water system.

As presented in Table 9.12, the total anticipated cost for improvements in the bp Nitrified system is approximately $48.0 M. The most costly component is the treatment associated with supplying MF water at the JWPCP to the Nitrification process. It is important to note that under supply alternative Option 1, discussed in Section 8.4, this cost would be partially encountered through expansion of the conventional Title 22 treatment processes at ELWRF. Phasing of these improvements are coordinated with the CRWRF Phase II Expansion.

Table 9.12 Project Summary for bp Nitrified Water System
Capital Implementation Master Plan
West Basin Municipal Water District

ID	Phase	Project Description	Capital Cost(1)
BPN-01	FY11/12	Treat SE from JWPCP w/ MF to serve growth in bp Nitrified System	$16,800,000
BPN-02	FY11/12	Nitrified Treatment - treat MF treated SE (BPN-01) from JWPCP to serve growth in bp Nitrified System	$12,205,000
BPN-03	FY11/12	New 20" pipeline from NTP to bp for conveyance of Nitrified Water.	$9,535,000
BPN-03A	FY11/12	Parallel 14" pipeline from CRWRF to bp for conveyance of Nitrified Water.	$4,245,000
BPN-04	FY11/12	New pump station at NTP to serve bp Nitrified (assumes 4-1,500 gpm pumps, in PS w/ BPRO-03)	$3,150,000
BPN-05	FY11/12	Add a 1.0 MG storage reservoir to NTP to maintain current number of hours of backup for bp Nitrified system.	$2,100,000
Total			**$48,035,000**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

The 14-inch diameter parallel pipeline from CRWRF to Gate 7 at the bp Carson Refinery would provide redundancy to the current 12-inch diameter pipeline used for conveyance of Nitrified Water. The configuration of the projects listed in Table 9.12 will need to be established during preliminary design.

9.1.11 CRWRF Brine Line

Table 9.13 presents the list of recommended improvements to the CRWRF Brine Line system. Recommended improvements for treatment, backup power, and replacement equipment for this system are included in the CRWRF improvement list in Table 9.16.

As presented in Table 9.13, the total anticipated cost for improvements in the CRWRF Brine Line system is approximately $1.3M. Phasing of these improvements is coordinated with the CRWRF Phase II Expansion.

Table 9.13	Project Summary for CRWRF Brine Line Capital Implementation Master Plan West Basin Municipal Water District		
ID	**Phase**	**Project Description**	**Capital Cost(1)**
CBRN-01	FY11/12	Install access ports for cleaning	$1,260,000
Total			**$1,260,000**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As discussed in Chapter 8, sufficient pressure is available at the CRWRF RO process train to convey the additional flow anticipated for this system. Costs for reconfiguring the RO process train to provide additional head for this system are assumed minimal and thus not included in the CIP.

9.1.12 System-Wide Improvements

Table 9.14 presents a list of recommended improvements which apply to more than one West Basin facility.

Table 9.14	Project Summary for System-Wide Improvements Capital Implementation Master Plan West Basin Municipal Water District		
ID	**Phase**	**Project Description**	**Capital Cost**
SW-01	Mult	United Water Recapitalization Improvements (recurring)	$4,230,000
SW-02	FY09/10	UW Recap - Major Painting Projects	$150,000
SW-03	FY09/10	UW Recap - Purchase trailer for spill response	$5,000
SW-04	FY09/10	UW Recap - Asset Management Software, Implementation and Training	$300,000
SW-05	FY09/10	UW Recap - Replace all Biofor valves at CNF and EMWRF	$200,000
SW-06	Mult	United Water Recapitalization Improvements (recurring)	$4,230,000
Total			**$9,115,000**

As shown in Table 9.14, the costs for improvements associated with more than one facility total $9.1M. The system-wide improvements consist solely of recapitalization improvements, identified by United Water (UW), West Basin's system operator. These are improvements requested by United Water and are listed individually for FY0910. For conservative planning purposes, it is assumed a similar cost will occur approximately every five years through the planning horizon, in FY1415, FY15-20, FY20-25, and FY25-30. The total capital cost of the recurrence of these items is summarized in SW-01 and SW-06 (listed as two separate projects to separate the costs for FY1415 through FY1920 and FY2021 through FY2930). United Water projects are listed similarly for all treatment facilities. For a summary of these project costs by treatment facility and other recurring costs, see Section 9.3.4.

9.1.13 ELWRF

The recommended projects for ELWRF are listed in Table 9.15.

As presented in Table 9.15, the total anticipated cost for improvements for ELWRF is anticipated to be approximately $276.2 M. Phasing of improvements related to Phase V are coordinated with the ELWRF Phase V Expansion, and are included in the relevant subsystems (i.e., Sections 9.1.3, 9.1.4, 9.1.5, and 9.1.6). A summary of items included in the Phase V expansion are included in Section 9.3.3).

Table 9.15 does not include treatment expansions at ELWRF associated with subsystems, as detailed in Sections 9.1.3, 9.1.4, 9.1.5, and 9.1.6. The total cost of all projects physically located at ELWRF, including projects listed in detailed in Sections 9.1.3, 9.1.4, 9.1.5, and 9.1.6, is estimated to be $316.2 M (excluding the Title 22 pump station and storage).

Table 9.15 Project Summary for ELWRF
Capital Implementation Master Plan
West Basin Municipal Water District

ID	Phase	Project Description	Capital Cost(1)
ELWRF-01	FY09/10	UW Recap - T-22 backwash pump total rebuilds (increase capacity of T22 backwash blower)	$100,000
ELWRF-03	FY10/11	ELWRF Phase V Expansion - Add redundant gravity thickener.	$1,960,000
ELWRF-04	FY10/11	ELWRF Phase V Expansion - Resolve underperformance of baskwash equalization basin.	$170,000
ELWRF-05	FY10/11	ELWRF Phase V Expansion - Redundant Sludge Conditioning Tank	$140,000
ELWRF-06	FY10/11	Increase Capacity of Title 22 Air Vacuum Release Valve for Product Water Storage Tanks	$100,000
ELWRF-07	FY12/13	Add Title 22 High Rate Clarifier and Title 22 Filters (to bring clarifier from 30.0 mgd to 50.0 mgd and filter capacity from 40.0 mgd to 50.0 mgd)	$12,600,000
ELWRF-09	FY15-20	Add 17.3 mgd of Title 22 Treatment, to increase Title 22 treatment capacity from 50.0 mgd to 67.3 mgd	$48,440,000

Table 9.15	**Project Summary for ELWRF Capital Implementation Master Plan West Basin Municipal Water District**		
ID	**Phase**	**Project Description**	**Capital Cost(1)**
ELWRF-10	FY15-20	Increase capacity of Title 22 Pump Station at ELWRF by 3,200 hp (from 4,800 hp to 8,000 hp) to serve Future Title 22 Customers	$14,340,000
ELWRF-11	FY15-20	Microfiltration - Replace existing Phase II and III MF System w/ Pressurized System	$16,800,000
ELWRF-12	FY15-20	Backup Power	$11,200,000
ELWRF-13	FY15-20	Dewatered Sludge Handling Transfer System	$2,800,000
ELWRF-15	FY15-20	Potable Water Connection to ELWRF	$280,000
ELWRF-16	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$21,860,000
ELWRF-17	Mult	Membrane Replacement (recurring)	$11,053,800
ELWRF-18	Mult	United Water Recapitalization Improvements (recurring)	$5,070,000
ELWRF-19	FY09/10	UW Recap - Pave area between T 22 filters and the holding basins	$8,800
ELWRF-20	FY09/10	UW Recap - Shelter/Overhead cover when CO2 tank is removed. To provide covered storage area for chemical totes. Include access for forklifts around dike area.	$100,000
ELWRF-21	FY09/10	UW Recap - Phase III Memcor and SCADA and PC	$5,000
ELWRF-22	FY09/10	UW Recap - No. 3 Sulfuric acid day tank replace	$30,000
ELWRF-23	FY09/10	UW Recap - Replace grating replacement in chemical area with chemical resistant grating	$40,000
ELWRF-24	FY09/10	UW Recap - Trench Drains at Decant Sump area	$30,000
ELWRF-25	FY09/10	UW Recap - Power receptacles for emergency generator hook up for Title 22	$20,000
ELWRF-26	FY09/10	UW Recap - Replace DCS back up power (48vac) generator	$45,000
ELWRF-27	FY09/10	UW Recap - Flow control valve and actuator for barrier product pump	$100,000
ELWRF-28	FY09/10	UW Recap - Replace or expand plant instrument air compressor system	$75,000
ELWRF-29	FY09/10	UW Recap - Replace phase II RO Membranes	$375,000
ELWRF-30	FY09/10	UW Recap - Data Parser to allow for direct entry of data from instrumentation into LIMS.	$25,000
ELWRF-31	FY09/10	UW Recap - Replace or repair lab wall to prevent water intrusion and mold	$25,000
ELWRF-32	FY20-25	Land Acquisition of 4.0 ac near ELWRF for Expansion of Title 22 Beyond 70.0 mgd	$9,600,000

Table 9.15	Project Summary for ELWRF Capital Implementation Master Plan West Basin Municipal Water District		
ID	**Phase**	**Project Description**	**Capital Cost[1]**
ELWRF-33	FY25-30	Increase capacity of Title 22 Pump Station at ELWRF by 4,000 hp (from 8,000 hp to 12,000 hp) to serve LADWP Harbor Expansion, Westside, and Kenneth Hahn	$16,800,000
ELWRF-34	FY25-30	Add 8.9 mgd of Additional Title 22 Treatment to Serve LADWP Harbor Expansion, increasing Title 22 Treatment Capacity from 67.3 mgd to 76.2 mgd	$24,945,000
ELWRF-35	FY25-30	Add 15.3 mgd of Additional Title 22 Treatment to Serve LADWP Westside and Kenneth Hahn Park, increasing Title 22 Treatment Capacity from 76.2 mgd to 91.5 mgd	$42,970,000
ELWRF-36	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$17,965,000
ELWRF-37	Mult	Membrane Replacement (recurring)	$11,055,000
ELWRF-38	Mult	United Water Recapitalization Improvements (recurring)	$5,070,000
Total			**$276,197,600**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

Recapitalization improvements requested by United Water are listed individually for FY09/10 (ELWRF-19 through ELWRF-31). For conservative planning purposes, it is assumed a similar cost will occur approximately every five years through the planning horizon, in FY14/15, FY15-20, FY20-25, and FY25-30. The total capital cost of the recurrence of these items is summarized in ELWRF-18 and ELWRF-38 (listed as two separate projects to separate the costs for FY14/15 through FY19/20 and FY20/21 through FY29/30). For detailed information on the development of recurring costs, see Section 9.3.4.

9.1.14 CRWRF

The recommended projects for CRWRF are listed in Table 9.16. As seen in Table 9.16, the total anticipated cost for improvements for CRWRF is anticipated to be approximately $126.1 M. The most costly recommendation for this distribution system is the Nitrified treatment for future Nitrified water demands served by CRWRF.

Table 9.15 does not include treatment expansions at the NTP, which are detailed in Sections 9.1.9 and 9.1.10. If the JWPCP secondary source is not utilized for service to bp and Dominguez Gap Barrier, most of the NTP projects would need to be redefined and included at CRWRF.

Figure 9.3 shows the proposed alignment of the pipeline required to convey recycled water to the boundary between the cities of Carson and Los Angeles to deliver the LADWP Harbor demand. This figure also shows the alignment of the pipeline to serve the bp Nitrification demands (listed in Table 9.12, with the bp Nitrified water distribution system) associated with the NTP. It should be noted that the actual locations of the NTP and the pipeline would need to be determined during preliminary design of these projects.

Table 9.16 Project Summary for CRWRF
Capital Implementation Master Plan
West Basin Municipal Water District

ID	Year / Phase	Project Description	Capital Cost[1]
CRWRF-01	FY11/12	Pipeline for LADWP Harbor demands at Carson City bndy	$29,100,000
CRWRF-02	FY11/12	Nitrified Treatment of Title 22 Water (Nitrified Water for LADWP Harbor Demand and Rhodia)	$43,141,278
CRWRF-03	FY11/12	Add new 11.6 mgd pump station at CRWRF to serve LADWP Harbor Demand Phase II (5 pumps)	$5,250,000
CRWRF-04	FY11/12	Surge Protection – Modify MF Units with Break Tank and Pumps	$6,300,000
CRWRF-05	FY11/12	Raw Water Storage (1 hour)	$5,250,000
CRWRF-06	FY11/12	Repair Nitrified Product Water Storage Tank	$560,000
CRWRF-07	FY15-20	Backup Power	$2,520,000
CRWRF-08	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$6,375,000
CRWRF-09	Mult	Membrane Replacement (recurring)	$2,799,000
CRWRF-10	Mult	United Water Recapitalization Improvements (recurring)	$1,690,000
CRWRF-11	FY09/10	UW Recap - Construct paved access way from road to rear side of RO CIP tank.	$10,000
CRWRF-12A	FY20-25	Nitrified Treatment of Title 22 Water (Nitrified Water for LADWP Harbor Demand Phase II)	$10,480,000
CRWRF-12B	FY20-25	Add new 7.1 mgd pump station at CRWRF to serve LADWP Harbor Demand Phase II (5 pumps)	$4,200,000
CRWRF-13	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$3,895,000
CRWRF-14	Mult	Membrane Replacement (recurring)	$2,800,000
CRWRF-15	Mult	United Water Recapitalization Improvements (recurring)	$1,690,000
Total			**$126,060,278**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

Recapitalization improvements requested by United Water are listed individually for FY09/10 (CRWRF-11). For conservative planning purposes, it is assumed a similar cost will occur approximately every five years through the planning horizon, in FY14/15, FY15-20, FY20-25, and FY25-30. The total capital cost of the recurrence of these items is summarized in CRWRF-10 and CRWRF-15 (listed as two separate projects to separate the costs for FY14/15 through FY19/20 and FY20/21 through FY29/30). For detailed information on the development of recurring costs, see Section 9.3.4.

9.1.15 EMWRF

Table 9.17 presents the list of recommended improvements to EMWRF.

**Table 9.17 Project Summary for EMWRF
Capital Implementation Master Plan
West Basin Municipal Water District**

ID	Phase	Project Description	Capital Cost[(1)]
EMWRF-01	FY11/12	Repair or Replace Bulk Chemical Storage Tank and Associated Equipment	$700,000
EMWRF-02	FY11/12	Inspect Nitrified Product Water Storage Tank Internal Condition	$85,000
EMWRF-03	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$6,980,000
EMWRF-04	FY15-20	Add 0.6 mgd of Industrial RO Treatment of Title 22 Water (half of 1,000 afy total w/ RO).(6)	$1,890,000
EMWRF-05	FY15-20	Add 0.5 mgd of Nitrified Treatment of Title 22 Water (half of 1,000 afy total w/ Nitrified).(6)	$735,000
EMWRF-06	FY15-20	Surge Protection - Modify MF Units with Break Tank and Pumps	$3,500,000
EMWRF-07	FY15-20	Backup Power for Product Water Pumps	$700,000
EMWRF-08	Mult	Membrane Replacement (recurring)	$1,650,000
EMWRF-09	Mult	United Water Recapitalization Improvements (recurring)	$850,000
EMWRF-10	FY09/10	UW Recap - Pavement of area between gated entrance and plant.	$20,000
EMWRF-11	FY09/10	UW Recap - Add an additional air compressor for the MF system	$30,000
EMWRF-12	FY09/10	UW Recap - RO Train 4 membrane change out	$160,000
EMWRF-13	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$3,265,000
EMWRF-14	Mult	Membrane Replacement (recurring)	$1,650,000
EMWRF-15	Mult	United Water Recapitalization Improvements (recurring)	$850,000
Total			**$23,065,000**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As presented in Table 9.17, the total anticipated cost for improvements for EMWRF is anticipated to be approximately $23.1 M. Projects EMWRF-04 and EMWRF-05 are included to accommodate potential expansion of the capacity of EMWRF. It should be noted that, as the projects due to growth or expansion anticipated at EMWRF are not associated with demands listed in the customer database, no analysis or hydraulic evaluation associated with the effects of these demands was conducted (these demands are not mentioned in Chapters 3, 4, or 8). All remaining projects are either replacement or rehabilitation of existing equipment, as planned by the condition assessment, reliability projects, or surge reduction projects to reduce surges to the Title 22 distribution system (i.e., EMWRF-06).

Recapitalization improvements requested by United Water are listed individually for FY09/10 (EMWRF-10 through EMWRF-12). For conservative planning purposes, it is assumed a similar cost will occur approximately every five years through the planning horizon, in FY14/15, FY15-20, FY20-25, and FY25-30. The total capital cost of the recurrence of these items is summarized in EMWRF-09 and EMWRF-15 (listed as two separate projects to separate the costs for FY14/15 through FY19/20 and FY20/21 through FY29/30). For detailed information on the development of recurring costs, see Section 9.3.4.

9.1.16 CNF

Table 9.18 presents the list of recommended improvements to CNF.

As presented in Table 9.17, the total anticipated cost for improvements for CNF is anticipated to be approximately $11.5 M. The vast majority of this cost is in replacement of existing equipment, as planned by the condition assessment. However, the costs for expansion of Nitrified treatment capacity are also significant. These improvements are described as the ELWRF Phase Va Expansion.

It should be noted that costs associated with the Chevron Nitrified Water system (consisting solely of expansion of the Nitrified water product water pump station) are included in Section 9.1.7, even though they are geographically located at the CNF. Since the Chevron Nitrified Water system costs total $1.7 M, the total cost of all improvements anticipated at the CNF is estimated to be $13.1 M.

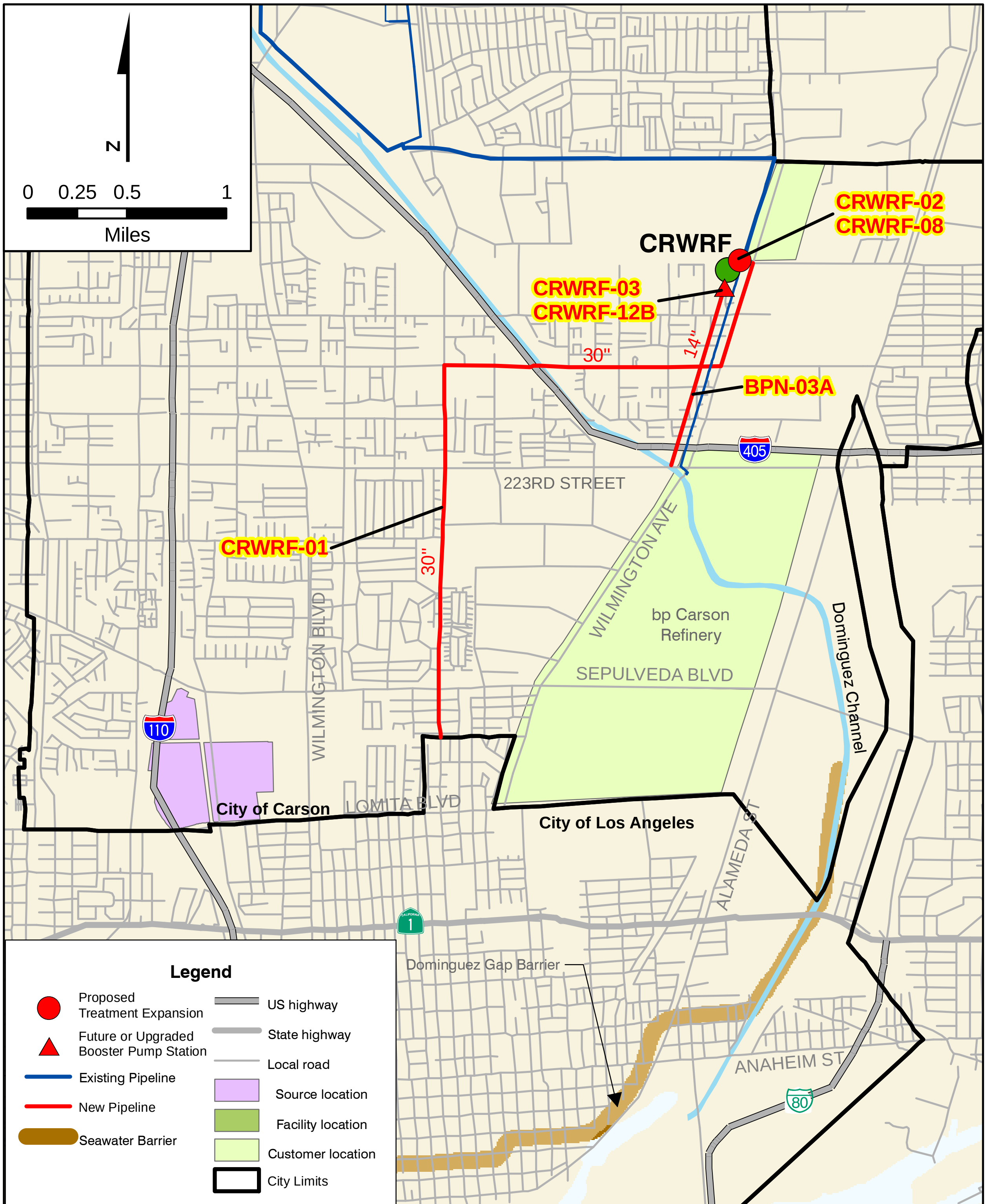

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Figure 9.3
Carson Regional Water Recycling Facility (CRWRF) Area CIP

West Basin Municipal Water District
Capital Implementation Master Plan For Recycled Water Systems

Table 9.18		Project Summary for CNF Capital Implementation Master Plan West Basin Municipal Water District	
ID	**Phase**	**Project Description**	**Capital Cost[1]**
CNF-01	FY15-20	ELWRF Phase Va Expansion - Increase treatment capacity of Nitrified by 2.1, from 4.9 mgd to 7.0 mgd. (Two Biofor Units)	$3,090,000
CNF-02	FY15-20	ELWRF Phase Va Expansion - Backup Power to Product Water Pumps	$700,000
CNF-03	FY10/11	ELWRF Phase Va Expansion - Replace Turbine	$700,000
CNF-04	FY15-20	ELWRF Phase Va Expansion - Potable Water Backup Supply	$350,000
CNF-05	FY11/12	ELWRF Phase Va Expansion - Inspect Nitrified Product Water Storage Tank Internal Condition	$85,000
CNF-06	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$4,520,000
CNF-07	Mult	United Water Recapitalization Improvements (recurring)	$850,000
CNF-08	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$350,000
CNF-09	Mult	United Water Recapitalization Improvements (recurring)	$850,000
Total			**$11,495,000**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

No recapitalization improvements requested by United Water are included for CNF. For conservative planning purposes, it is assumed United Water costs will be required in future years, similar to West Basin's other treatment facilities approximately every five years through the planning horizon, in FY14/15, FY15-20, FY20-25, and FY25-30. The total capital cost of the recurrence of these items is summarized in CNF-07 and CNF-09 (listed as two separate projects to separate the costs for FY14/15 through FY19/20 and FY20/21 through FY29/30). For detailed information on the development of recurring costs, see Section 9.3.4.

9.1.17 New Treatment Plant System

A new treatment plant (NTP) is needed to cost-effectively meet expanded advanced treatment demands in the south-east portion of West Basin's service area. As discussed in Chapter 8, it was determined that it would be most beneficial to add additional treatment on the south-east side to the West Basin recycled water system by treating secondary effluent from the Los Angeles County Sanitation District's JWPCP. This would provide cost savings and increase the overall system reliability. Sizing of the NTP is discussed in Section 8.4.1. The major recommended components for this treatment plant and associated distribution system are listed in Table 9.19. Treatment, pump station, and pipeline improvements associated with specific distribution systems are included separately with those distribution systems (i.e., Sections 9.1.9 and 9.1.10).

Table 9.19 Project Summary for the New Treatment Plant
Capital Implementation Master Plan
West Basin Municipal Water District

ID	Phase	Project Description	Capital Cost(1)
NTP-01	FY11/12	Land Acquisition of 4.5 ac near JWPCP for NTP	$4,800,000
NTP-02	Mult	Membrane Replacement (recurring)	$8,525,000
NTP-03	FY20-25	Barrier Water Treatment - treat SE from JWPCP to serve Dominguez Gap (Phase I and II)	$34,125,000
NTP-04	FY20-25	Add new 3.1 mgd pump station at NTP to serve Dominguez Gap (Phase I + II)	$2,100,000
NTP-05	FY20-25	New Pipeline from NTP to Dominguez Gap Barrier Blending Station for conveyance of Barrier Water.	$9,640,000
NTP-06	Mult	Membrane Replacement (recurring)	$17,050,000
Total			**$76,240,000**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As presented in Table 9.19, the total anticipated cost for improvements for the NTP is approximately $76.2 M. The most costly recommendation listed in Table 9.19 is the treatment costs associated with the Dominguez Gap Barrier. However, treatment capacities for the bp Nitrified water system and bp RO system are listed separately in Sections 9.1.9 and 9.1.10 although they would be geographically located at the NTP.

The total cost of all improvements located at the NTP is estimated to be $187.8 M. It is important to note that under supply alternative Option 1, as discussed in Section 8.4, this cost would be partially encountered through expansion of the conventional Title 22 treatment processes at ELWRF. Phasing of these improvements is coordinated with the CRWRF Phase II Expansion.

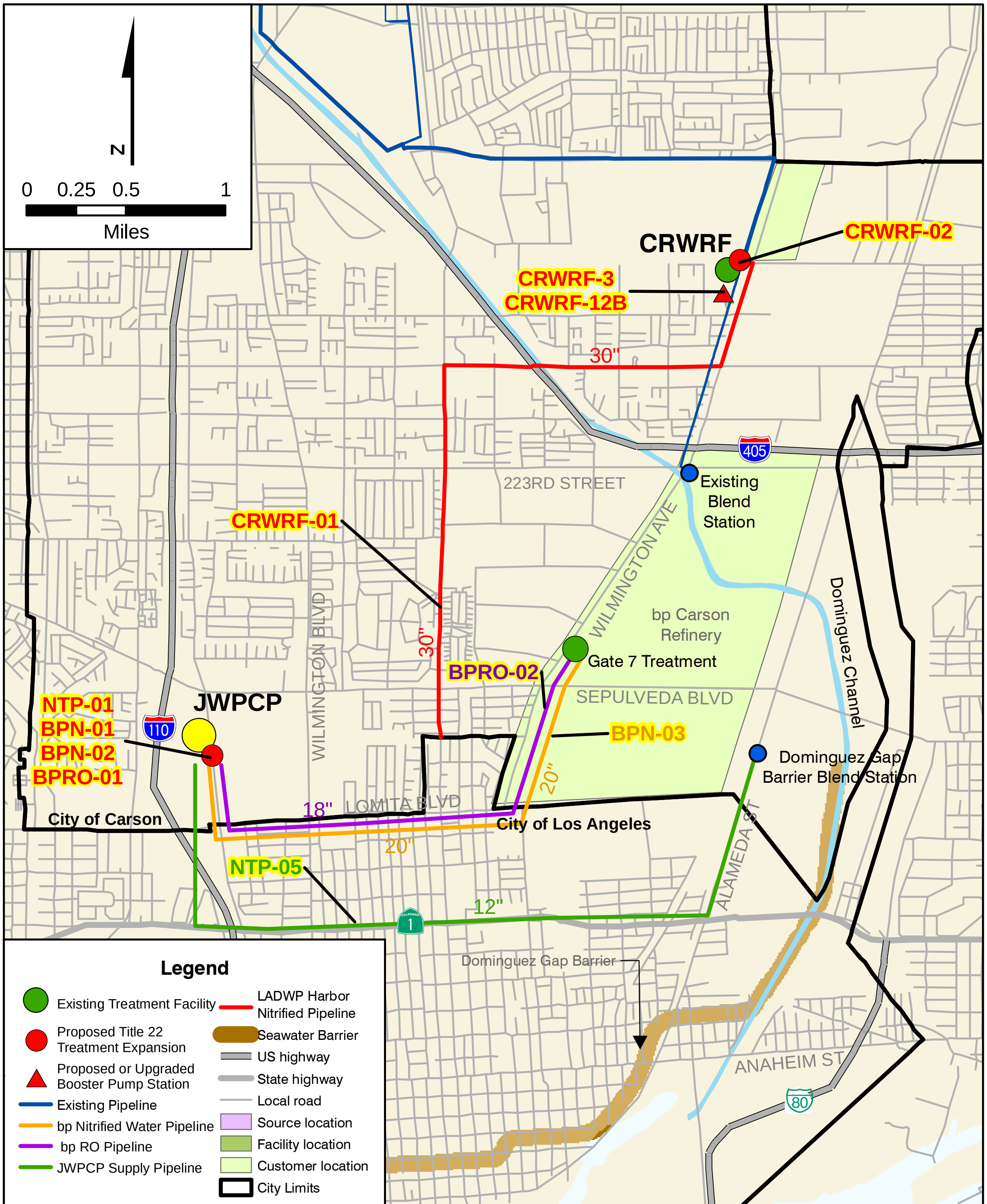

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Figure 9.4
New Treatment Plant
(NTP) Area CIP

West Basin Municipal Water District
Capital Implementation Master Plan For Recycled Water Systems

Based on the modeling conducted with *OPTIMO*™, the major treatment process components that would need to be included in this NTP are:

- Microfiltration (MF)
- Reverse Osmosis (RO)
- MF Backwash Disposal
- RO Brine Disposal
- Disinfection

This NTP could be located at or in the vicinity of JWPCP, CRWRF, or along the transmission main alignment between the two plants. The preliminary locations of the facilities are shown on Figure 9.4. It should be noted that the actual locations of the NTP and the associated pipelines would need to be determined during preliminary design of these projects.

9.1.18 CIP Summary by System

The total estimated capital cost for the proposed projects of each of the systems described in Sections 9.1.1through 9.1.16 are summarized in Table 9.20.

Table 9.20 Project Summary by System
Capital Implementation Master Plan
West Basin Municipal Water District

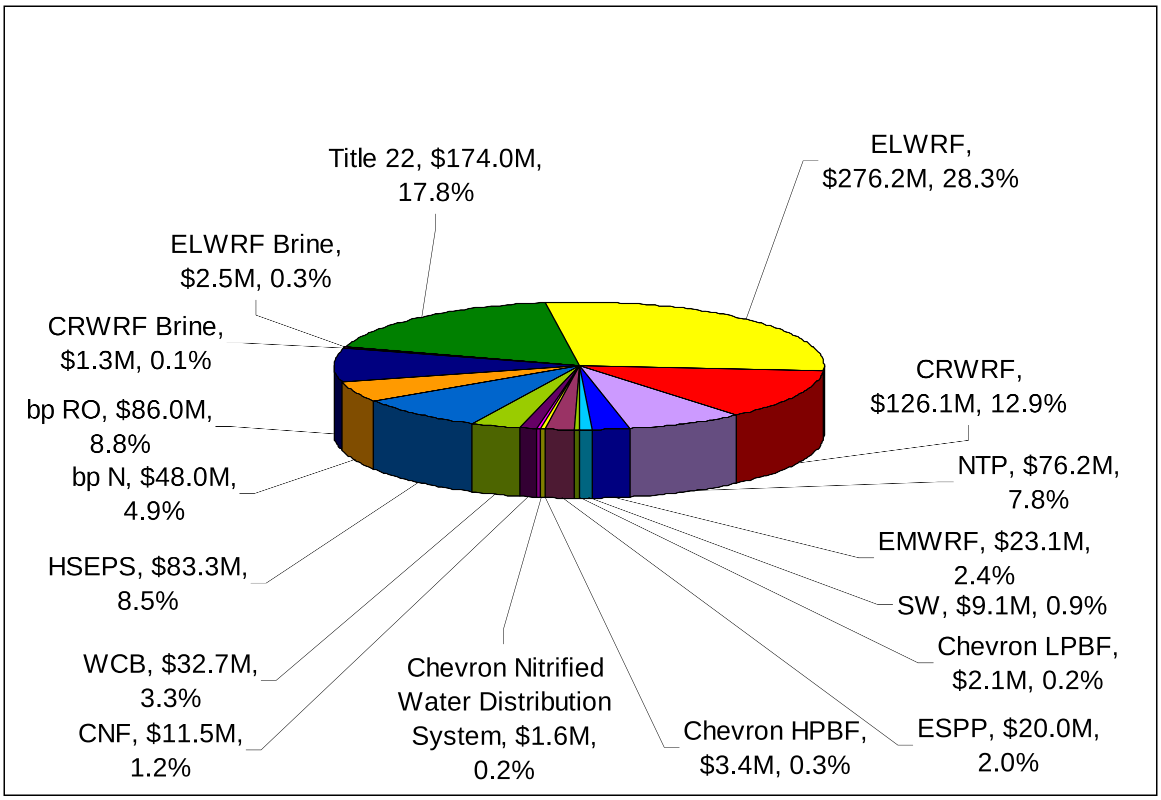
Facility ID	System/Treatment Plant Name	No. of Projects	Capital Cost(1)	Percentage of Total
HPS	Hyperion Secondary Effluent Pumping System	7	$83,320,000	8.6%
T22	Title 22 Distribution System	27	$174,000,000	18.1%
BW	West Coast Barrier Water System	3	$32,675,000	3.4%
CH	Chevron High Pressure Boiler Feed System	2	$3,350,000	0.3%
CL	Chevron Low Pressure Boiler Feed System	2	$2,100,000	0.2%
ESPP	El Segundo Power Plant System	3	$5,875,000	0.6%
CN	Chevron Nitrified Water System	1	$1,575,000	0.2%
EBRN	ELWRF Brine Line	2	$2,515,000	0.3%
BPRO	bp RO System	3	$85,985,000	8.9%
BPN	bp Nitrified Water System	6	$48,035,000	5.0%
CBRN	CRWRF Brine Line	1	$1,260,000	0.1%
SW	System Wide Improvements	6	$9,115,000	0.9%
ELWRF	Edward C. Little Water Recycling Facility	35	$276,197,600	28.7%
CRWRF	Carson Regional Water Recycling	16	$126,060,278	13.1%

Table 9.20	Project Summary by System Capital Implementation Master Plan West Basin Municipal Water District			
Facility ID	**System/Treatment Plant Name**	**No. of Projects**	**Capital Cost(1)**	**Percentage of Total**
	Facility			
EMWRF	ExxonMobil Water Recycling Facility	15	$23,065,000	2.4%
CNF	Chevron Nitrification Facility	9	$11,495,000	1.2%
NTP	New Treatment Plant	6	$76,240,000	7.9%
Total		**144**	**$962,862,878**	**100.0%**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As presented in Table 9.20, the total capital cost for all facilities is estimated at approximately $963.0 M. Figure 9.5 shows the distribution of these capital costs by system.

Figure 9.5
Distribution of Capital Costs by System



As shown in Figure 9.5, more than half of the total CIP costs are contributed by four of the fifteen systems, the Title 22 system, ELWRF, CRWRF, and the NTP.

9.2 PHASING OF RECOMMENDATIONS

This CIP is divided into six 1-year planning periods from Fiscal Year (FY) 2009/2010 through FY 2014/2015, and three 5-year planning periods from FY2015/2016 through FY 2025/2030. The phasing for a large number of projects is related to the phasing of the CRWRF Phase II Expansion project, for which the Carson Regional WRF Expansion Feasibility Study should be completed in April 2009. Project phasing is also based on the anticipated year that customers could be connected as determined in discussions with West Basin staff and as listed in Chapter 3.

This section presents a summary of the CIP projects by planning phase.

9.2.1 CIP Projects for FY09/10

Table 9.21 presents the CIP projects phased in FY2009/2010 (FY09/10).

Table 9.21 CIP Projects for FY09/10
Capital Implementation Master Plan
West Basin Municipal Water District

ID	System	Project Description	Capital Cost(1)
T22-02A	T22	Mariposa Lateral (Mattel, Hilton, Marriot)	$750,000
T22-06	T22	Carson Mall Lateral	$2,500,000
T22-09	T22	Anza Lateral Phase II	$3,500,000
T22-10	T22	Anza PS (4-500 gpm pumps)	$2,000,000
T22-19	T22	Dyehouse Lateral	$3,000,000
T22-20	T22	Dyehouse PS (3-250 gpm pumps)	$1,500,000
Subtotal – Title 22 Distribution System			***$13,250,000***
ELWRF-01	ELWRF	UW Recap - T-22 backwash pump total rebuilds (increase capacity of T22 backwash blower)	$100,000
ELWRF-19	ELWRF	UW Recap - Pave area between T 22 filters and the holding basins	$8,800
ELWRF-20	ELWRF	UW Recap - Shelter/Overhead cover when CO2 tank is removed. To provide covered storage area for chemical totes. Include access for forklifts around dike area.	$100,000
ELWRF-21	ELWRF	UW Recap - Phase III Memcor and SCADA and PC	$5,000
ELWRF-22	ELWRF	UW Recap - No. 3 Sulfuric acid day tank replace	$30,000
ELWRF-23	ELWRF	UW Recap - Replace grating replacement in chemical area with chemical resistant grating	$40,000
ELWRF-24	ELWRF	UW Recap - Trench Drains at Decant	$30,000

Table 9.21 CIP Projects for FY09/10 Capital Implementation Master Plan West Basin Municipal Water District			
ID	**System**	**Project Description**	**Capital Cost(1)**
		Sump area	
ELWRF-25	ELWRF	UW Recap - Power receptacles for emergency generator hook up for Title 22	$20,000
ELWRF-26	ELWRF	UW Recap - Replace DCS back up power (48vac) generator	$45,000
ELWRF-27	ELWRF	UW Recap - Flow control valve and actuator for barrier product pump	$100,000
ELWRF-28	ELWRF	UW Recap - Replace or expand plant instrument air compressor system	$75,000
ELWRF-29	ELWRF	UW Recap - Replace phase II RO Membranes	$375,000
ELWRF-30	ELWRF	UW Recap - Data Parser to allow for direct entry of data from instrumentation into LIMS.	$25,000
ELWRF-31	ELWRF	UW Recap - Replace or repair lab wall to prevent water intrusion and mold	$25,000
CRWRF-11	CRWRF	UW Recap - Construct paved access way from road to rear side of RO CIP tank.	$10,000
EMWRF-10	EMWRF	UW Recap - Pavement of area between gated entrance and plant.	$20,000
EMWRF-11	EMWRF	UW Recap - Add an additional air compressor for the MF system	$30,000
EMWRF-12	EMWRF	UW Recap - RO Train 4 membrane change out	$160,000
SW-02	SW	UW Recap - Major Painting Projects	$150,000
SW-03	SW	UW Recap - Purchase trailer for spill response	$5,000
SW-04	SW	UW Recap - Asset Management Software, Implementation and Training	$300,000
SW-05	SW	UW Recap - Replace all Biofor valves at CNF and EMWRF	$200,000
Subtotal – United Water Recapitalization Improvements			***$1,853,800***
Total			**$15,103,800**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As shown in Table 9.21, projects currently anticipated in FY09/10 include only rehabilitation and recapitalization projects. These projects total $15.1M. The projects listed for FY09/10 are either Title 22 distribution system improvements or United Water recapitalization improvements.

9.2.2 CIP Projects for FY10/11

Table 9.22 presents the CIP projects phased in FY2010/2011 (FY10/11).

Table 9.22 CIP Projects for FY10/11
Capital Implementation Master Plan
West Basin Municipal Water District

ID	System	Project Description	Capital Cost(1)
CL-01	CL	ELWRF Phase V Expansion - Increase treatment capacity of Industrial RO treatment for LPBF by 0.4 mgd, from 1.7 mgd to 2.1 mgd (to meet MMD of 1,218 gpm).	$1,050,000
CL-02	CL	Replace existing pumps with 3-1,250 gpm pumps (to meet MDD of 2,039 gpm).	$1,050,000
CH-01	CH	ELWRF Phase V Expansion - Increase treatment capacity of Industrial RO Ultra treatment for HPBF by 0.5 mgd, from 2.6 mgd to 3.1 mgd (to meet MMD of 2,153 gpm).	$2,650,000
CH-02	CH	Replace existing pumps with 2-2,400 gpm pumps (to meet MDD of 2,395 gpm).	$700,000
CN-01	CN	ELWRF Phase Va Expansion - Replace existing pumps with 4-1,800 gpm pumps (to meet peak demand of 5,164 gpm).	$1,575,000
CNF-03	CNF	ELWRF Phase Va Expansion - Replace Turbine	$700,000
BW-01	BW	ELWRF Phase V Expansion - Increase treatment capacity of Barrier treatment by 5.0 mgd, from 12.5 mgd to 17.5 mgd.	$31,800,000
BW-02	BW	Add VFDs to product water pumps	$700,000
BW-04	BW	Modify site piping at ELWRF, replacing 20-inch discharge piping and meter with 27-inch discharge piping and meter.	$175,000
HPS-01	HPS	Add 23 mgd of additional pumping capacity, to bring firm capacity to 74 mgd of firm capacity. (Phase I of II; total project assumes 7 pumps, 7,000 hp total)	$14,700,000
HPS-03	HPS	Secondary Power Connection for Backup Power	$2,520,000
HPS-04	HPS	PS Building	$560,000
EBRN-01	EBRN	Install pinch valves/reducers	$630,000
T22-04	T22	Virco-Torrance Lateral	$340,000
T22-13	T22	Dominguez Street Lateral	$4,500,000
ELWRF-03	ELWRF	ELWRF Phase V Expansion - Add redundant gravity thickener.	$1,960,000
ELWRF-04	ELWRF	ELWRF Phase V Expansion - Resolve underperformance of backwash equalization basin.	$170,000

Table 9.22	CIP Projects for FY10/11 Capital Implementation Master Plan West Basin Municipal Water District		
ID	**System**	**Project Description**	**Capital Cost(1)**
ELWRF-05	ELWRF	ELWRF Phase V Expansion - Redundant Sludge Conditioning Tank	$140,000
ELWRF-06	ELWRF	Increase Capacity of Title 22 Air Vacuum Release Valve for Product Water Storage Tanks	$100,000
Mult	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$1,340,000
Mult	Mult	Membrane Replacement (recurring)	$1,550,280
Total			**$68,910,280**

Notes:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.
(2) Recurrence for United Water improvements is assumed to be every five years.

As presented in Table 9.22, the total anticipated cost for the project recommended for phase FY10/11 are approximately $68.9 M. The most costly projects proposed for this phase are associated with the ELWRF Phase V Expansion.

9.2.3 CIP Projects for FY11/12

Table 9.23 presents the CIP projects phased in FY2011/2012 (FY11/12).

As presented in Table 9.23, the total anticipated cost for the project recommended for phase FY11/12 are approximately $251.9 M. The most costly projects proposed for this phase are associated with the bp / CRWRF expansion.

9.2.4 CIP Projects for FY12/13

Table 9.24 presents the rehabilitation and recapitalization projects anticipated in FY2012/2013 (FY12/13).

Table 9.23	CIP Projects for FY11/12 Capital Implementation Master Plan West Basin Municipal Water District		
ID	**System**	**Project Description**	**Capital Cost(1)**
CNF-05	CNF	ELWRF Phase Va Expansion - Inspect Nitrified Product Water Storage Tank Internal Condition	$85,000
HPS-05	HPS	Add 23 mgd of additional pumping capacity, to bring firm capacity to 97 mgd of firm capacity. (Phase II of II; total project assumes 7 pumps, 7,000 hp total)	$14,700,000
BPN-01	BPN	Treat SE from JWPCP w/ MF to serve growth in bp Nitrified System	$16,800,000
BPN-02	BPN	Nitrified Treatment - treat MF treated SE (BPN-01) from JWPCP to serve growth in bp Nitrified System	$12,205,000
BPN-03	BPN	New 20" pipeline from NTP to bp for conveyance of Nitrified Water.	$9,535,000
BPN-03A	BPN	Parallel 14" pipeline from CRWRF to bp for conveyance of Nitrified Water.	$4,245,000
BPN-04	BPN	New pump station at NTP to serve bp Nitrified (assumes 4-1,500 gpm pumps, in PS w/ BPRO-03)	$3,150,000
BPN-05	BPN	Add a 1.0 MG storage reservoir to NTP to maintain current number of hours of backup for bp Nitrified system.	$2,100,000
BPRO-01	BPRO	Treat SE from JWPCP w/ MF/RO to serve growth in bp RO System	$73,080,000
BPRO-02	BPRO	New Pipeline from NTP to bp for conveyance of Industrial RO Water.	$8,705,000
BPRO-03	BPRO	New pump station at NTP to serve bp Industrial RO (assumes 4-2,100 gpm pumps, in PS w/ BPN-04)	$4,200,000
CBRN-01	CBRN	Install access ports for cleaning	$1,260,000
EBRN-02	EBRN	Install access ports for cleaning	$1,885,000
T22-02	T22	El Segundo Lateral (Boeing, Kilroy Airport)	$1,500,000
T22-07	T22	Redondo Beach Lateral (Pete's Nursery)	$660,000
T22-08	T22	Mills Park Lateral	$245,000
CRWRF-01	CRWRF	Pipeline for LADWP Harbor demands at Carson City bndy	$29,100,000
CRWRF-02	CRWRF	Nitrified Treatment of Title 22 Water (Nitrified Water for LADWP Harbor Demand and Rhodia)	$43,141,278
CRWRF-03	CRWRF	Add new 11.6 mgd pump station at CRWRF to serve LADWP Harbor Demand Phase II (5 pumps)	$5,250,000

Table 9.23	CIP Projects for FY11/12 Capital Implementation Master Plan West Basin Municipal Water District		
ID	**System**	**Project Description**	**Capital Cost[(1)]**
CRWRF-04	CRWRF	Surge Protection - Modify MF Units with Break Tank and Pumps	$6,300,000
CRWRF-05	CRWRF	Raw Water Storage (1 hour)	$5,250,000
CRWRF-06	CRWRF	Repair Nitrified Product Water Storage Tank	$560,000
NTP-01	NTP	Land Acquisition of 4.5 ac near JWPCP for NTP	$4,800,000
EMWRF-01	EMWRF	Repair or Replace Bulk Chemical Storage Tank and Associated Equipment	$700,000
EMWRF-02	EMWRF	Inspect Nitrified Product Water Storage Tank Internal Condition	$85,000
Mult	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$775,000
Mult	Mult	Membrane Replacement (recurring)	$1,550,280
Total			**$251,866,558**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

Table 9.24	CIP Projects for FY12/13 Capital Implementation Master Plan West Basin Municipal Water District		
ID	**System**	**Project Description**	**Capital Cost[(1)]**
T22-01	T22	Caltrans Inglewood Lateral	$260,000
T22-11	T22	Chlorination Stations (Phase I)	$1,960,000
ELWRF-07	ELWRF	Add Title 22 High Rate Clarifier and Title 22 Filters (to bring clarifier from 30.0 mgd to 50.0 mgd and filter capacity from 40.0 mgd to 50.0 mgd)	$12,600,000
Mult	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$345,000
Mult	Mult	Membrane Replacement (recurring)	$1,550,280
Total			**$16,715,280**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As shown in Table 9.24, the total anticipated cost for the projects recommended for phase FY12/13 is approximately $16.7 M. Recommendations in this planning year consist primarily of improvements to the Title 22 distribution system and treatment processes. Project ELWRF-07, the Title 22 High Rate Clarifier is triggered by growth in Title 22 demand, with the total Title 22 demand exceeding 30.0 mgd in this planning year.

9.2.5 CIP Projects for FY13/14

Table 9.25 presents the rehabilitation and recapitalization projects anticipated in FY2013/2014 (FY13/14).

Table 9.25 CIP Projects for FY13/14
Capital Implementation Master Plan
West Basin Municipal Water District

ID	System	Project Description	Capital Cost[1]
T22-12	T22	Main Street Carson Lateral	$17,075,000
Mult	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$6,895,000
Mult	Mult	Membrane Replacement (recurring)	$1,550,280
Total			**$25,520,280**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As shown in Table 9.25, the total anticipated cost for the projects recommended for phase FY13/14 is approximately $25.5M. Recommendations for this planning period consist of the Main Street Carson Lateral, and equipment rehabilitation and replacement estimates and ongoing membrane replacement.

9.2.6 CIP Projects for FY14/15

Table 9.25 presents the rehabilitation and recapitalization projects anticipated in FY2014/2015 (FY14/15).

Table 9.26 CIP Projects for FY14/15
Capital Implementation Master Plan
West Basin Municipal Water District

ID	System	Project Description	Capital Cost[1]
T22-14	T22	Caltrans Gardena Lateral	$985,000
Mult	Mult	United Water Recapitalization Improvements (recurring)	$6,345,000
Mult	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$1,110,000
Mult	Mult	Membrane Replacement (recurring)	$1,550,280
Total			**$9,990,280**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As shown in Table 9.25, the total anticipated cost for the projects recommended for phase FY14/15 is approximately $10.0 M. Recommendations for this planning period consist of a Title 22 lateral, triggered by individual customers estimated date of connection (as detailed in the customer database), and equipment rehabilitation and replacement estimates. United Water recapitalization recurrences also occur in this year, as they are assumed to recur every five years.

9.2.7 CIP Projects for FY15/20

Table 9.27 presents the CIP projects phased in FY2015/2020 (FY15/20).

Table 9.27 CIP Projects for FY15/20
Capital Implementation Master Plan
West Basin Municipal Water District

ID	System	Project Description	Capital Cost[1]
ESPP-01	ESPP	Add to treatment capacity of Industrial RO treatment for ESPP of 0.5 mgd (to meet MMD of 325 gpm).	$1,900,000
ESPP-02	ESPP	El Segundo Power Plant Pipeline from Chevron to El Segundo Power Plant	$3,895,000
ESPP-03	ESPP	PRV at Chevron	$80,000
CNF-01	CNF	ELWRF Phase Va Expansion - Increase treatment capacity of Nitrified by 2.1, from 4.9 mgd to 7.0 mgd. (Two Biofor Units)	$3,090,000
CNF-02	CNF	ELWRF Phase Va Expansion - Backup Power to Product Water Pumps	$700,000
CNF-04	CNF	ELWRF Phase Va Expansion - Potable Water Backup Supply	$350,000
T22-15	T22	Palos Verdes - Lateral 6B	$27,290,000
T22-16	T22	Palos Verdes PS (4-1,250 gpm pumps)	$4,900,000
T22-17	T22	Increase Title 22 product water storage by 5.0 MG	$10,500,000
T22-18A	T22	Gardena Lateral - Normandie Ave	$3,635,000
T22-18B	T22	Gardena Lateral - Normandie and Vermont	$6,170,000
T22-18C	T22	Gardena Lateral - Van Ness	$4,480,000
T22-21	T22	Chlorination Stations (Phase II)	$1,960,000
T22-22	T22	Hawthorne Lateral (Solec)	$1,595,000
T22-23	T22	Title-22 PS Discharge Pipeline Modification	$465,000
ELWRF-09	ELWRF	Add 17.3 mgd of Title 22 Treatment, to increase Title 22 treatment capacity from 50.0 mgd to 67.3 mgd	$48,440,000

Table 9.27 CIP Projects for FY15/20
Capital Implementation Master Plan
West Basin Municipal Water District

ID	System	Project Description	Capital Cost(1)
ELWRF-10	ELWRF	Increase capacity of Title 22 Pump Station at ELWRF by 3,200 hp (from 4,800 hp to 8,000 hp) to serve Future Title 22 Customers	$14,340,000
ELWRF-11	ELWRF	Microfiltration - Replace existing Phase II and III MF System w/ Pressurized System	$16,800,000
ELWRF-12	ELWRF	Backup Power	$11,200,000
ELWRF-13	ELWRF	Dewatered Sludge Handling Transfer System	$2,800,000
ELWRF-15	ELWRF	Potable Water Connection to ELWRF	$280,000
CRWRF-07	CRWRF	Backup Power	$2,520,000
EMWRF-04	EMWRF	Add 0.6 mgd of Industrial RO Treatment of Title 22 Water (half of 1,000 afy total w/ RO).(6)	$1,890,000
EMWRF-05	EMWRF	Add 0.5 mgd of Nitrified Treatment of Title 22 Water (half of 1,000 afy total w/ Nitrified).(6)	$735,000
EMWRF-06	EMWRF	Surge Protection - Modify MF Units with Break Tank and Pumps	$3,500,000
EMWRF-07	EMWRF	Backup Power for Product Water Pumps	$700,000
Mult	Mult	United Water Recapitalization Improvements (recurring)	$6,345,000
Mult	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$29,995,000
Mult	Mult	Membrane Replacement (recurring)	$16,276,400
Total			**$226,831,400**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As presented in Table 9.27, the total anticipated cost for the project recommended for phase FY15/20 are approximately $226.8 M. The most costly projects proposed for this phase are related to increasing Title 22 treatment capacity at ELWRF.

It should be noted that improvements required to serve all customers included in Scenario 5, as discussed in Section 8.1 are incorporated by the end of this planning phase. Remaining planning phases include improvements required to serve customers in Scenario 6 and 7 and recurring rehabilitation or replacement projects associated with equipment useful life.

9.2.8 CIP Projects for FY20/25

Table 9.28 presents the CIP projects phased in FY2020/25 (FY20/25).

Table 9.28 CIP Projects for FY20/25
Capital Implementation Master Plan
West Basin Municipal Water District

ID	System	Project Description	Capital Cost(1)
HPS-07	HPS	Add 38 mgd of additional firm pumping capacity, to bring total firm capacity to 135 mgd. (For LADWP Westside, Kenneth Hahn, LADWP Harbor Expansion) (Assumes 3 pumps, 3,000 hp increase)	$27,300,000
HPS-08	HPS	Parallel HSEFM w/ 36"	$22,815,000
T22-24	T22	Anza Lateral Break Tank	$4,200,000
ELWRF-32	ELWRF	Land Acquisition of 4.0 ac near ELWRF for Expansion of Title 22 Beyond 70.0 mgd	$9,600,000
CRWRF-11	CRWRF	Nitrified Treatment of Title 22 Water (Nitrified Water for LADWP Harbor Demand Phase II)	$10,480,000
CRWRF-12	CRWRF	Add new 7.1 mgd pump station at CRWRF to serve LADWP Harbor Demand Phase II (5 pumps)	$4,200,000
NTP-03	NTP	Barrier Water Treatment - treat SE from JWPCP to serve Dominguez Gap (Phase I and II)	$34,125,000
NTP-04	NTP	Add new 3.1 mgd pump station at NTP to serve Dominguez Gap (Phase I + II)	$2,100,000
NTP-05	NTP	New Pipeline from NTP to Dominguez Gap Barrier Blending Station for conveyance of Barrier Water.	$9,640,000
Mult	Mult	United Water Recapitalization Improvements (recurring)	$6,345,000
Mult	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$16,245,000
Mult	Mult	Membrane Replacement (recurring)	$16,277,500
Total			**$163,327,500**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As presented in Table 9.28, the total anticipated cost for the project recommended for phase FY20/25 are approximately $163.3 M. The most costly projects proposed for this phase are treatment costs at the NTP related to service of the Dominguez Gap and HSEPS and HSEFM expansions associated with serving future demands from Hyperion.

9.2.9 CIP Projects for FY25/30

Table 9.29 presents the CIP projects phased in FY2025/30 (FY25/30).

Table 9.29 CIP Projects for FY25/30
Capital Implementation Master Plan
West Basin Municipal Water District

ID	System	Project Description	Capital Cost[1]
T22-25	T22	LA Westside Lateral	$40,005,000
T22-26	T22	Inglewood/LA Westside PS (assumes 4-8,500 gpm pumps)	$28,025,000
ELWRF-33	ELWRF	Increase capacity of Title 22 Pump Station at ELWRF by 4,000 hp (from 8,000 hp to 12,000 hp) to serve LADWP Harbor Expansion, Westside, and Kenneth Hahn	$16,800,000
ELWRF-34	ELWRF	Add 8.9 mgd of Additional Title 22 Treatment to Serve LADWP Harbor Expansion, increasing Title 22 Treatment Capacity from 67.3 mgd to 76.2 mgd	$24,945,000
ELWRF-35	ELWRF	Add 15.3 mgd of Additional Title 22 Treatment to Serve LADWP Westside and Kenneth Hahn Park, increasing Title 22 Treatment Capacity from 76.2 mgd to 91.5 mgd	$42,970,000
Mult	Mult	United Water Recapitalization Improvements (recurring)	$6,345,000
Mult	Mult	Rehabilitation and Replacement from Condition Assessment (recurring)	$9,230,000
Mult	Mult	Membrane Replacement (recurring)	$16,277,500
Total			**$184,597,500**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As presented in Table 9.29, the total anticipated cost for the project recommended for phase FY25/30 are approximately $184.6 M. The most costly projects proposed for this phase are related to service of the LADWP Westside Title 22 demands.

9.3 CIP SUMMARIES

This section presents the following summaries of the CIP:

- CIP by Phase
- CIP by Facility Type
- Recurring Projects by Treatment Plant Facility

- Summary of ELWRF Phase V Projects
- Summary of Recommended Studies
- Escalated CIP Cost by Phase

In addition, a detailed list of all CIP projects is presented at the end of this chapter in Table 9.37.

9.3.1 CIP Summary by Phase

The project phasing presented in Section 9.2 is summarized in Table 9.30.

Table 9.30 Summary of Project Phasing
Capital Implementation Master Plan
West Basin Municipal Water District

Planning Phase	Planning Year	Capital Cost(1)	Percentage of Total Capital Cost
FY09/15	FY09/10	$15,103,800	1.6%
	FY10/11	$68,910,280	7.2%
	FY11/12	$251,866,558	26.2%
	FY12/13	$16,715,280	1.7%
	FY13/14	$25,520,280	2.7%
	FY14/15	$9,990,280	1.0%
	FY09/15	***$388,106,478***	***40.3%***
FY15/20		$226,831,400	23.6%
Subtotal	***FY09-20***	***$614,937,878***	
FY20/25		$163,327,500	17.0%
FY25/30		$184,597,500	19.2%
Total		**$962,862,878**	**100.0%**

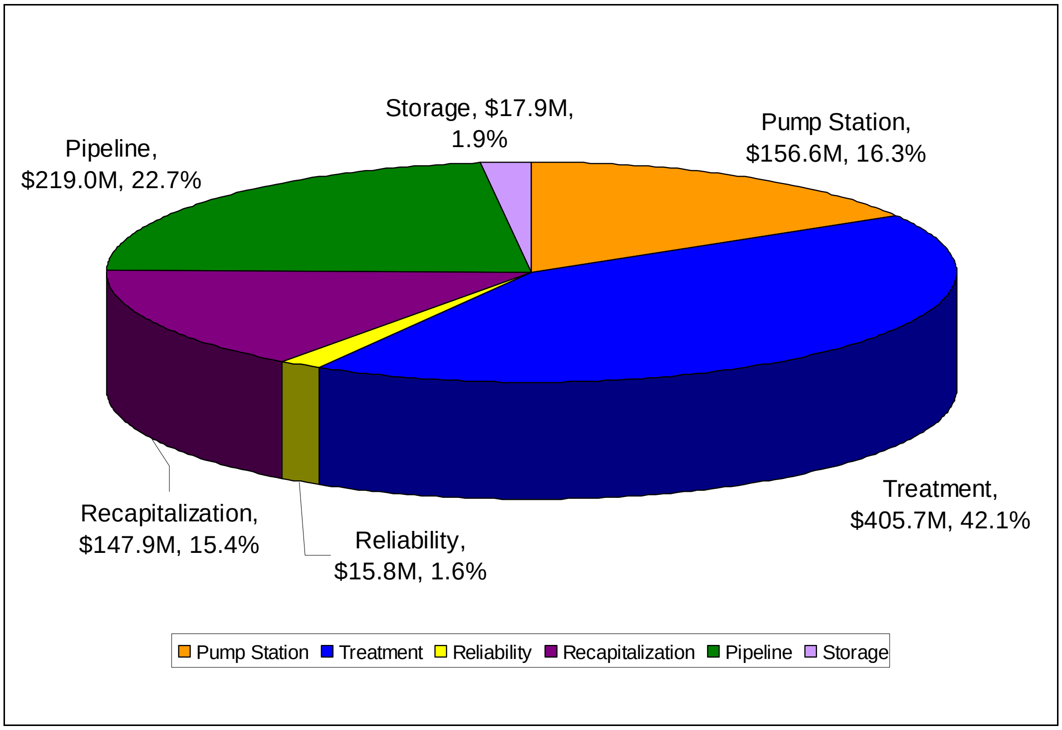
Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

As presented in Table 9.30, the total estimated capital cost of all projects recommended in Chapters 7 and 8, combined with rehabilitation and recapitalization projects, is about $962.9M. As shown, the phase with the largest contribution to the overall CIP cost is FY11/12 with $251.9 M. The total estimated cost through FY19/20 is $615 M.

9.3.2 CIP Summary by Facility Type

The CIP cost distribution of by project type is depicted on Figure 9.6. As shown in this figure, the majority of costs are related to water treatment, contributing to $406M or 42 percent of the total CIP. The second largest category is pipelines with a combined estimated capital cost of $219M or 23 percent of the total CIP.

Figure 9.6
Distribution of Capital Costs by Facility Type



9.3.3 Summary of ELWRF Phase V Expansion Costs

The above projects, which are a part of the ELWRF Phase V Expansion Costs are summarized in Table 9.31.

As shown in Table 9.31, the total cost estimated for the ELWRF Phase V expansion is $58.8 M. The most costly portion of this expansion is the Barrier water treatment capacity expansion for the West Coast Barrier. Note that the cost estimates presented here are based on the ELWRF Phase V Expansion Study.

**Table 9.31 Projects Included in ELWRF Phase IV Expansion
Capital Implementation Master Plan
West Basin Municipal Water District**

ID	Phase	Project Description	Capital Cost[1]
BW-01	FY1011	ELWRF Phase V Expansion - Increase treatment capacity of Barrier treatment by 5.0 mgd, from 12.5 mgd to 17.5 mgd.	$31,800,000
BW-02	FY1011	Add VFDs to product water pumps	$700,000
BW-04	FY1011	Modify site piping at ELWRF, replacing 20-inch discharge piping and meter with 27-inch discharge piping and meter.	$175,000
ELWRF-04	FY1011	ELWRF Phase V Expansion - Resolve underperformance of backwash equalization basin.	$170,000
ELWRF-05	FY1011	ELWRF Phase V Expansion - Redundant Sludge Conditioning Tank	$140,000
ELWRF-07	FY1213	Add Title 22 High Rate Clarifier and Title 22 Filters (to bring clarifier from 30.0 mgd to 50.0 mgd and filter capacity from 40.0 mgd to 50.0 mgd)	$12,600,000
ELWRF-03	FY1011	ELWRF Phase V Expansion - Add redundant gravity thickener.	$1,960,000
Subtotal - ELWRF Phase V Barrier System			***$47,545,000***
CH-01	FY1011	ELWRF Phase V Expansion - Increase treatment capacity of Industrial RO Ultra treatment for HPBF by 0.5 mgd, from 2.6 mgd to 3.1 mgd (to meet MMD of 2,153 gpm).	$2,650,000
CH-02	FY1011	Replace existing pumps with 2-2,400 gpm pumps (to meet MDD of 2,395 gpm).	$700,000
CL-01	FY1011	ELWRF Phase V Expansion - Increase treatment capacity of Industrial RO treatment for LPBF by 0.4 mgd, from 1.7 mgd to 2.1 mgd (to meet MMD of 1,218 gpm).	$1,050,000
CL-02	FY1011	Replace existing pumps with 3-1,250 gpm pumps (to meet MDD of 2,039 gpm).	$1,050,000
Subtotal - ELWRF Phase V Chevron Systems			***$5,450,000***
ESPP-01	FY15-20	Add to treatment capacity of Industrial RO treatment for ESPP of 0.5 mgd (to meet MMD of 325 gpm).	$1,900,000
ESPP-02	FY15-20	El Segundo Power Plant Pipeline from Chevron to El Segundo Power Plant	$3,895,000
ESPP-03	FY15-20	PRV at Chevron	$80,000
Subtotal - ELWRF Phase V ESPP Systems			***$5,875,000***
Total			**$58,870,000**

Note:
(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

9.3.4 Recurring Improvements by Treatment Facility

Table 9.32 summarizes United Water improvements for each of West Basin's treatment facilities for each planning period.

Table 9.32 United Water Improvement Summary
Capital Implementation Master Plan
West Basin Municipal Water District

	Planning Year / Phase					Total
Facility	**FY0910**	**FY1415**	**FY15-20**	**FY20-25**	**FY25-30**	**Capital Cost(1)**
ELWRF	$978,800	$2,535,000	$2,535,000	$2,535,000	$2,535,000	$11.1 M
CRWRF	$10,000	$845,000	$845,000	$845,000	$845,000	$3.4 M
EMWRF	$210,000	$425,000	$425,000	$425,000	$425,000	$1.9 M
CNF	$0	$425,000	$425,000	$425,000	$425,000	$1.7 M
SW	$655,000	$2,115,000	$2,115,000	$2,115,000	$2,115,000	$9.1 M
Total	**$1,853,800**	**$6,345,000**	**$6,345,000**	**$6,345,000**	**$6,345,000**	**$27.2 M**

Note:
(1) Costs based on United Water estimates. Additional markups are applied to costs for FY1415 through FY25-30.

In addition to the United Water recommendations, the Rehabilitation and Replacement from the Condition Assessment and Membrane Replacement projects are listed as recurring and consist of summarized values of more detailed items for each treatment facility.

The Rehabilitation and Replacement from Condition Assessment items are estimates of the expected replacement costs based on the anticipated remaining life of various assets evaluated during the Condition Assessment portion of this project. The assumptions used for this cost estimate are described in Appendix F, the Condition Assessment TM.

The membrane replacement costs are costs to replace all of the existing membranes at West Basin's facilities on a continuous basis, assuming individual membrane life of 5 years. The estimated annual costs for the membrane replacement are detailed in Table 9.33.

Table 9.33 Membrane Replacement Costs Capital Implementation Master Plan West Basin Municipal Water District					
	Number of Membranes			Replacement Cost ($M / 5 yrs)	Annual Cost ($M / yr)
Facility	**RO**	**MF (Type I)**	**MF (Type II)**		
Unit Replacement Cost	$500	$750	$900		
ELWRF	4,536	1,350	2,496	$5.5	$1.1
CRWRF	1,584	810	0	$1.4	$0.3
EMWRF	840	540	0	$0.8	$0.2
Total for Existing	**6,960**	**2,700**	**2,496**	$7.8	$1.6
NTP(2)				$8.5	$1.7
Total				$16.3	$3.3

Note:
(1) Membrane replacement cost based on typical costs for type of membrane.
(2) Membrane replacement costs for future facilities were based on total flow and similar facilities rather than number of membranes.

As discussed in Chapter 8, several alternatives were evaluated for reducing surges in the Title 22 distribution system through modifications to the membrane systems at EMWRF and CRWRF. Alternatives were also evaluated for replacing the Phase II and III microfiltration units at ELWRF (to improve performance). A summary of the costs for each alternative discussed in Chapter 7 and 8 is presented in Table 9.34. The costing details for these alternatives are provided at the end of Appendix F. Within Chapter 7, it was recommended that further study be conducted before selecting an alternative. Within the CIP, it was assumed that the second option be implemented in each facility—a break tank and pumps at EMWRF and CRWRF, and pressurized MF units at ELWRF.

9.3.5 Summary of Recommended Studies

Within this report, several studies were considered beyond the scope of this report but recommended for further investigation. Table 9.35 lists each of the recommended studies mentioned within this report. If applicable, the CIP IDs of the related projects are indicated in brackets. Several of the studies listed in Table 9.35 could be incorporated into larger projects, such as the ELWRF Phase V Expansion.

Table 9.34 Alternatives for Resolving Microfiltration Surges Capital Implementation Master Plan West Basin Municipal Water District			
	Alternatives		
Facility	**Dedicated Flush System**	**Break Tank and Pumps**	**Alternate MF Units (Submerged)**
EMWRF	$659,000	$2,058,000	$10,129,000
CRWRF	$887,000	$6,907,000	$15,409,000
	Retrofit Existing MF Units	**Replace with Pressurized MF Units**	**Replace with Submerged MF Units**
ELWRF	$12,254,190	$14,893,970	$19,737,510

Notes:
(1) Cost estimate details are included in Appendix F (following the Condition Assessment TM).
(2) Cost estimates shown in this table vary from the estimates used in the CIP (Table 9.37) due to adjustments made to the contingency and markups (as discussed in Chapter 5).

Table 9.35 Recommended Studies Capital Implementation Master Plan West Basin Municipal Water District		
Study	**Description**	**Report Section**
Demand Pattern Revision for Chester Washington Golf Course	For Title 22 Customer Chester Washington Golf Course, review the existing golf course irrigation schedule with the customer to reduce their daily peak demands to a more reasonable level in order to extend life of lateral.	7.1.1.3
CMF Unit Surge Study	Detailed Study to determine the most feasible method for reducing the magnitude of the observed pressure surges. [CRWRF-02, EMWRF-01, ELWRF-03]	7.1.1.3.1
Title 22 Pump Station Control Study	Detailed Study to develop an efficient pumping system that allows operation of the pumps within the preferred operating ranges	7.1.1.3.2
Title 22 Pipe Cleaning Test Program	Study to evaluate whether pipe cleaning test program increases chlorine residual in distribution system, possibly including installation of pig launching and retrieval stations. [T22-11]	7.1.1.3.3
Barrier Product Water Pump Station Operational Efficiency Study	Detailed analysis to evaluate the pump station to resolve energy loss and establish a more efficient method of operation of the Barrier Product Water Pump Station.	7.1.2.3
Hyperion Secondary Effluent Pump	Detailed analysis to optimize system controls, to eliminate the need for manual control of VFD.	7.1.3.3

Table 9.35 Recommended Studies
Capital Implementation Master Plan
West Basin Municipal Water District

Study	Description	Report Section
Station Control Automation and Optimization		
Chevron Nitrified Water Product Pump Station Firm Capacity Study	Detailed analysis to maintain firm capacity of the pump station.	7.1.6.3
CRWRF Brine Line Inspection Program	Evaluate inspection of brine line and establish routine inspection program. [CBRN-01]	7.1.7.3
ELWRF Brine Line Inspection Program	Evaluate inspection of brine line and establish routine inspection program. [EBRN-01]	7.1.8.3
ELWRF Brine Line Velocity Reduction Study	Detailed analysis to mitigate high velocities, possibly installing pinch valves or pipe restrictions.[EBRN-02]	7.1.8.3
ELWRF Brine Line	Inspection program and taps for pipeline calibration	8.2.8.3
Title 22 Pump Station Pressure Increase Evaluation	A detailed study of the existing and future water demand patterns, including phased development, should be conducted in selecting the pumps and increase the discharge pressure to 105 psi.	8.2.1.3.3
Title 22 Surge Analysis	Surge analysis of the Title 22 distribution system following modifications made to EMWRF and CRWRF to reduce surge effects.	8.2.1.3.4
Title 22 Pump Station Operation Evaluation	A detailed study of the demands on the Title 22 pump station, including phased development, should be conducted in selecting the pumps and increase the discharge pressure to 105 psi.	8.2.1.3.5
Title 22 Distribution System Water Quality Analysis	Following incorporation of existing system water quality recommendations, water quality of the distribution system should be reevaluated.	8.2.1.3.6
West Coast Barrier Pump Station Operational Evaluation	Field testing to determine the firm capacity of the pump station. Result should be used to determine improvements to the pump station. [BW-02]	8.2.2.3
Hyperion Secondary Effluent Pump Station Design Study	Detailed design study to review the existing pump station modification for incorporation into the future facility. Increase the capacity of the pump station to meet future supply requirements (add a 9,000 hp PS for Scenario 5A, and a 12,000 hp PS for Scenario 7A).	8.2.3.3

Table 9.35 Recommended Studies Capital Implementation Master Plan West Basin Municipal Water District		
Study	**Description**	**Report Section**
Hyperion Secondary Effluent Pump Station Reliability Study	Detailed design study of the system to formulate the most feasible means of meeting the demand criteria and providing supply reliability	8.2.3.3
Hyperion Secondary Effluent Pumping System Surge Evaluation	Update surge study for future system design conditions.	8.2.3.3
Chevron Nitrified Water System Pump Station Design	Preliminary design to add 1,564 gpm of pump station capacity. To make the maximum use out of the existing facility the future facility should have three identical duty and one standby pump, all operated by VFDs..	8.2.6.3
Chevron Nitrified Water System Hydrogenerator Feasibility Study	Investigate feasibility of placing the hydro generator in service.	8.2.6.3
CRWRF RO Discharge Pressure Adjustment	Evaluate how to effectively increase discharge pressure of RO Trains at CRWRF.	8.2.7.3
CRWRF Brine Line Permit	Apply for revised brine line permit accommodating increased flows[1]	8.2.7.3
CRWRF Power	Investigate power problems at this site.	Condition Assessment

Note:
1. This is not necessary under Scenario 5B and 7B, but will be required wherever the potential bp demands are treated.

The studies listed in Table 9.35 are not included within the CIP, but may affect costs for several of the projects included in the CIP.

9.3.6 Escalated CIP Cost

The CIP cost presented in the Master Plan are all based on 2009 dollars and an ENR index for the greater Los Angeles area of 9811 published in January 2009. However, as most projects will be implemented in the future, the actual CIP cost in dollars will be higher based on the phasing of each project. The CIP presented in Table 9.36 shows the escalated CIP cost for each project phase based on an annual inflation rate of 3 percent.

Table 9.36	Escalated CIP Cost Summary by Phase Capital Implementation Master Plan West Basin Municipal Water District		
Planning Phase	**Planning Year**	**Capital Cost In 2009 Dollars(1)**	**Escalated Capital Cost(2)**
FY09-15	FY09/10	$15,103,800	$15,300,000
	FY10/11	$68,910,280	$71,860,000
	FY11/12	$251,866,558	$270,520,000
	FY12/13	$16,715,280	$18,500,000
	FY13/14	$25,520,280	$29,080,000
	FY14/15	$9,990,280	$11,730,000
	FY09-15	**$388,106,478**	**$416,990,000**
FY15-20	FY15-20	$226,831,400	$286,640,000
Subtotal	***FY09/10 – FY19/20***		***$703,630,000***
FY20-25	FY20-25	$163,327,500	$239,270,000
FY25-30	FY25-30	$184,597,500	$313,500,000
Total		**$962,862,878**	**$1,256,400,000**

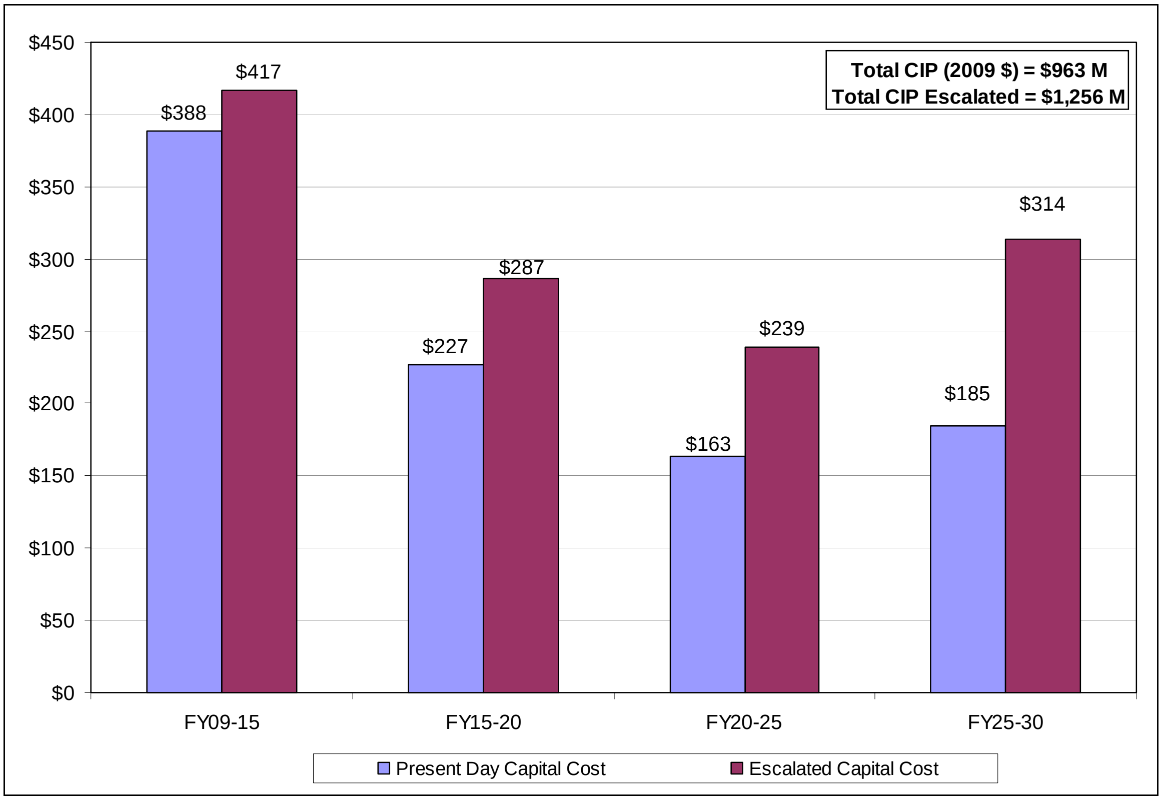
Notes:

(1) Includes markups, contingency, and construction costs. See Table 5.5 for detailed cost breakdown and Table 9.37 for construction costs.

(2) Escalated from January 2009 to the mid-point of each planning period using an annual inflation rate of 3.0% (rounded to $10,000).

As presented in Table 9.36, the escalated cost of the $963M CIP (2009 Dollars) is estimated at $1,256M. The phasing of cost by phase, with and without escalation, is also depicted on Figure 9.7.

Figure 9.7
Breakdown of Capital Costs by Phase including Escalation



WB Project ID	Project ID	System Name	Project Type	Project Description	Year	Size	Unit	Capacity	Unit	Unit Cost	Unit	Construction Cost (w/o Spcl Cond)	Special Construction	Spcl Cnst	Construction Cost	Project Location (for TTC)	Contingency	Capital Cost	Other Payer	Cost to Other Party	Cost to West Basin	FY0910	FY10-15	FY15-20	FY20-25	FY25-30
1	BW-01	BW	Treatment	ELWRF Phase V Expansion - Increase treatment capacity of Barrier treatment by 5.0 mgd, from 12.5 mgd to 17.5 mgd.	FY1011	5.0	mgd			$ -	lumpsum(3)	$ -	1.00	-	$ 14,672,833	-	217%	$ 31,800,000	WRD	$ 31,800,000	$ -	-	$ 31,800,000	-	$ -	$ -
1	BW-02	BW	PS	Add VFDs to product water pumps	FY1011					$ 500,000	lumpsum(1)	$ 500,000	1.00	-	$ 500,000	IF	140%	$ 700,000	None	$ -	$ 700,000	-	$ 700,000	-	$ -	$ -
1	BW-04	BW	Pipeline	Modify site piping at ELWRF, replacing 20-inch discharge piping and meter with 27-inch discharge piping and meter.	FY1011	1	site			$ 125,000	lumpsum(1)	$ 125,000	1.00	-	$ 125,000	IF	140%	$ 175,000	None	$ -	$ 175,000	-	$ 175,000	-	$ -	$ -
1	ELWRF-04	ELWRF	Recapitalization	ELWRF Phase V Expansion - Resolve underperformance of backwash equalization basin.	FY1011	1	system			$ 120,000	lumpsum(5)	$ 120,000	1.00	-	$ 120,000	IF	140%	$ 170,000	None	$ -	$ 170,000	-	$ 170,000	-	$ -	$ -
1	ELWRF-05	ELWRF	Recapitalization	ELWRF Phase V Expansion - Redundant Sludge Conditioning Tank	FY1011	2	tanks	25,000	gallon	$ 2.00	per gallon	$ 100,000	1.00	-	$ 100,000	IF	140%	$ 140,000	None	$ -	$ 140,000	-	$ 140,000	-	$ -	$ -
1	ELWRF-07	ELWRF	Treatment	Add Title 22 High Rate Clarifier and Title 22 Filters (to bring clarifier from 30.0 mgd to 50.0 mgd and filter capacity from 40.0 mgd to 50.0 mgd)	FY1213	1	system			$ 9,000,000	lumpsum(1)	$ 9,000,000	1.00	-	$ 9,000,000	IF	140%	$ 12,600,000	None	$ -	$ 12,600,000	-	$ 12,600,000	-	$ -	$ -
1	ELWRF-03	ELWRF	Recapitalization	ELWRF Phase V Expansion - Add redundant gravity thickener.	FY1011	1	system			$ 1,400,000	system(5)	$ 1,400,000	1.00	0	$ 1,400,000	IF	140%	$ 1,960,000	None	$ -	$ 1,960,000	-	$ 1,960,000	-	$ -	$ -
Subtotal	ECLWRF Phase V Expansion - Barrier System											$ 11,245,000			$ 25,917,833			$ 47,545,000		$ 31,800,000	$ 15,745,000	$ -	$ 47,545,000	$ -	$ -	$ -
2	CH-01	CH	Treatment	ELWRF Phase V Expansion - Increase treatment capacity of Industrial RO Ultra treatment for HPBF by 0.5 mgd, from 2.6 mgd to 3.1 mgd (to meet MMD of 2,153 gpm).	FY1011	0.5	mgd			$ -	lumpsum(5)	$ -	0.00	0.00	$ -		0%	$ 2,650,000	Chev	$ 2,650,000	$ -	-	$ 2,650,000	-	$ -	$ -
2	CH-02	CH	PS	Replace existing pumps with 2-2,400 gpm pumps (to meet MDD of 2,395 gpm).	FY1011	4,600	gpm	200	hp	$ 2,500	per hp	$ 500,000	1.00	-	$ 500,000	IF	140%	$ 700,000	Chev	$ 700,000	$ -	-	$ 700,000	-	$ -	$ -
2	CL-01	CL	Treatment	ELWRF Phase V Expansion - Increase treatment capacity of Industrial RO treatment for LPBF by 0.4 mgd, from 1.7 mgd to 2.1 mgd (to meet MMD of 1,218 gpm).	FY1011	0.4	mgd			$ -	lumpsum(5)	$ -	0.00	0.00	$ -		0%	$ 1,050,000	Chev	$ 1,050,000	$ -	-	$ 1,050,000	-	$ -	$ -
2	CL-02	CL	PS	Replace existing pumps with 3-1,250 gpm pumps (to meet MDD of 2,039 gpm).	FY1011	3,750	gpm	300	hp	$ 2,500	per hp	$ 750,000	1.00	-	$ 750,000	IF	140%	$ 1,050,000	Chev	$ 1,050,000	$ -	-	$ 1,050,000	-	$ -	$ -
Subtotal	ECLWRF Phase V Expansion - Chevron Boilerfeed											$ 1,250,000			$ 1,250,000			$ 5,450,000		$ 5,450,000	$ -	$ -	$ 5,450,000	$ -	$ -	$ -
3	ESPP-01	ESPP	Treatment	Add to treatment capacity of Industrial RO treatment for ESPP of 0.5 mgd (to meet MMD of 325 gpm).	FY15-20	0.7	mgd			$ -	lumpsum(7)	$ 1,355,000	1.00	-	$ 1,355,000	IF	140%	$ 1,900,000	ESPP	$ 1,900,000	$ -	-	$ -	$ 1,900,000	$ -	$ -
3	ESPP-02	ESPP	Pipeline	El Segundo Power Plant Pipeline from Chevron to El Segundo Power Plant	FY15-20	8,000	lineal ft	12	inches	$ 310	per ft	$ 2,480,000	1.00	-	$ 2,480,000	OF	157%	$ 3,895,000	ESPP	$ 3,895,000	$ -	-	$ -	$ 3,895,000	$ -	$ -
3	ESPP-03	ESPP	Pipeline	PRV at Chevron	FY15-20	1	PRV	8	inches	$ 50,000	per PRV	$ 50,000	1.00	-	$ 50,000	OF	157%	$ 80,000	ESPP	$ 80,000	$ -	-	$ -	$ 80,000	$ -	$ -
Subtotal	ECLWRF Phase V Expansion - El Segundo Power Plant											$ 3,885,000			$ 3,885,000			$ 5,875,000		$ 5,875,000	$ -	$ -	$ -	$ 5,875,000	$ -	$ -
4	CN-01	CN	PS	ELWRF Phase Va Expansion - Replace existing pumps with 4-1,800 gpm pumps (to meet peak demand of 5,164 gpm).	FY1011	7,200	gpm	500	hp	$ 2,250	per hp	$ 1,125,000	1.00	-	$ 1,125,000	IF	140%	$ 1,575,000	Chev	$ 1,575,000	$ -	-	$ 1,575,000	-	$ -	$ -
4	CNF-01	CNF	Treatment	ELWRF Phase Va Expansion - Increase treatment capacity of Nitrified by 2.1, from 4.9 mgd to 7.0 mgd. (Two Biofor Units)	FY15-20	2.1	mgd			$ 1.05	per gal	$ 2,205,000	1.00	-	$ 2,205,000	IF	140%	$ 3,090,000	Chev	$ 3,090,000	$ -	-	$ -	$ 3,090,000	$ -	$ -
4	CNF-03	CNF	Recapitalization	ELWRF Phase Va Expansion - Replace Turbine	FY1011	1	site			$ 500,000	lumpsum(1)	$ 500,000	1.00	-	$ 500,000	IF	140%	$ 700,000	Chev	$ 700,000	$ -	-	$ 700,000	-	$ -	$ -
4	CNF-02	CNF	Reliability	ELWRF Phase Va Expansion - Backup Power to Product Water Pumps	FY15-20	1	system			$ 500,000	lumpsum(1)	$ 500,000	1.00	-	$ 500,000	IF	140%	$ 700,000	Chev	$ 700,000	$ -	-	$ -	$ 700,000	$ -	$ -
4	CNF-04	CNF	Reliability	ELWRF Phase Va Expansion - Potable Water Backup Supply	FY15-20	1	site			$ 250,000	per site	$ 250,000	1.00	-	$ 250,000	IF	140%	$ 350,000	Chev	$ 350,000	$ -	-	$ -	$ 350,000	$ -	$ -
Subtotal	Chevron Nitrification Facility - Nitrified System Expansion											$ 4,580,000			$ 4,580,000			$ 6,415,000		$ 6,415,000	$ -	$ -	$ 2,275,000	$ 4,140,000	$ -	$ -
5	BPN-01	BPN	Treatment	Treat SE from JWPCP w/ MF to serve growth in bp Nitrified System	FY1112	8.7	mgd			$ 12,000,000	lumpsum(1)	$ 12,000,000	1.00	-	$ 12,000,000	IF	140%	$ 16,800,000	bp	$ 16,800,000	$ -	-	$ 16,800,000	-	$ -	$ -
5	BPN-02	BPN	Treatment	Nitrified Treatment - treat MF treated SE (BPN-01) from JWPCP to serve growth in bp Nitrified System	FY1112	8.3	mgd			$ 1.05	per gpd	$ 8,715,000	1.00	-	$ 8,715,000	IF	140%	$ 12,205,000	bp	$ 12,205,000	$ -	-	$ 12,205,000	-	$ -	$ -
5	BPN-03	BPN	Pipeline	New 20" pipeline from NTP to bp for conveyance of Nitrified Water.	FY1112	10,560	lineal ft	20	inches	$ 460	per lineal ft	$ 4,857,600	1.25	A	$ 6,072,000	OF	157%	$ 9,535,000	bp	$ 9,535,000	$ -	-	$ 9,535,000	-	$ -	$ -
5	BPN-03A	BPN	Pipeline	Parallel 14" pipeline from CRWRF to bp for conveyance of Nitrified Water.	FY1112	6,178	lineal ft	14	inches	$ 350	per lineal ft	$ 2,162,160	1.25	A	$ 2,702,700	OF	157%	$ 4,245,000	bp	$ 4,245,000	$ -	-	$ 4,245,000	-	$ -	$ -
5	BPN-04	BPN	PS	New pump station at NTP to serve bp Nitrified (assumes 4-1,500 gpm pumps, in PS w/ BPRO-03)	FY1112	6,000	gpm	300	hp	$ 7,500	per hp	$ 2,250,000	1.00	-	$ 2,250,000	IF	140%	$ 3,150,000	bp	$ 3,150,000	$ -	-	$ 3,150,000	-	$ -	$ -
5	BPN-05	BPN	Storage	Add a 1.0 MG storage reservoir to NTP to maintain current number of hours of backup for bp Nitrified system.	FY1112	1.0	MG			$ 1.50	per gallon	$ 1,500,000	1.00	-	$ 1,500,000	IF	140%	$ 2,100,000	bp	$ 2,100,000	$ -	-	$ 2,100,000	-	$ -	$ -
5	BPRO-01	BPRO	Treatment	Treat SE from JWPCP w/ MF/RO to serve growth in bp RO System	FY1112	8.7	mgd			$ 6.00	per gal	$ 52,200,000	1.00	-	$ 52,200,000	IF	140%	$ 73,080,000	bp	$ 73,080,000	$ -	-	$ 73,080,000	-	$ -	$ -
5	BPRO-02	BPRO	Pipeline	New Pipeline from NTP to bp for conveyance of Industrial RO Water.	FY1112	10,560	lineal ft	18	inches	$ 420	per lineal ft	$ 4,435,200	1.25	A	$ 5,544,000	OF	157%	$ 8,705,000	bp	$ 8,705,000	$ -	-	$ 8,705,000	-	$ -	$ -
5	BPRO-03	BPRO	PS	New pump station at NTP to serve bp Industrial RO (assumes 4-2,100 gpm pumps, in PS w/ BPN-04)	FY1112	8,400	gpm	400	hp	$ 7,500	per hp	$ 3,000,000	1.00	-	$ 3,000,000	IF	140%	$ 4,200,000	bp	$ 4,200,000	$ -	-	$ 4,200,000	-	$ -	$ -
5	CRWRF-04	CRWRF	Treatment	Surge Protection - Modify MF Units with Break Tank and Pumps	FY1112			lump sum		$ 4,500,000	lumpsum(2)	$ 4,500,000	1.00	-	$ 4,500,000	IF	140%	$ 6,300,000	None	$ -	$ 6,300,000	-	$ 6,300,000	-	$ -	$ -
5	CRWRF-05	CRWRF	Storage	Raw Water Storage (1 hour)	FY1112	2.5	MG			$ 1.50	per gallon	$ 3,750,000	1.00	-	$ 3,750,000	IF	140%	$ 5,250,000	None	$ -	$ 5,250,000	-	$ 5,250,000	-	$ -	$ -
5	NTP-01	NTP	Treatment	Land Acquisition of 4.5 ac near JWPCP for NTP	FY1112	21.3	mgd	4.0	ac	$ 1,000,000	per acre(1)	$ 4,000,000	1.00	-	$ 4,000,000	LA	120%	$ 4,800,000	None	$ -	$ 4,800,000	-	$ 4,800,000	-	$ -	$ -
Subtotal	bp Refinery Capacity Expansion Project											$ 103,369,960			$ 106,233,700			$ 150,370,000		$ 134,020,000	$ 16,350,000	$ -	$ 150,370,000	$ -	$ -	$ -
6	CRWRF-01	CRWRF	Pipeline	Pipeline for LADWP Harbor demands at Carson City bndy	FY1112	20,200	lineal ft	30	inches	$ -	lumpsum(7)	$ 18,535,000	1.00	-	$ 18,535,000	OF	157%	$ 29,100,000	Other	$ 29,100,000	$ -	-	$ 29,100,000	-	$ -	$ -
6	CRWRF-02	CRWRF	Treatment	Nitrified Treatment of Title 22 Water (Nitrified Water for LADWP Harbor Demand and Rhodia)	FY1112	12.3	mgd			$ -	lumpsum(7)	$ 30,815,000	1.00	-	$ 30,815,000	IF	140%	$ 43,141,278	None	$ -	$ 43,141,278	-	$ 43,141,278	-	$ -	$ -
6	CRWRF-03	CRWRF	PS	Add new 11.6 mgd pump station at CRWRF to serve LADWP Harbor Demand Phase II (5 pumps)	FY1112	9,667	gpm	500	hp	$ 7,500	per hp	$ 3,750,000	1.00	-	$ 3,750,000	IF	140%	$ 5,250,000	None	$ -	$ 5,250,000	-	$ 5,250,000	-	$ -	$ -
Subtotal	Los Angeles Harbor Area Expansion Project											$ 53,100,000			$ 53,100,000			$ 77,491,278		$ 29,100,000	$ 48,391,278	$ -	$ 77,491,278	$ -	$ -	$ -

WB Project ID	Project ID	System Name	Project Type	Project Description	Year	Size	Unit	Capacity	Unit	Unit Cost	Unit	Construction Cost (w/o Spcl Cond)	Special Construction	Spcl Cnst	Construction Cost	Project Location (for TTC)	Contingency	Capital Cost	Other Payer	Cost to Other Party	Cost to West Basin	FY0910	FY10-15	FY15-20	FY20-25	FY25-30
7	ELWRF-09	ELWRF	Treatment	Add 17.3 mgd of Title 22 Treatment, to increase Title 22 treatment capacity from 50.0 mgd to 67.3 mgd	FY15-20	17.3	mgd			$ 2.00	per gpd	$ 34,600,000	1.00	-	$ 34,600,000	IF	140%	$ 48,440,000	None	$ -	$ 48,440,000	-	$ -	$ 48,440,000	$ -	$ -
7	ELWRF-10	ELWRF	PS	Increase capacity of Title 22 Pump Station at ELWRF by 3,200 hp (from 4,800 hp to 8,000 hp) to serve Future Title 22 Customers	FY15-20			3,200	hp	$ 3,200	per hp	$ 10,240,000	1.00	-	$ 10,240,000	IF	140%	$ 14,340,000	None	$ -	$ 14,340,000	-	$ -	$ 14,340,000	$ -	$ -
7	ELWRF-11	ELWRF	Treatment	Microfiltration - Replace existing Phase II MF System w/ Pressurized System	FY15-20	8.4	mgd			$ 12,000,000	lumpsum(1)	$ 12,000,000	1.00	-	$ 12,000,000	IF	140%	$ 16,800,000	None	$ -	$ 16,800,000	-	$ -	$ 16,800,000	$ -	$ -
7	ELWRF-12	ELWRF	Reliability	Backup Power	FY15-20	1	system			$ 8,000,000	lumpsum(1)	$ 8,000,000	1.00	-	$ 8,000,000	IF	140%	$ 11,200,000	None	$ -	$ 11,200,000	-	$ -	$ 11,200,000	$ -	$ -
7	ELWRF-13	ELWRF	Treatment	Dewatered Sludge Handling Transfer System	FY15-20	1	system			$ 2,000,000	lumpsum(1)	$ 2,000,000	1.00	-	$ 2,000,000	IF	140%	$ 2,800,000	None	$ -	$ 2,800,000	-	$ -	$ 2,800,000	$ -	$ -
7	ELWRF-15	ELWRF	Reliability	Potable Water Connection to ELWRF	FY15-20					$ 200,000	per site(1)	$ 200,000	1.00	-	$ 200,000	IF	140%	$ 280,000	None	$ -	$ 280,000	-	$ -	$ 280,000	$ -	$ -
7	EMWRF-07	EMWRF	Reliability	Backup Power for Product Water Pumps	FY15-20	1	system			$ 500,000	lumpsum(1)	$ 500,000	1.00	-	$ 500,000	IF	140%	$ 700,000	None	$ -	$ 700,000	-	$ -	$ 700,000	$ -	$ -
7	T22-17	T22	Storage	Increase Title 22 product water storage by 5.0 MG	FY15-20	5	MG			$ 1.50	per gallon	$ 7,500,000	1.00	-	$ 7,500,000	IF	140%	$ 10,500,000	None	$ -	$ 10,500,000	-	$ -	$ 10,500,000	$ -	$ -
7	T22-23	T22	Pipeline	Title-22 PS Discharge Pipeline Modification	FY15-20	300	lineal ft	54	inches	$ 1,100	per lineal ft	$ 330,000	1.00	-	$ 330,000	IF	140%	$ 465,000	None	$ -	$ 465,000	-	$ -	$ 465,000	$ -	$ -
Subtotal	ELWRF Phase VI - Future Plant Expansions											$ 75,370,000			$ 75,370,000			$ 105,525,000		$ -	$ 105,525,000	$ -	$ -	$ 105,525,000	$ -	$ -
13	HPS-01	HPS	PS	Add 23 mgd of additional pumping capacity, to bring firm capacity to 74 mgd of firm capacity. (Phase I of II; total project assumes 7 pumps, 7,000 hp total)	FY1011			7,000	hp	$ 3,000	per hp	$ 10,500,000	1.00	-	$ 10,500,000	IF	140%	$ 14,700,000	None	$ -	$ 14,700,000	-	$ 14,700,000	-	$ -	$ -
13	HPS-04	HPS	PS	PS Building	FY1011	1	building					$ 400,000	1.00	-	$ 400,000	IF	140%	$ 560,000	None	$ -	$ 560,000	-	$ 560,000	-	$ -	$ -
13	HPS-05	HPS	PS	Add 23 mgd of additional pumping capacity, to bring firm capacity to 97 mgd of firm capacity. (Phase II of II; total project assumes 7 pumps, 7,000 hp total)	FY1112			7,000	hp	$ 3,000	per hp	$ 10,500,000	1.00	-	$ 10,500,000	IF	140%	$ 14,700,000	None	$ -	$ 14,700,000	-	$ 14,700,000	-	$ -	$ -
Subtotal	Hyperion Secondary Effluent Pump Station Expansion											$ 21,400,000			$ 21,400,000			$ 29,960,000		$ -	$ 29,960,000	$ -	$ 29,960,000	$ -	$ -	$ -
14	HPS-03	HPS	PS	Secondary Power Connection for Backup Power	FY1011	1	system			$ 1,800,000	lumpsum(1)	$ 1,800,000	1.00	-	$ 1,800,000	IF	140%	$ 2,520,000	None	$ -	$ 2,520,000	-	$ 2,520,000	-	$ -	$ -
Subtotal	Hyperion Secondary Effluent Pump Station Secondary Feed											$ 1,800,000			$ 1,800,000			$ 2,520,000		$ -	$ 2,520,000	$ -	$ 2,520,000	$ -	$ -	$ -
15	T22-11	T22	Pipeline	Chlorination Stations (Phase I)	FY1213	5	stations			$ 280,000	per station	$ 1,400,000	1.00	-	$ 1,400,000	IF	140%	$ 1,960,000	None	$ -	$ 1,960,000	-	$ 1,960,000	-	$ -	$ -
15	T22-21	T22	Pipeline	Chlorination Stations (Phase II)	FY15-20	5	stations			$ 280,000	per station	$ 1,400,000	1.00	-	$ 1,400,000	IF	140%	$ 1,960,000	None	$ -	$ 1,960,000	-	$ -	$ 1,960,000	$ -	$ -
Subtotal	Water Quality Facility Improvements											$ 2,800,000			$ 2,800,000			$ 3,920,000		$ -	$ 3,920,000	$ -	$ 1,960,000	$ 1,960,000	$ -	$ -
16	T22-02	T22	Pipeline	El Segundo Lateral (Boeing, Kilroy Airport)	FY1112	6,300	lineal ft	6	inches		see detail	$ 955,000	1.00	-	$ 955,000	OF	157%	$ 1,500,000	Fed	$ 1,031,250	$ 468,750	-	$ 1,500,000	-	$ -	$ -
16	T22-02A	T22	Pipeline	Mariposa Lateral (Mattel, Hilton, Marriot)	FY0910	1,700	lineal ft	6	inches		see detail	$ 475,000	1.00	-	$ 475,000	OF	157%	$ 750,000	Fed	$ 515,625	$ 234,375	$ 750,000	$ -	-	$ -	$ -
16	T22-06	T22	Pipeline	Carson Mall Lateral	FY0910	10,000	lineal ft	6 - 16	inches		lumpsum(7)	$ 1,070,000	1.48	A,F	$ 1,590,000	OF	157%	$ 2,500,000	Fed	$ 1,718,750	$ 781,250	$ 2,500,000	$ -	-	$ -	$ -
16	T22-08	T22	Pipeline	Mills Park Lateral	FY1112	1,000	lineal ft	6	inches		see detail	$ 175,000	1.00	-	$ 175,000	IF	140%	$ 245,000	Fed	$ 168,438	$ 76,563	-	$ 245,000	-	$ -	$ -
16	T22-09	T22	Pipeline	Anza Lateral Phase II	FY0910	12,000	lineal ft	4 - 8	inches		lumpsum(8)	$ -	0.00	0.00	$ -	-	0%	$ 3,500,000	Fed	$ 2,406,250	$ 1,093,750	$ 3,500,000	$ -	-	$ -	$ -
16	T22-10	T22	PS	Anza PS (4-500 gpm pumps)	FY0910	2,000	gpm	200	hp		lumpsum(4)	$ -	0.00	0.00	$ -	-	0%	$ 2,000,000	Fed	$ 1,375,000	$ 625,000	$ 2,000,000	$ -	-	$ -	$ -
16	T22-13	T22	Pipeline	Dominguez Street Lateral	FY1011	14,500	lineal ft	6 - 8	inches		lumpsum(4)	$ -	0.00	0.00	$ -	-	0%	$ 4,500,000	Fed	$ 3,093,750	$ 1,406,250	-	$ 4,500,000	-	$ -	$ -
16	T22-19	T22	Pipeline	Dyehouse Lateral	FY0910	12,000	lineal ft	8	inches		lumpsum(4)	$ -	0.00	0.00	$ -	-	0%	$ 3,000,000	Fed	$ 2,062,500	$ 937,500	$ 3,000,000	$ -	-	$ -	$ -
16	T22-20	T22	PS	Dyehouse PS (3-250 gpm pumps)	FY0910	600	gpm	40	hp		lumpsum(4)	$ -	0.00	0.00	$ -	-	0%	$ 1,500,000	Fed	$ 1,031,250	$ 468,750	$ 1,500,000	$ -	-	$ -	$ -
Subtotal	Harbor / South Bay Project Laterals - US ARMY CORPS											$ 2,675,000			$ 3,195,000			$ 19,495,000		$ 13,402,813	$ 6,092,188	$ 13,250,000	$ 6,245,000	$ -	$ -	$ -
17	T22-01	T22	Pipeline	Caltrans Inglewood Lateral	FY1213	1,000	lineal ft	4	inches		see detail	$ 130,000	1.25	A	$ 165,000	OF	157%	$ 260,000	Fed	$ 178,750	$ 81,250	-	$ 260,000	-	$ -	$ -
17	T22-04	T22	Pipeline	Virco-Torrance Lateral	FY1011	1,500	lineal ft	6	inches		see detail	$ 215,000	1.00	-	$ 215,000	OF	157%	$ 340,000	None	$ -	$ 340,000	-	$ 340,000	-	$ -	$ -
17	T22-07	T22	Pipeline	Redondo Beach Lateral (Pete's Nursery)	FY1112	2,500	lineal ft	6	inches		see detail	$ 420,000	1.00	-	$ 420,000	OF	157%	$ 660,000	None	$ -	$ 660,000	-	$ 660,000	-	$ -	$ -
17	T22-12	T22	Pipeline	Main Street Carson Lateral	FY1314	37,000	lineal ft	6 - 16	inches		see detail	$ 9,715,000	1.12	A	$ 10,875,000	OF	157%	$ 17,075,000	None	$ -	$ 17,075,000	-	$ 17,075,000	-	$ -	$ -
17	T22-14	T22	Pipeline	Caltrans Gardena Lateral	FY1415	3,500	lineal ft	6 - 8	inches		see detail	$ 625,000	1.00	-	$ 625,000	OF	157%	$ 985,000	None	$ -	$ 985,000	-	$ 985,000	-	$ -	$ -
17	T22-15	T22	Pipeline	Palos Verdes - Lateral 6B	FY15-20	42,500	lineal ft	12 - 24	inches		see detail	$ 17,380,000	1.00	-	$ 17,380,000	OF	157%	$ 27,290,000	Fed	$ 18,761,875	$ 8,528,125	-	$ -	$ 27,290,000	$ -	$ -
17	T22-16	T22	PS	Palos Verdes PS (4-1,250 gpm pumps)	FY15-20	5,000	gpm	375	hp		lumpsum(1)	$ 3,500,000	1.00	-	$ 3,500,000	IF	140%	$ 4,900,000	None	$ -	$ 4,900,000	-	$ -	$ 4,900,000	$ -	$ -
17	T22-18A	T22	Pipeline	Gardena Lateral - Normandie Ave	FY15-20	9,500	lineal ft	8	inches		see detail	$ 2,260,000	1.02	A	$ 2,315,000	OF	157%	$ 3,635,000	None	$ -	$ 3,635,000	-	$ -	$ 3,635,000	$ -	$ -
17	T22-18B	T22	Pipeline	Gardena Lateral - Normandie and Vermont	FY15-20	19,500	lineal ft	4 - 6	inches		see detail	$ 3,815,000	1.03	A	$ 3,930,000	OF	157%	$ 6,170,000	None	$ -	$ 6,170,000	-	$ -	$ 6,170,000	$ -	$ -
17	T22-18C	T22	Pipeline	Gardena Lateral - Van Ness	FY15-20	15,000	lineal ft	4 - 6	inches		see detail	$ 2,855,000	1.00	A	$ 2,855,000	OF	157%	$ 4,480,000	None	$ -	$ 4,480,000	-	$ -	$ 4,480,000	$ -	$ -
17	T22-22	T22	Pipeline	Hawthorne Lateral (Solec)	FY15-20	5,500	lineal ft	6	inches		see detail	$ 1,015,000	1.00	-	$ 1,015,000	OF	157%	$ 1,595,000	Fed	$ 1,096,563	$ 498,438	-	$ -	$ 1,595,000	$ -	$ -
Subtotal	Harbor / South Bay Project Laterals - DISTRICT											$ 41,930,000			$ 43,295,000			$ 67,390,000		$ 20,037,188	$ 47,352,813	$ -	$ 19,320,000	$ 48,070,000	$ -	$ -
18	CRWRF-07	CRWRF	Reliability	Backup Power	FY15-20	1	system			$ 1,800,000	lumpsum	$ 1,800,000	1.00	-	$ 1,800,000	IF	140%	$ 2,520,000	None	$ -	$ 2,520,000	-	$ -	$ 2,520,000	$ -	$ -
Subtotal	Backup Power and Water Supply											$ 1,800,000			$ 1,800,000			$ 2,520,000		$ -	$ 2,520,000	$ -	$ -	$ 2,520,000	$ -	$ -
30	CNF-05	CNF	Recapitalization	ELWRF Phase Va Expansion - Inspect Nitrified Product Water Storage Tank Internal Condition	FY1112	1	site			$ 60,000	lumpsum(1)	$ 60,000	1.00	-	$ 60,000	IF	140%	$ 85,000	Chev	$ 85,000	$ -	-	$ 85,000	-	$ -	$ -
30	CNF-06	CNF	Recapitalization	Rehabilitation and Replacement from Condition Assessment (recurring)	Mult							$ 3,765,000	1.00	-	$ 3,765,000	CA	120%	$ 4,520,000	Chev	$ 4,520,000	$ -	$ -	$ 2,740,000	$ 1,780,000	$ -	$ -
30	CNF-07	CNF	Recapitalization	United Water Recapitalization Improvements (recurring)	Mult							$ 500,000	1.00	-	$ 500,000	IF	140%	$ 850,000	Chev	$ 850,000	$ -	$ -	$ 425,000	$ 425,000	$ -	$ -
30	HPS-06	HPS	Recapitalization	Rehabilitation and Replacement from Condition Assessment (recurring)	Mult							$ 600,000	1.00	-	$ 600,000	CA	120%	$ 725,000	None	$ -	$ 725,000	$ -	$ 350,000	$ 375,000	$ -	$ -
Subtotal	Treatment Facility Repair, Replacement, and Improvements											$ 4,925,000			$ 4,925,000			$ 6,180,000		$ 5,455,000	$ 725,000	$ -	$ 3,600,000	$ 2,580,000	$ -	$ -
	EMWRF-04	EMWRF	Treatment	Add 0.6 mgd of Industrial RO Treatment of Title 22 Water (half of 1,000 afy total w/ RO).(6)	FY15-20						per gpd	$ 1,350,000	1.00	-	$ 1,350,000	IF	140%	$ 1,890,000	EMWRF	$ 1,890,000	$ -	-	$ -	$ 1,890,000	$ -	$ -
	EMWRF-05	EMWRF	Treatment	Add 0.5 mgd of Nitrified Treatment of Title 22 Water (half of 1,000 afy total w/ Nitrified).(6)	FY15-20	0.5	mgd			$ 1	per gpd	$ 525,000	1.00	-	$ 525,000	IF	140%	$ 735,000	EMWRF	$ 735,000	$ -	-	$ -	$ 735,000	$ -	$ -
Subtotal	EMWRF Expansion											$ 1,875,000			$ 1,875,000			$ 2,625,000		$ 2,625,000	$ -	$ -	$ -	$ 2,625,000	$ -	$ -
31	CBRN-01	CBRN	Pipeline	Install access ports for cleaning	FY1112	8	ports			$ 100,000	per port	$ 800,000	1.00	-	$ 800,000	OF	157%	$ 1,260,000	None	$ -	$ 1,260,000	-	$ 1,260,000	-	$ -	$ -
31	CRWRF-06	CRWRF	Recapitalization	Repair Nitrified Product Water Storage Tank	FY1112	0.2	MG			$ 2.00	per gallon	$ 400,000	1.00	-	$ 400,000	IF	140%	$ 560,000	None	$ -	$ 560,000	-	$ 560,000	-	$ -	$ -
31	CRWRF-08	CRWRF	PS	Rehabilitation and Replacement from Condition Assessment (recurring)	Mult							$ 5,310,000	1.00	-	$ 5,310,000	CA	120%	$ 6,375,000	None	$ -	$ 6,375,000	$ -	$ 1,125,000	$ 5,250,000	$ -	$ -
31	CRWRF-09	CRWRF	Recapitalization	Membrane Replacement (recurring)	Mult					$ 279,900	per year	$ 2,795,000	1.00	-	$ 2,795,000	MR	100%	$ 2,799,000	None	$ -	$ 2,799,000	-	$ 1,399,500	$ 1,399,500	$ -	$ -
31	CRWRF-10	CRWRF	Recapitalization	United Water Recapitalization Improvements (recurring)	Mult							$ 1,205,000	1.00	-	$ 1,205,000	IF	140%	$ 1,690,000	None	$ -	$ 1,690,000	$ -	$ 845,000	$ 845,000	$ -	$ -
31	CRWRF-11	CRWRF	Recapitalization	UW Recap - Construct paved access way from road to rear side of RO CIP tank.	FY0910							$ 10,000	1.00	-	$ 10,000	UW	100%	$ 10,000	None	$ -	$ 10,000	$ 10,000	$ -	-	$ -	$ -
31	EBRN-01	EBRN	Pipeline	Install pinch valves/reducers	FY1011	10	reducers			$ 40,000	per valve(1)	$ 400,000	1.00	-	$ 400,000	OF	157%	$ 630,000	None	$ -	$ 630,000	-	$ 630,000	-	$ -	$ -
31	EBRN-02	EBRN	Pipeline	Install access ports for cleaning	FY1112	12	ports			$ 100,000	per port	$ 1,200,000	1.00	-	$ 1,200,000	OF	157%	$ 1,885,000	None	$ -	$ 1,885,000	-	$ 1,885,000	-	$ -	$ -
31	ELWRF-01	ELWRF	Recapitalization	UW Recap - T-22 backwash pump total rebuilds (increase capacity of T22 backwash blower)	FY0910					$ 100,000	lumpsum(9)	$ 100,000	1.00	-	$ 100,000	UW	100%	$ 100,000	None	$ -	$ 100,000	$ 100,000	$ -	-	$ -	$ -
31	ELWRF-06	ELWRF	Recapitalization	Increase Capacity of Title 22 Air Vacuum Release Valve for Product Water Storage Tanks	FY1011	1	valve			$ 70,000	lumpsum(1)	$ 70,000	1.00	-	$ 70,000	IF	140%	$ 100,000	None	$ -	$ 100,000	-	$ 100,000	-	$ -	$ -

WB Project ID	Project ID	System Name	Project Type	Project Description	Year	Size	Unit	Capacity	Unit	Unit Cost	Unit	Construction Cost (w/o Spcl Cond)	Special Construction	Spcl Cnst	Construction Cost	Project Location (for TTC)	Contingency	Capital Cost	Other Payer	Cost to Other Party	Cost to West Basin	FY0910	FY10-15	FY15-20	FY20-25	FY25-30
31	ELWRF-16	ELWRF	Recapitalization	Rehabilitation and Replacement from Condition Assessment (recurring)	Mult							$ 18,215,000	1.00	-	$ 18,215,000	CA	120%	$ 21,860,000	None	$ -	$ 21,860,000	$ -	$ 4,660,000	$ 17,200,000	$ -	$ -
31	ELWRF-17	ELWRF	Recapitalization	Membrane Replacement (recurring)	Mult					$ 1,105,380	per year	$ 11,050,000	1.00	-	$ 11,050,000	MR	100%	$ 11,053,800	None	$ -	$ 11,053,800	-	$ 5,526,900	$ 5,526,900	$ -	$ -
31	ELWRF-18	ELWRF	Recapitalization	United Water Recapitalization Improvements (recurring)	Mult							$ 3,620,000	1.00	-	$ 3,620,000	IF	140%	$ 5,070,000	None	$ -	$ 5,070,000	$ -	$ 2,535,000	$ 2,535,000	$ -	$ -
31	ELWRF-19	ELWRF	Recapitalization	UW Recap - Pave area between T 22 filters and the holding basins	FY0910							$ 8,800	1.00	-	$ 8,800	UW	100%	$ 8,800	None	$ -	$ 8,800	$ 8,800	$ -	-	$ -	$ -
31	ELWRF-20	ELWRF	Recapitalization	UW Recap - Shelter/Overhead cover when CO2 tank is removed. To provide covered storage area for chemical totes. Include access for forklifts around dike area.	FY0910							$ 100,000	1.00	-	$ 100,000	UW	100%	$ 100,000	None	$ -	$ 100,000	$ 100,000	$ -	-	$ -	$ -
31	ELWRF-21	ELWRF	Recapitalization	UW Recap - Phase III Memcor and SCADA and PC	FY0910							$ 5,000	1.00	-	$ 5,000	UW	100%	$ 5,000	None	$ -	$ 5,000	$ 5,000	$ -	-	$ -	$ -
31	ELWRF-22	ELWRF	Recapitalization	UW Recap - No. 3 Sulfuric acid day tank replace	FY0910							$ 30,000	1.00	-	$ 30,000	UW	100%	$ 30,000	None	$ -	$ 30,000	$ 30,000	$ -	-	$ -	$ -
31	ELWRF-23	ELWRF	Recapitalization	UW Recap - Replace grating replacement in chemical area with chemical resistant grating	FY0910							$ 40,000	1.00	-	$ 40,000	UW	100%	$ 40,000	None	$ -	$ 40,000	$ 40,000	$ -	-	$ -	$ -
31	ELWRF-24	ELWRF	Recapitalization	UW Recap - Trench Drains at Decant Sump area	FY0910							$ 30,000	1.00	-	$ 30,000	UW	100%	$ 30,000	None	$ -	$ 30,000	$ 30,000	$ -	-	$ -	$ -
31	ELWRF-25	ELWRF	Recapitalization	UW Recap - Power receptacles for emergency generator hook up for Title 22	FY0910							$ 20,000	1.00	-	$ 20,000	UW	100%	$ 20,000	None	$ -	$ 20,000	$ 20,000	$ -	-	$ -	$ -
31	ELWRF-26	ELWRF	Recapitalization	UW Recap - Replace DCS back up power (48vac) generator	FY0910							$ 45,000	1.00	-	$ 45,000	UW	100%	$ 45,000	None	$ -	$ 45,000	$ 45,000	$ -	-	$ -	$ -
31	ELWRF-27	ELWRF	Recapitalization	UW Recap - Flow control valve and actuator for barrier product pump	FY0910							$ 100,000	1.00	-	$ 100,000	UW	100%	$ 100,000	None	$ -	$ 100,000	$ 100,000	$ -	-	$ -	$ -
31	ELWRF-28	ELWRF	Recapitalization	UW Recap - Replace or expand plant instrument air compressor system	FY0910							$ 75,000	1.00	-	$ 75,000	UW	100%	$ 75,000	None	$ -	$ 75,000	$ 75,000	$ -	-	$ -	$ -
31	ELWRF-29	ELWRF	Recapitalization	UW Recap - Replace phase II RO Membranes	FY0910							$ 375,000	1.00	-	$ 375,000	UW	100%	$ 375,000	None	$ -	$ 375,000	$ 375,000	$ -	-	$ -	$ -
31	ELWRF-30	ELWRF	Recapitalization	UW Recap - Data Parser to allow for direct entry of data from instrumentation into LIMS.	FY0910							$ 25,000	1.00	-	$ 25,000	UW	100%	$ 25,000	None	$ -	$ 25,000	$ 25,000	$ -	-	$ -	$ -
31	ELWRF-31	ELWRF	Recapitalization	UW Recap - Replace or repair lab wall to prevent water intrusion and mold	FY0910							$ 25,000	1.00	-	$ 25,000	UW	100%	$ 25,000	None	$ -	$ 25,000	$ 25,000	$ -	-	$ -	$ -
31	EMWRF-01	EMWRF	Recapitalization	Repair or Replace Bulk Chemical Storage Tank and Associated Equipment	FY1112		1 system			$ 500,000	lumpsum(1)	$ 500,000	1.00	-	$ 500,000	IF	140%	$ 700,000	None	$ -	$ 700,000	-	$ 700,000	-	$ -	$ -
31	EMWRF-02	EMWRF	Recapitalization	Inspect Nitrified Product Water Storage Tank Internal Condition	FY1112		1 site			$ 60,000	lumpsum(1)	$ 60,000	1.00	-	$ 60,000	IF	140%	$ 85,000	None	$ -	$ 85,000	-	$ 85,000	-	$ -	$ -
31	EMWRF-03	EMWRF	Recapitalization	Rehabilitation and Replacement from Condition Assessment (recurring)	Mult						lumpsum(1)	$ 5,815,000	1.00	-	$ 5,815,000	CA	120%	$ 6,980,000	None	$ -	$ 6,980,000	$ -	$ 1,590,000	$ 5,390,000	$ -	$ -
31	EMWRF-06	EMWRF	Treatment	Surge Protection - Modify MF Units with Break Tank and Pumps	FY15-20		1 system	lump sum for alternatives		$ 2,500,000	lumpsum(2)	$ 2,500,000	1.00	-	$ 2,500,000	IF	140%	$ 3,500,000	None	$ -	$ 3,500,000	-	$ -	$ 3,500,000	$ -	$ -
31	EMWRF-08	EMWRF	Recapitalization	Membrane Replacement (recurring)	Mult					$ 165,000	per year	$ 1,650,000	1.00	-	$ 1,650,000	MR	100%	$ 1,650,000	None	$ -	$ 1,650,000	-	$ 825,000	$ 825,000	$ -	$ -
31	EMWRF-09	EMWRF	Recapitalization	United Water Recapitalization Improvements (recurring)	Mult							$ 605,000	1.00	-	$ 605,000	IF	140%	$ 850,000	None	$ -	$ 850,000	$ -	$ 425,000	$ 425,000	$ -	$ -
31	EMWRF-10	EMWRF	Recapitalization	UW Recap - Pavement of area between gated entrance and plant.	FY0910							$ 20,000	1.00	-	$ 20,000	UW	100%	$ 20,000	None	$ -	$ 20,000	$ 20,000	$ -	-	$ -	$ -
31	EMWRF-11	EMWRF	Recapitalization	UW Recap - Add an additional air compressor for the MF system	FY0910							$ 30,000	1.00	-	$ 30,000	UW	100%	$ 30,000	None	$ -	$ 30,000	$ 30,000	$ -	-	$ -	$ -
31	EMWRF-12	EMWRF	Recapitalization	UW Recap - RO Train 4 membrane change out	FY0910							$ 160,000	1.00	-	$ 160,000	UW	100%	$ 160,000	None	$ -	$ 160,000	$ 160,000	$ -	-	$ -	$ -
31	NTP-02	NTP	Recapitalization	Membrane Replacement (recurring)	Mult					$ 1,705,000	per year	$ 5,040,000	1.00	-	$ 5,040,000	MR	100%	$ 8,525,000	None	$ -	$ 8,525,000	-	$ -	$ 8,525,000	$ -	$ -
31	SW-01	SW	Recapitalization	United Water Recapitalization Improvements (recurring)	Mult							$ 3,020,000	1.00	-	$ 3,020,000	IF	140%	$ 4,230,000	None	$ -	$ 4,230,000	$ -	$ 2,115,000	$ 2,115,000	$ -	$ -
31	SW-02	SW	Recapitalization	UW Recap - Major Painting Projects	FY0910							$ 150,000	1.00	-	$ 150,000	UW	100%	$ 150,000	None	$ -	$ 150,000	$ 150,000	$ -	-	$ -	$ -
31	SW-03	SW	Recapitalization	UW Recap - Purchase trailer for spill response	FY0910							$ 5,000	1.00	-	$ 5,000	UW	100%	$ 5,000	None	$ -	$ 5,000	$ 5,000	$ -	$ -	$ -	$ -
31	SW-04	SW	Recapitalization	UW Recap - Asset Management Software, Implementation and Training	FY0910							$ 300,000	1.00	-	$ 300,000	UW	100%	$ 300,000	None	$ -	$ 300,000	$ 300,000	$ -	-	$ -	$ -
31	SW-05	SW	Recapitalization	UW Recap - Replace all Biofor valves at CNF and EMWRF	FY0910							$ 200,000	1.00	-	$ 200,000	UW	100%	$ 200,000	None	$ -	$ 200,000	$ 200,000	$ -	-	$ -	$ -
Subtotal	Conveyance Facility Repair, Replacement, and Improvements											$ 66,108,800			$ 66,108,800			$ 81,656,600		$ -	$ 81,656,600	$ 1,853,800	$ 26,266,400	$ 53,536,400	$ -	$ -
											Total	**$ 398,113,760**	**$ -**	**$ -**	**$ 417,535,333**	**-**	**$ -**	**$ 614,937,878**	**$ -**	**$ 254,180,000**	**$ 360,757,878**	**$ 15,103,800**	**$ 373,002,678**	**$ 226,831,400**	**$ -**	**$ -**

Notes:

1) Cost estimated based on considerations specific to the site, application, or project, rather than through utilization of unit costs.
2) Withfor this report, multiple alternatives were proposed. For conservative planning purposes, the more expensive option is included here. Decisions regarding alternatives will need to be made during preliminary design. See Chapters 7 and 8 for more details.
3) Cost estimate obtained from ELWRF Phase V Expansion Feasibility Study (HDR April 2008). Cost estimate does not reflect unit costs or markups developed for this report.
4) Budget for project prepared by West Basin as a part of preliminary design. Cost estimate does not reflect unit costs or markups developed for this report.
5) Cost based on recent discussions with West Basin staff. Cost estimate does not reflect unit costs or markups developed for this report.
6) Expansion of the EMWRF Facility and associated increase in Title 22 water are not included in the Customer Database or System Analysis portions of this report.
7) Cost provided by West Basin staff. Based on recent customer revisions.
8) Length reduced from 16,000 lf to 12,000 lf based on discussions with West Basin staff.
9) Cost provided by United Water cost estimate.

Post 2020 Projects

Project ID	System Name (Lookup)	Project Type	Project Description	Year	Size	Unit	Capacity	Unit	Unit Cost	Unit	Construction Cost (w/o Spcl Cond)	Special Construction	Spcl Cnst	Construction Cost	Project Location (for TTC)	Contingency	Capital Cost	Other Payer	Cost to Other Party	Cost to West Basin	FY0910	FY10-15	FY15-20	FY20-25	FY25-30
CNF-08	CNF	Recapitalization	Rehabilitation and Replacement from Condition Assessment (recurring)	Mult							$ 290,000	1.00	-	$ 290,000	CA	120%	$ 350,000	None	$ -	$ 350,000	$ -	$ -	$ -	$ 170,000	$ 180,000
CNF-09	CNF	Recapitalization	United Water Recapitalization Improvements (recurring)	Mult							$ 500,000	1.00	-	$ 500,000	IF	140%	$ 850,000	None	$ -	$ 850,000	$ -	$ -	$ -	$ 425,000	$ 425,000
HPS-07	HPS	PS	Add 38 mgd of additional firm pumping capacity, to bring total firm capacity to 135 mgd. (For LADWP Westside, Kenneth Hahn, LADWP Harbor Expansion) (Assumes 3 pumps, 3,000 hp increase)	FY20-25	46	mgd	3,000	hp	$ 6,500	per hp	$ 19,500,000	1.00	-	$ 19,500,000	IF	140%	$ 27,300,000	None	$ -	$ 27,300,000	-	$ -	$ -	$ 27,300,000	-
HPS-08	HPS	Pipeline	Parallel HSEFM w/ 36"	FY20-25	15,500	lineal ft	36	inches	$ 750	per lineal ft	$ 11,625,000	1.25	A	$ 14,531,250	OF	157%	$ 22,815,000	None	$ -	$ 22,815,000	-	$ -	$ -	$ 22,815,000	-
T22-24	T22	Pipeline	Anza Lateral Break Tank	FY20-25					0	lumpsum	$ 3,000,000	1.00	-	$ 3,000,000	IF	140%	$ 4,200,000	None	$ -	$ 4,200,000	-	$ -	$ -	$ 4,200,000	-
T22-25	T22	Pipeline	LA Westside Lateral	FY25-30	40,500	lineal ft	24 - 36	inches	0	see detail	$ 24,355,000	1.05	F,R	$ 25,480,000	OF	157%	$ 40,005,000	None	$ -	$ 40,005,000	-	$ -	$ -	-	$ 40,005,000
T22-26	T22	PS	Inglewood/LA Westside PS (assumes 4-8,500 gpm pumps)	FY25-30	34,000	gpm	5,950	hp	$ 3,000	per hp	$ 17,850,000	1.00	-	$ 17,850,000	OF	157%	$ 28,025,000	None	$ -	$ 28,025,000	-	$ -	$ -	-	$ 28,025,000
ELWRF-32	ELWRF	Treatment	Land Acquisition of 4.0 ac near ELWRF for Expansion of Title 22 Beyond 70.0 mgd	FY20-25	21.5	mgd	4.0	ac	$ 2,000,000	per acre	$ 8,000,000	1.00	-	$ 8,000,000	LA	120%	$ 9,600,000	None	$ -	$ 9,600,000	-	$ -	$ -	$ 9,600,000	-
ELWRF-33	ELWRF	PS	Increase capacity of Title 22 Pump Station at ELWRF by 4,000 hp (from 8,000 hp to 12,000 hp) to serve LADWP Harbor Expansion, Westside, and Kenneth Hahn	FY25-30			4,000	hp	$ 3,000	per hp	$ 12,000,000	1.00	-	$ 12,000,000	IF	140%	$ 16,800,000	None	$ -	$ 16,800,000	-	$ -	$ -	-	$ 16,800,000
ELWRF-34	ELWRF	Treatment	Add 8.9 mgd of Additional Title 22 Treatment to Serve LADWP Harbor Expansion, increasing Title 22 Treatment Capacity from 67.3 mgd to 76.2 mgd	FY25-30	8.9	mgd			$ 2.00	per gal	$ 17,815,000	1.00	-	$ 17,815,000	IF	140%	$ 24,945,000	None	$ -	$ 24,945,000	-	$ -	$ -	-	$ 24,945,000
ELWRF-35	ELWRF	Treatment	Add 15.3 mgd of Additional Title 22 Treatment to Serve LADWP Westside and Kenneth Hahn Park, increasing Title 22 Treatment Capacity from 76.2 mgd to 91.5 mgd	FY25-30	15.3	mgd			$ 2.00	per gal	$ 30,690,000	1.00	-	$ 30,690,000	IF	140%	$ 42,970,000	None	$ -	$ 42,970,000	-	$ -	$ -	-	$ 42,970,000
ELWRF-36	ELWRF	Recapitalization	Rehabilitation and Replacement from Condition Assessment (recurring)	Mult							$ 14,970,000	1.00	-	$ 14,970,000	CA	120%	$ 17,965,000	None	$ -	$ 17,965,000	$ -	$ -	$ -	$ 11,040,000	$ 6,925,000
ELWRF-37	ELWRF	Recapitalization	Membrane Replacement (recurring)	Mult					$ 1,105,380	per year	$ 11,055,000	1.00	-	$ 11,055,000	MR	100%	$ 11,055,000	None	$ -	$ 11,055,000	$ -	$ -	$ -	$ 5,527,500	$ 5,527,500
ELWRF-38	ELWRF	Recapitalization	United Water Recapitalization Improvements (recurring)	Mult							$ 3,620,000	1.00	-	$ 3,620,000	IF	140%	$ 5,070,000	None	$ -	$ 5,070,000	$ -	$ -	$ -	$ 2,535,000	$ 2,535,000
CRWRF-12A	CRWRF	Treatment	Nitrified Treatment of Title 22 Water (Nitrified Water for LADWP Harbor Demand Phase II)	FY20-25	7.1	mgd			$ 1.05	per gpd	$ 7,485,000	1.00	-	$ 7,485,000	IF	140%	$ 10,480,000	None	$ -	$ 10,480,000	-	$ -	$ -	$ 10,480,000	-
CRWRF-12B	CRWRF	PS	Add new 7.1 mgd pump station at CRWRF to serve LADWP Harbor Demand Phase II (5 pumps)	FY20-25	5,917	gpm	300	hp	$ 10,000	per hp	$ 3,000,000	1.00	-	$ 3,000,000	IF	140%	$ 4,200,000	None	$ -	$ 4,200,000	-	$ -	$ -	$ 4,200,000	-
CRWRF-13	CRWRF	Recapitalization	Rehabilitation and Replacement from Condition Assessment (recurring)	Mult							$ 3,245,000	1.00	-	$ 3,245,000	CA	120%	$ 3,895,000	None	$ -	$ 3,895,000	$ -	$ -	$ -	$ 2,595,000	$ 1,300,000
CRWRF-14	CRWRF	Recapitalization	Membrane Replacement (recurring)	Mult					$ 279,900	per year	$ 2,800,000	1.00	-	$ 2,800,000	MR	100%	$ 2,800,000	None	$ -	$ 2,800,000	$ -	$ -	$ -	$ 1,400,000	$ 1,400,000
CRWRF-15	CRWRF	Recapitalization	United Water Recapitalization Improvements (recurring)	Mult							$ 1,205,000	1.00	-	$ 1,205,000	IF	140%	$ 1,690,000	None	$ -	$ 1,690,000	$ -	$ -	$ -	$ 845,000	$ 845,000
NTP-03	NTP	Treatment	Barrier Water Treatment - treat SE from JWPCP to serve Dominguez Gap (Phase I and II)	FY20-25	3.9	mgd			$ 6.25	per gal	$ 24,375,000	1.00	-	$ 24,375,000	IF	140%	$ 34,125,000	None	$ -	$ 34,125,000	-	$ -	$ -	$ 34,125,000	-
NTP-04	NTP	PS	Add new 3.1 mgd pump station at NTP to serve Dominguez Gap (Phase I + II)	FY20-25	2,583	gpm	150	hp	$ 10,000	per hp	$ 1,500,000	1.00	-	$ 1,500,000	IF	140%	$ 2,100,000	None	$ -	$ 2,100,000	-	$ -	$ -	$ 2,100,000	-
NTP-05	NTP	Pipeline	New Pipeline from NTP to Dominguez Gap Barrier Blending Station for conveyance of Barrier Water.	FY20-25	15,840	lineal ft	12	inches	$ 310	per ft	$ 4,910,400	1.25	A	$ 6,138,000	OF	157%	$ 9,640,000	None	$ -	$ 9,640,000	-	$ -	$ -	$ 9,640,000	-
NTP-06	NTP	Recapitalization	Membrane Replacement (recurring)	Mult					$ 1,705,000	per year	$ 10,085,000	1.00	-	$ 10,085,000	MR	100%	$ 17,050,000	None	$ -	$ 17,050,000	$ -	$ -	$ -	$ 8,525,000	$ 8,525,000
EMWRF-13	EMWRF	Recapitalization	Rehabilitation and Replacement from Condition Assessment (recurring)	Mult							$ 2,720,000	1.00	-	$ 2,720,000	CA	120%	$ 3,265,000	None	$ -	$ 3,265,000	$ -	$ -	$ -	$ 2,440,000	$ 825,000
EMWRF-14	EMWRF	Recapitalization	Membrane Replacement (recurring)	Mult					$ 165,000	per year	$ 1,650,000	1.00	-	$ 1,650,000	MR	100%	$ 1,650,000	None	$ -	$ 1,650,000	$ -	$ -	$ -	$ 825,000	$ 825,000
EMWRF-15	EMWRF	Recapitalization	United Water Recapitalization Improvements (recurring)	Mult							$ 605,000	1.00	-	$ 605,000	IF	140%	$ 850,000	None	$ -	$ 850,000	$ -	$ -	$ -	$ 425,000	$ 425,000
SW-06	SW	Recapitalization	United Water Recapitalization Improvements (recurring)	Mult							$ 3,020,000	1.00	-	$ 3,020,000	IF	140%	$ 4,230,000	None	$ -	$ 4,230,000	$ -	$ -	$ -	$ 2,115,000	$ 2,115,000
										Total	**$ 241,870,400**	**$ -**	**$ -**	**$ 247,129,250**	**-**	**$ -**	**$ 347,925,000**	**$ -**	**$ -**	**$ 347,925,000**	**$ -**	**$ -**	**$ -**	**$ 163,327,500**	**$ 184,597,500**
										Grand Total	**$ 639,984,160**	**$ -**	**$ -**	**$ 664,664,583**	**-**	**$ -**	**$ 962,862,878**	**$ -**	**$ 254,180,000**	**$ 708,682,878**	**$ 15,103,800**	**$ 373,002,678**	**$ 226,831,400**	**$ 163,327,500**	**$ 184,597,500**

Bay-Delta Water Quality Evaluation
Draft Final Report

California Urban Water Agencies

Expert Panel:

Douglas M. Owen, P.E., Chair
Vice President
Malcolm Pirnie, Inc.

Phillippe A. Daniel, P.E.
Associate
Camp, Dresser and McKee

R. Scott Summers, PhD
Associate Professor
University of Cincinnati

Preface by California Urban Water Agencies

One objective of the CALFED Bay-Delta Program is to provide good water quality in water diverted from the Delta to meet drinking water needs. To accomplish this, CALFED must select a long-term solution that provides a quality of source water that urban water providers can treat with reasonable cost to meet current and future federal and state health-based drinking water standards. To enable a quantitative assessment of the impact of alternative Bay-Delta solutions, specific water quality criteria must be chosen for analysis. Although there are numerous water quality constituents of concern in meeting drinking water standards, the major constituents of health concern in Delta water are pathogens (*Giardia* and *Cryptosporidium*) and disinfection by-product (DBP) precursors (bromide and total organic carbon). The quality of water diverted from the Delta will bear heavily on the treatment technology which needs to be employed to meet increasingly stringent drinking water standards. Municipal water providers are already investing hundreds of millions of dollars in advanced treatment processes to meet more restrictive treatment standards. Without a higher quality of source water, probable future standards could make these investments obsolete and force technology which can neither be guaranteed to perform, be feasible due to market constraints or environmental regulation constraints, or be realistically affordable to the end users.

Setting water quality criteria requires knowledge about both the future regulatory setting under the Safe Drinking Water Act and the relative performance characteristics of currently available treatment technologies under a variety of actual conditions. Rather than asking its treatment experts to make this assessment, CUWA convened a panel of nationally recognized drinking water quality experts to determine the required criteria for total organic carbon (TOC) and bromide that will allow utilities treating Delta water to comply with current and probable future drinking water regulations utilizing available advanced technology. The expert panel consists of Douglas Owen, P.E. Vice President at Malcolm Pirnie, Inc., Phillippe Daniel, P.E. Associate at Camp Dresser & McKee and R. Scott Summers, PhD, Associate Professor at the University of Cincinnati. The purpose of the expert panel report is to recommend Delta drinking water quality criteria with which CALFED staff can evaluate Bay-Delta alternative's relative performance in meeting program objectives. These criteria have been developed in recognition of the interaction between source water quality, treatment efficacy and probable regulatory outcomes, as developed by the panel. This report, however, does not represent CUWA's or any of its members endorsement of a specific regulatory outcome.

This report concludes that for currently available advanced water treatment technology (i.e., enhanced coagulation and ozone disinfection) to be able to meet potential long-term drinking water quality standards for water diverted from the Delta, the source water quality should have concentrations less than 3.0 mg/L for TOC and less than 50 μg/L for bromide (<20 mg/L chloride concentration). Although using granular activated carbon or membranes allows upward flexibility in these values, the feasibility of these processes in terms of cost,

residual disposal, and construction is uncertain (there are only one or two facilities in the United States of the size applicable to CUWA member facilities which use GAC or membranes for drinking water treatment). Source water quality with concentrations higher than 3.0 mg/L TOC and 50 μg/L bromide could still meet a near-term regulatory scenario, but the long-term scenario is more appropriate for planning eventual CALFED Bay-Delta solution.

CUWA recognizes that based upon historic concentrations of these constituents measured at Clifton Court Forebay in the Delta, it is unlikely that the above criterion for bromide could be met by all urban water agencies using ozonation under existing conditions, even in wet years. Therefore, CALFED must carefully analyze a variety of actions within its alternatives analysis to determine which combination of actions can assure the achievement of the program's drinking water quality objective in concert with other important objectives. These actions should include at least the following:

- The capability of in-Delta hydraulic modifications to limit seawater intrusion and resulting increase in bromide concentration
- Pollutant source control programs for TOC and pathogens (actions should include areas where water is degraded after diversion from the Delta as well as the Bay-Delta watershed itself.)
- Water storage and storage management
- Increased outflow
- An isolated facility

These actions must be assessed in appropriate combinations designed to meet CALFED's multiple program objectives.

CUWA also recognizes that CALFED should assess the environmental and economic impact and the practical feasibility of **not** providing a water quality for Delta diversions which would allow future standards to be met with currently available advanced technology. CUWA does not believe such technology, including membrane technologies and granulated activated carbon filtration, are either affordable or feasible on the scale needed for municipal treatment in California and are not likely to be in the foreseeable future.

Public water agencies have a unique public trust responsibility to provide the highest quality of water reasonably achievable. This approach to public health protection is one that is balanced by combining (1) source selection to enhance water quality, (2) source protection to preserve water quality, and (3) effective and reliable treatment technology. CUWA believes the CALFED Bay-Delta Program solution should be consistent with the following principles.

- Maintenance and improvement of existing high quality urban water supplies and in-Delta supplies as the most effective means to protect public health
- A strong program of water pollutant source control is required to assure public health and environmental quality
- Provision for the highest quality drinking water quality reasonably available. This will assure the greatest likelihood that available treatment technologies will meet future drinking water standards.

California Urban Water Agencies
June 1998

EXECUTIVE SUMMARY

The California Urban Water Agencies (CUWA) retained the assistance of three water quality and treatment specialists who have specific expertise in the formation of disinfection by-products (DBPs). These three individuals -- the expert panel -- evaluated specific source water quality characteristics which would be necessary to permit diverted water from the San Francisco Bay/Sacramento-San Joaquin River Delta (Delta) to be used for meeting potential public health related water quality standards under defined treatment conditions. Specifically, the expert panel was charged with 1) developing potential future regulatory scenarios, 2) defining appropriate process criteria for coagulation, ozonation, granular activated carbon and membrane treatment processes, and 3) estimating source water quality diverted from the Delta which would allow users implementing the defined treatment technologies to comply with the regulatory scenario. The source water quality characteristics were framed in the context of total organic carbon (TOC) and bromide concentrations, both constituents which have the potential to be controlled by different management strategies for the Delta.

Two potential regulatory scenarios were projected based upon regulatory negotiations conducted in 1992-93 and 1997. The near-term scenario focuses on Stage 1 of the Disinfectant/Disinfection By-Product (D/DBP) Rule and the Interim Enhanced Surface Water Treatment Rule. The long-term scenario focuses on Stage 2 of the D/DBP Rule and the Long Term Enhanced Surface Water Treatment Rule. The potential regulatory scenarios include specific limits for two organic classifications of DBPs recently proposed in rulemaking by EPA; total trihalomethanes (TTHMs) and the sum of five haloacetic acids (HAA5). In addition, a potential limit was projected for bromate, an inorganic by-product formed by the ozonation of bromide-containing waters; a standard has been proposed by EPA for this DBP, as well. These DBP limits were coupled with various potential requirements for microbial removal and inactivation.

The treatment criteria specified by the expert panel for the near-term regulatory scenario included: 1) the use of 40 mg/L of alum at a pH of 7.0 and possibly as low as 6.5 in the coagulation process, followed by chlorine disinfection with a chloramine residual in the distribution system, and 2) the use of ozone at specific ozone:TOC ratios followed by a chloramine residual. The chlorine and ozone disinfection criteria were proposed to meet potential 1 or 2 log *Giardia* inactivation requirements. For the long-term regulatory scenario, the use of post-filter GAC adsorbers, GAC in combination with ozone, membrane filtration in combination with ozone, and nanofiltration with free chlorine were considered. The long-term scenario included inactivation for *Giardia* and *Cryptosporidium*, the latter of which could only be achieved by ozone disinfection or the "absolute barrier" of membrane treatment.

The expert panel used data submitted by CUWA members, available literature and ongoing research, as well as their own experience and best professional judgement to arrive at potential source water quality requirements. Available models for DBP formation were evaluated to investigate threshold DBP formation behavior and to support the initial conclusions reached by the expert panel.

Specific combinations for TOC and bromide necessary in the water diverted from the Delta can vary depending upon the treatment technology implemented and microbiological inactivation required. Further, the selected bromate level of 5 μg/L in the long-term regulatory scenario is significant in establishing limiting bromide levels in this evaluation. The rationale for this level in this analysis ultimately may be modified by a variety of factors including allowing for trade-offs for disinfection and the formation of organically-based brominated DBPs (e.g., THMs or HAAs) or evidence of a cancer threshold for bromate (investigations underway). On the other hand, there are other potential regulatory outcomes involving 1) further lowering the MCLs for DBPs, 2) the regulation of individual DBP species (rather than the groups of compounds represented by TTHM and HAA5 due to the potentially more severe health effects associated with brominated compounds), 3) regulating other DBPs beyond TTHMs and HAA5, including the addition of other regulated HAAs (there are nine total) as analytical methods are developed and refined, 4) a comparative risk framework which balances all of the risk attributable to the DBPs formed, rather than providing specific MCLs for each group, and 5) concerns over reproductive and developmental effects that may be associated with DBPs, which may lower the regulatory levels and/or the permissible maximum concentration (i.e., annual averaging may no longer be the basis for determining compliance).

In summary, it was the opinion of the panel that < 3 mg/L of TOC and < 50 μg/L of bromide would be necessary to allow users the flexibility to incorporate either enhanced coagulation or ozone disinfection to meet the potential long-term regulatory scenario in this evaluation. The TOC value is constrained by the formation of total trihalomethanes when using enhanced coagulation for TOC removal and free chlorine to inactivate *Giardia*. The bromide value is constrained by the formation of bromate when using ozone to inactivate *Cryptosporidium*. Looking only at the potential near-term regulatory scenario provides significantly more source water flexibility when using enhanced coagulation or ozone, with source water TOC concentrations ranging between 4 and up to 7 mg/L (the 90th percentile value for waters diverted from the south Delta) and bromide ranging between 100 and 300 μg/L, depending upon the extent of *Giardia* inactivation required (the near-term scenario does not include *Cryptosporidium* inactivation).

Similarly, the use of either GAC or membrane treatment in the long-term regulatory scenario broadens the allowable source water quality. For GAC, a source water TOC value of 5 mg/L is acceptable with bromide of 150 μg/L or 50 μg/L, depending upon *Giardia* inactivation. GAC alone is not applicable to instances in which *Cryptosporidium* inactivation is required, and must be coupled with ozone disinfection. This allows the source water TOC concentration to increase to at least 7 mg/L, although bromide is constrained to < 50 μg/L even at an ozone pH of 6.5.

The use of microfiltration or ultrafiltration, coupled with ozone for primary disinfection and chloramines for secondary disinfection, is an "absolute barrier" for protozoan (*Giardia* and *Cryptosporidium*) removal. Viruses, however, must still be inactivated. This treatment scheme allows source water TOC concentrations to increase to at least 7 mg/L. The bromide concentration is again limited by bromate formation under ozone addition for virus inactivation, and is < 150 $\mu g/L$ for microfiltration and < 300 $\mu g/L$ for ultrafiltration (less virus inactivation is required for ultrafiltration). If nanofiltration is used with free chlorination, TOC concentration can be up to 10 mg/L for all bromide concentrations evaluated (< 300 $\mu g/L$).

It is important to note that when ozone disinfection is used for treatment, the allowable TOC is not unlimited. There are concerns regarding the ability of biological filters or GAC to remove biodegradable organic carbon to adequate levels as TOC approaches 7 mg/L (the 90th percentile for water diverted from the south Delta). In general, ozone disinfection is more effective and reliable as TOC decreases.

The feasibility of implementing either GAC or NF/RO membranes in California, given cost considerations, environmental permitting constraints, and limited residual disposal options, is uncertain. The use of MF/UF membranes address some residual disposal issues, but large system design issues affect feasibility on a site-specific basis.

1.0 INTRODUCTION

The California Urban Water Agencies (CUWA) engaged the services of three water quality experts to assist in providing input to the CALFED process regarding potential management alternatives in the San Francisco Bay/Sacramento-San Joaquin River Delta (Delta). The expert panel was charged with determining the required raw water quality diverted from the Delta which would permit the effective implementation of specific drinking water treatment processes to meet potential future drinking water quality standards. The expert panel was comprised of Douglas M. Owen, P.E., Vice President at Malcolm Pirnie, Inc., Phillippe A. Daniel, P.E., Associate at Camp, Dresser & McKee, and R. Scott Summers, PhD, Associate Professor at the University of Cincinnati.

The expert panel used data submitted by CUWA members, available literature and ongoing research, as well as their own experience and best professional judgement to arrive at potential source water quality requirements. Available models for DBP formation were evaluated to investigate threshold DBP formation behavior and to support the preliminary conclusions reached by the expert panel. This report presents the best professional judgement from this expert panel.

This report is subdivided into the following chapters:

Chapter 2 - Potential Regulatory Scenario and Schedule

Chapter 3 - Treatment Processes to Meet Regulatory Requirements

Chapter 4 - Evaluation of Source Water Quality and Treatment Efficiency

In Chapter 2, the general trends in drinking water regulations are discussed and plausible, future regulatory criteria are presented. Treatment processes relevant to users of water diverted from the Delta are presented in Chapter 3, together with general assumptions regarding the design and application of these processes. In Chapter 4, source water quality is projected which allows the treatment processes defined in Chapter 3 to be used to meet the potential regulatory scenario presented in Chapter 2.

2.0 POTENTIAL REGULATORY SCENARIO AND SCHEDULE

2.1 REGULATORY SCENARIO

2.1.1 Introduction

From a perspective of water quality parameters which can be controlled through management strategies in the Delta [e.g., total organic carbon (TOC) and bromide], the most critical present and future human health-related regulations affecting the implementation and performance of drinking water treatment processes for agencies using Delta water are:

1. Microbiological control - The focus for disinfection and microbial control currently pivots around the removal and inactivation of *Giardia* and *Cryptosporidium*. Currently, 3 log (99.9 percent) removal and inactivation of *Giardia* is required in the Surface Water Treatment Rule (SWTR). The EPA began considering an Enhanced SWTR (ESWTR) starting in late 1992, which would address the ability of systems to maintain microbiological control as disinfection practices were scrutinized. This rule would also address the removal/ inactivation of *Cryptosporidium*, through either removal or inactivation. The ESWTR has been proposed in two stages (USEPA, 1994) and is currently being re-evaluated, as discussed below.

2. Disinfection By-Product Control - The disinfectant residual concentration and the organic and inorganic compounds formed by the disinfection process (termed disinfection by-products or DBPs) will be regulated under the Disinfectants/Disinfection By-Products (D/DBP) Rule. This rule also was proposed in two stages (USEPA, 1994) and is currently being re-evaluated.

Other water quality contaminants, such as pesticides, herbicides, and metals, are of concern but are not likely to constrain treatment requirements as significantly as the microbial and DBP regulations, based upon their occurrence in water currently diverted from the Delta.

Both stages of the ESWTR and D/DBP Rule will impact the CUWA members and will affect the quality of water diverted from the Delta to meet regulatory requirements using an array of treatment technologies. Although a longer-term view of the regulations (i.e., second stage) is more appropriate to coordinate with the ultimate Delta management solutions, these future regulations are still relatively uncertain. The initial regulations -- Stage 1 of the D/DBP Rule and the Interim ESWTR — have been agreed to in principle through a Federal Advisory Committee Act (FACA) process involving stakeholder meetings held in the Spring and Summer of 1997. Consequently, the expert panel evaluated potential future source water quality requirements using the specified technologies for both the near-term and long-term regulations.

The following sections discuss potential regulatory scenarios for both the near-term (i.e., Stage 1 D/DBP Rule and Interim ESWTR) and the long-term (i.e., Stage 2 D/DBP Rule and Long Term 2 ESWTR) regulations. Source water quality requirements are developed in Chapter 4, using the defined technologies in Chapter 3, to meet both the near-term and long-term potential regulatory outcomes.

2.1.2 Potential Near-Term Regulatory Scenario

Stage 1 D/DBP Rule

The requirements for the Stage 1 D/DBP Rule have been agreed to in principle through the FACA process. The requirements most significantly impacting treatment technologies and source water quality requirements include maximum contaminant levels (MCLs) and a treatment technique. Relevant MCLs include an 80 $\mu g/L$ standard for total trihalomethanes (TTHMs) and 60 $\mu g/L$ value for the sum of five haloacetic acids (HAA5). In addition, a 10 $\mu g/L$ MCL has been proposed for bromate (a compound formed in bromide-containing waters, particularly with ozone treatment).

The treatment technique is enhanced coagulation and enhanced precipitative softening. For the CUWA members, the requirements of enhanced coagulation are more relevant than those for softening. With a few exceptions based upon treated water quality, enhanced coagulation must be implemented at existing conventional treatment facilities. It will not be enforced for direct filtration facilities. The treatment requirements for enhanced coagulation, as they apply to this evaluation, are discussed in Chapter 3.

Interim ESWTR

The Interim ESWTR (IESWTR), also agreed to in principle at the FACA negotiations, is designed to provide microbial protection as systems are potentially modifying treatment practices to comply with Stage 1 of the D/DBP Rule. In summary, the IESWTR focuses on maintaining the level of chemical disinfection currently provided at existing facilities, while requiring a higher standard of particle removal. Briefly, the standard for combined filtered water turbidity will be reduced to <0.3 NTU at least 95% of the time. Individual filter turbidities must be monitored and there is a series of evaluations which must be performed if individual filter water turbidities exceed 1 or 2 NTU for consecutive 15 minute measurements.

The chemical disinfection requirements are based upon a microbial "backstop." In concept, the backstop focuses on maintaining the minimum level of disinfection that existing facilities have historically been providing. If a system modifies disinfection practices to meet the requirements of Stage 1 of the D/DBP Rule, they must either 1) meet or exceed the "backstop" disinfection practice, or 2) discuss their proposed disinfection modifications with the primacy agency (e.g., California Department of Health Services). The backstop is calculated through profiling existing disinfection practices as follows:

1. The monthly average of daily *Giardia* inactivation is calculated for three consecutive calendar years.

2. The minimum monthly average inactivation is identified for each calendar year.

3. The three minimum monthly average inactivations are averaged to calculate a single, "backstop" value.

This backstop is only applicable if a significant change in disinfection (e.g., disinfectant type, dosage) is implemented by the system which results in an inactivation that is less than the backstop value. It is important to note that the backstop triggers a discussion with the primacy agency. It is possible that the utility may be allowed to reduce the level of disinfection below the backstop level, depending upon the backstop value, disinfectant type, and other site-specific issues. The final disinfection requirements, if less than the backstop, are determined by the primacy agency together with the utility.

Historical disinfection data submitted by the Metropolitan Water District of Southern California and the Alameda County Water District were reviewed to determine a "central tendency" backstop for the CUWA members. The evaluation indicated that the backstop value could vary between 90 percent (1 log) and 99 percent (2 log) inactivation of *Giardia*.

Therefore, the expert panel considered both of these backstop values in determining source water quality requirements.

Potential Near-Term Regulatory Scenario

Based upon the above discussion, the potential near-term regulatory scenario is summarized in Table 2.1:

TABLE 2.1

POTENTIAL NEAR-TERM REGULATORY SCENARIO

Regulation	**Parameter**	**Treatment Requirement or MCL**
Interim ESWTR	*Giardia*	Additional 1 or 2 log inactivation by disinfection, after treatment removal credit
Stage 1 D/DBP Rule	TTHMs	80 μg/L
	HAA5	60 μg/L
	Bromate	10 μg/L

2.1.3 Potential Long-Term Regulatory Scenario

Stage 2 D/DBP Rule

Stage 2 DBP levels which were proposed in 1994, while acknowledged to be "placeholder" values until additional data can be collected and reviewed, were assumed to be reasonable targets for this analysis (i.e., TTHM of 40 μg/L, HAA5 of 30 μg/L). Further, a bromate MCL of 5 μg/L was considered for the long-term. The rational for this level is based upon a host of factors. First, the 10^{-4}, 10^{-5}, and 10^{-6} excess cancer risk levels for bromate are 5 μg/L, 0.5 μg/L and 0.05 μg/L, respectively. These levels were confirmed in EPA's recent Notice of Data Availability for Disinfectants and Disinfection By-Products in March 1998 (USEPA, 1998). Although a 5 μg/L limit was considered during the regulatory negotiation in 1992-1993, a value of 10 μg/L was established based upon practical quantitation levels (PQLs) for this compound at that time. Since 1994, however, many improvements have been made in the analytical technique for bromate thereby providing an excellent potential for reducing the PQL in future rulemaking. Because of EPA's reaffirmation of the carcinogenicity of bromate in recent studies and the improvement in analytical techniques, a bromate target of 5 μg/L was selected for the long-term scenario.

Long-Term ESWTR

The final outcome for a Long Term 2 ESWTR (LT2ESWTR) is uncertain, but many alternatives in the ESWTR proposed by EPA require treatment based on pathogen density in source waters (USEPA, 1994). Based upon 1) a review of pathogen data collected at various locations in the Delta by the Metropolitan Water District of Southern California, and 2) regulatory alternatives proposed in the ESWTR, plausible requirements identified by the expert panel for Delta water range from 1 log and 2 log inactivation of *Giardia* to 1 log inactivation of *Cryptosporidium*. This level of inactivation would be required after treatment removal credit is achieved. These criteria assume that higher log inactivations will be required as the concentration of pathogens in the source water increases. For every log increase in source water concentration, an additional log increase in removal/inactivation is required to achieve a constant finished water quality. This concept was proposed in the SWTR Guidance Manual and was furthered in several proposals published by EPA for the ESWTR.

Potential Long-Term Regulatory Scenario

Based upon the above discussion, the potential long-term regulatory scenario is summarized in Table 2.2:

TABLE 2.2

POTENTIAL LONG-TERM REGULATORY SCENARIO

Regulation	Parameter	Treatment Requirement or MCL
Long-Term 2 ESWTR	*Giardia*	Additional 1 or 2 log inactivation by disinfection, after treatment removal credit
	Cryptosporidium	Additional 1 log inactivation by disinfection, after treatment removal credit
Stage 2 D/DBP Rule	TTHMs	40 μg/L
	HAA5	30 μg/L
	Bromate	5 μg/L

While there are many factors that contribute to the uncertainty surrounding the projected regulatory scenario in Table 2.2, it is the selected bromate level of 5 μg/L that most keenly influences the analysis. The rationale for this level (i.e., advances in detection limit, the weight of the carcinogenic evidence, the precedence for THM and HAA5 limits in Stage 2 at half the Stage 1 levels) in this analysis could ultimately be modified by a variety of factors. Nevertheless, in the absence of more definitive direction, the panel considers a 5 μg/L value to be both prudent and plausible.

There are other potential regulatory outcomes involving 1) further lowering the MCLs for DBPs, 2) the regulation of individual DBP species (rather than the groups of compounds represented by TTHM and HAA5 due to the potentially more severe health effects associated with brominated compounds), 3) regulating other DBPs beyond TTHMs and HAA5, including the addition of other HAAs (there are nine total) as analytical methods are developed and refined, 4) a comparative risk framework which balances all of the risk attributable to the DBPs formed, rather than providing specific MCLs for each group, and 5) concerns over reproductive and developmental effects that may be associated with DBPs, which may lower the regulatory levels and/or the permissible maximum concentration (i.e., annual averaging may no longer be the basis for determining compliance). The potential implications of such regulatory outcomes is briefly discussed in Section 4.4.

2.2 REGULATORY SCHEDULE

The recently-enacted 1996 Amendments to the Safe Drinking Water Act (SDWA) have caused EPA to adopt a more ambitious schedule than EPA presented in June 1996 (see Table 2.3). The June 1996 dates were based upon a scenario in which EPA would not be "pushed" to develop an Interim ESWTR, and promulgate Stage 1 of the D/DBP Rule and the Interim ESWTR, until pathogen data were available from the Information Collection Rule (ICR).

TABLE 2.3

COMPARISON OF OLD AND NEW REGULATORY SCHEDULE

Regulation	Promulgation Date	
	Initial (June 1996)	Revised (August 1996)
Interim ESWTR	June 2000	November 1998
Long Term 2 ESWTR	NA [1]	November 2000
Stage 1 D/DBP Rule	June 2000	November 1998
Stage 2 D/DBP Rule	June 2003	May 2002

Notes:
(1) NA = Not available

EPA understands, however, that the LT2ESWTR and Stage 2 of the D/DBP Rule, at a minimum, are linked to data availability through the ICR. Monitoring for the 18-month ICR began in July 1997. Consequently, EPA was pressed between the statutory requirements and the recognition that a longer time frame would be required to promulgate Stage 1 of the D/DBP Rule and the IESWTR if the ICR data were to be considered. Therefore, EPA proceeded with interim regulations for microbial and DBP control based upon the existing knowledge base rather than waiting for the ICR data. The FACA process for the agreement in principle concluded in June 1997 to allow EPA to meet the schedule in Table 2.3 for the near-term regulations. Nevertheless, both the LT2ESWTR and Stage 2 of the D/DBP Rule will ultimately need to be finalized and become effective by the dates given in the reauthorized SDWA (November 2000 and May 2002, respectively) and take the ICR data into account. Even though the ICR monitoring has begun, the schedule will remain tight as a result of the time needed to analyze the data and to perform treatability studies to support compliance forecasts for the Stage 2 D/DBP Rule.

3.0 TREATMENT PROCESSES REQUIRED TO MEET FUTURE REGULATIONS

In this chapter, general process criteria are defined to characterize specific treatment processes relevant to users of water diverted from the Delta. Source water quality is determined in Chapter 4 which permits these treatment processes to meet the potential regulatory scenarios discussed in Chapter 2.

3.1 SELECTION OF TREATMENT PROCESSES TO BE EVALUATED

As a part of this effort, CUWA requested that the expert panel initially focus on those treatment processes which were considered to be the most cost-effective for simultaneously meeting the requirements of the D/DBP Rule and the ESWTR when treating water diverted from the Delta. These processes were defined as enhanced coagulation, a treatment technique proposed for Stage 1 of the D/DBP Rule, and ozone disinfection. These two processes are also relevant for Stage 2 of the D/DBP Rule and were considered appropriate because they can be implemented into facilities currently owned and operated by the CUWA agencies (as well as a majority of conventional filtration facilities across the country). For example, the majority of filtration systems across the country use conventional treatment including sedimentation, which allows for increased coagulation dosages to meet proposed enhanced coagulation requirements. In addition, some CUWA facilities already use ozone disinfection. The most cost-effective option(s) for meeting potential future regulations is specific for each water purveyor, depending upon water source and quality.

Based upon comments received from the Natural Resources Defense Council (NRDC), CUWA also directed the expert panel to evaluate the impact of implementing post-filter granular activated carbon (GAC) adsorbers and membranes on the potential allowable source water quality characteristics. Neither of these processes are currently used by any of the CUWA members and their feasibility for large scale water treatment facilities in California is uncertain. Post-filter GAC adsorbers and membranes can be at least an order of magnitude more expensive than ozone and the feasibility of these technologies is much more uncertain based upon cost, environmental permitting constraints, and availability of residual handling alternatives. This view is shared by much of the water industry. For reference, only one or two treatment plants in the country at the size comparable to many of the CUWA members use post-filter GAC or membranes for drinking water treatment.

There are CUWA members who now treat much higher quality water than that currently diverted from the Delta. These entities are able to use in-line filtration or simply disinfection without filtration to produce high quality drinking water. It should be emphasized that the determination of feasible treatment processes is dependent upon the existing source and that this evaluation is based only upon those entities currently using water diverted from the Delta.

3.2 GENERAL ASSUMPTIONS FOR SELECTED TREATMENT PROCESSES

3.2.1 Enhanced Coagulation

Enhanced coagulation offers the advantages of removing naturally-occurring organic material, thereby removing DBP precursors which, upon disinfection, form DBPs. As such, MCLs for TTHMs and HAA5 can be addressed by enhanced coagulation, when followed by chlorine disinfection. Upon review of the potential for DBP formation, it was determined that enhanced coagulation would only be required under conditions in which free chlorine is used for primary disinfection (pathogen inactivation), followed by chloramines for secondary disinfection to maintain a distribution system residual. Further, this treatment option is only applicable to instances in which either 1 or 2 log *Giardia* inactivation is required to demonstrate microbial control, as discussed in Chapter 2. It was assumed that *Cryptosporidium* inactivation could not be achieved by free chlorine disinfection under treatment conditions feasible for drinking water systems.

The conditions for enhanced coagulation were defined according to the specific percent removal requirements for Total Organic Carbon (TOC) -- as proposed in Stage 1 of the D/DBP Rule (USEPA, 1994) and amended through the FACA process -- by raw water TOC and alkalinity. Given the specific TOC removal percentages in the proposed D/DBP Rule, this translated to a projected 40 mg/L dosage of alum at a coagulation pH of 7.0, and possibly as low as 6.5. Consequently, acid addition may be required since the 40 mg/L dosage will likely only lower the pH to a value between 7.0 and 7.2. These coagulant dosages are not atypical of those currently being used by some CUWA members (e.g., Alameda County, Contra Costa, and Santa Clara Valley Water Districts), although these systems do not reduce pH with acid to improve precursor removal. It was assumed that a chlorine: TOC ratio of 1:1 and 60 minutes of free chlorine contact (t_{50}) would be required to achieve 1 log inactivation of *Giardia*. For 2 log *Giardia* inactivation, 120 minutes of free chlorine contact would be required. The above criteria for chlorine dose and contact time assume a chlorine residual of approximately 1 to 1.5 mg/L after the associated contact time, with a t_{10}:t_{50} ratio of between 0.5 and 0.6 in a moderately well-baffled contactor. This allows for the appropriate CT values to be met at the limiting case of a temperature between 10 and 15° C and a chlorination pH of 7.0 to 7.5. The 1 and 2 log *Giardia* inactivation targets are applicable to both the backstop for the IESWTR and some of the microbial requirements for the LT2ESWTR in the potential regulatory scenarios in Chapter 2.

In the above definition, it is assumed that chlorination would be postponed until after coagulation, flocculation and sedimentation is complete. It is recognized that during the latest round of regulatory deliberations, the USEPA accepted that utilities may need to provide raw water chlorination -- and receive credit for microbial inactivation -- simultaneously with removing organic material to reduce DBP formation. Recent enhanced coagulation research (Summers, 1997) indicates that the DBPs formed when chlorination is delayed until after sedimentation may be only 75 to 80 percent of those formed when prechlorination is practiced. Consequently, the definition of enhanced coagulation used in this evaluation represents the best that systems could achieve in terms of DBP production. This translates to a larger allowable range for source water quality. In addition, the above definition assumes that the systems can and will construct additional dedicated contact chambers to meet inactivation requirements, if required. There are costs associated with providing additional clearwell contact time beyond that currently available.

In the evaluation in Chapter 4, regions of "uncertainty" are illustrated to delineate those source water conditions under which the selection of specific treatment technologies will be highly system-specific. For enhanced coagulation, these regions will include the uncertainty associated with potential differences in DBP formation based upon whether or not prechlorination is practiced under enhanced coagulation conditions.

3.2.2 Ozone Disinfection

The use of ozone disinfection offers the opportunity to meet the MCLs for TTHM and HAA5 in the potential regulatory scenario by again using chloramines as the secondary disinfectant. Therefore, additional removal of naturally-occurring organic matter may not be necessary. That is, enhanced coagulation may not have to be coupled with ozone disinfection, as long as the source water TOC is ≤ 4.0 mg/L and alkalinity is > 60 mg/L as $CaCO_3$. Implementing ozone and chloramines under the Stage 1 timeframe to meet both Stage 1 and Stage 2 MCLs is one strategy for water utilities to avoid implementing enhanced coagulation when treating source waters with TOC concentrations ≤ 4.0 mg/L and alkalinity > 60 mg/L as $CaCO_3$. Many entities using water diverted from the Delta, however, treat source water TOC concentrations > 4 mg/L.

Based upon the ozone dosage and inactivation data from the CUWA members, the expert panel's experience, and recent research, possible ozone: TOC ratios which may be required to achieve pathogen inactivation were evaluated. These ratios take into consideration a host of factors, including 1) CT requirements for 1 log *Cryptosporidium* inactivation may be up to 10 times that required for 1 log *Giardia* inactivation, 2) ozone residuals increase as dosages increase for a fixed contact time once the initial ozone demand has been satisfied, and 3) pH affects the persistence of ozone residuals. The ratios were adjusted for pH effects (i.e., greater ozone residual persistence as pH decreases resulting in lower ozone requirements). For example, to meet 1 log *Giardia* inactivation at ambient pH, Alameda County Water District routinely requires an ozone to TOC ratio of 0.8 (ambient pH for entities using water diverted from the Delta can range from 7.5 to 9.5, a "typical" value of 7.8 is used in this analysis). At pH 7, MWD's demonstration plant results indicated roughly a 0.7 ozone: TOC ratio for achieving 2 log *Giardia* inactivation. It is important to note that CT compliance needs to be achieved continuously, and therefore an approximate

20 percent safety factor was applied to the CUWA member data. This also partially accounts for EPA's approach in setting CT values based upon 90 percentile values versus median (50 percentile values) which are represented by the CUWA member data. The selection of ozone: TOC ratios also considered operational issues, for which it was assumed that there would be a certain "overshoot" of specific dosage targets to ensure continual CT compliance. Based upon these assumptions, bromate formation was evaluated at a range of ozone: TOC ratios and pH values, as summarized in Table 3.1.

TABLE 3.1

OZONE: TOC RATIO AND PH CONDITIONS FOR BROMATE EVALUATION

pH	Ozone: TOC Ratios
7.8	0.8, 1.2, 1.5
7.2	0.7, 1.0, 1.3
6.8	0.6, 0.9, 1.1
6.5	0.5, 0.75, 1.0

The ozone: TOC ratios at each pH were considered to inactivate 1 log *Giardia*, 2 log *Giardia*, and 1 log *Cryptosporidium*. The 1 and 2 log *Giardia* inactivation is relevant to both the potential near and long-term regulatory scenarios presented in Chapter 2. The 1 log *Cryptosporidium* inactivation is only relevant to the LT2ESWTR in the potential regulatory scenario in Chapter 2.

It is recognized that the above ozone:TOC ratios are dependent upon other ozone design criteria proposed, such as a 12 minute contact time in a single, multi-chamber contactor. Other facility configurations, such as two-stage ozonation (e.g., ozone added at raw and settled water) and longer ozone contact times may yield different source water quality constraints for a fixed water quality target (e.g., bromate MCL). The criteria proposed here are based upon typical ozone system designs throughout the country.

The expert panel was also requested to evaluate bromate formation at pH 6.0. Relatively fewer data are available at this pH, and this value is outside the boundary conditions of available models (Ozekin, 1994) that were used to assist in validating the expert panel's initial opinions. Further, very few systems with moderate to high alkalinity

(> 60 to 80 mg/L as $CaCO_3$) would consider providing treatment at a pH of 6.0. It has a significant impact on chemical (acid) feed requirements to reduce pH which, in turn, have secondary impacts. For example, total dissolved solids (TDS) levels can increase significantly as a result of acid addition to achieve a pH of 6.0 in moderate to high alkalinity waters. A pH of 6.0 is also very aggressive to basin and pipe surfaces, and special precautions should be implemented in the design and construction of facilities to accommodate this pH.

It is the relative lack of data, however, that led the expert panel to not predict bromate production at a pH of 6.0. Any bromate concentration predicted at this pH would be speculative in nature, and would have a much greater uncertainty than other values presented in this report. Consequently, predictions of bromate formation at pH 6.0 are not presented.

3.2.3 Granular Activated Carbon Adsorption

Post-Filter GAC

Like enhanced coagulation, granular activated carbon controls the formation of DBPs through the removal of DBP precursors. Initially, GAC can remove over 80 percent of the organic DBP precursors. It is an unsteady-state process, however, in which the effluent concentration increases with time and the GAC has a finite adsorption capacity. Thus, when the effluent treatment objective is exceeded the GAC must be removed from the adsorbers and reactivated or replaced. The critical design parameter is the empty bed contact time (EBCT), which is the ratio of the volume of GAC to the volumetric flow rate. The critical operational parameter is the reactivation time or run time to the controlling effluent treatment objective. For the control of DBP precursors, typically measured as TOC, design EBCTs of 15 to 30 minutes are used and the GAC is operated until the effluent concentration (C) reaches 30 to 70 percent of that in the influent (C_0). The EBCTs are chosen so that the reactivation periods are at least 60 days. More frequent removal/reactivation of the GAC is expensive and limits feasibility from an operational perspective.

GAC is normally applied after the coagulation/sedimentation process and was assumed to follow rapid media filtration for this evaluation (post-filter adsorption mode). A GAC influent TOC range of 3 to 7 mg/L was evaluated and Table 3.2 lists the resulting effluent TOC concentration values for a range of breakthrough ratios (C/C_0).

TABLE 3.2

PREDICTED GAC EFFLUENT QUALITY FOR A RANGE OF INFLUENT TOC CONCENTRATIONS

Influent TOC (mg/L)	Effluent TOC (mg/L)		
	$C/C_0 = 0.3$	$C/C_0 = 0.5$	$C/C_0 = 0.7$
3	0.9	1.5	2.0
4	1.2	2.0	2.8
5	1.5	2.5	3.5
6	2.8	3.0	4.2
7	2.1	3.5	4.9

The same disinfection assumptions that applied to enhanced coagulation are also applicable to post-GAC microbial inactivation (i.e., a 1:1 chlorine to TOC dose ratio, 60 and 120 minutes of free chlorine contact to yield 1 and 2 log *Giardia* inactivation, respectively; free chlorine followed by chloramines for distribution system residual; no *Cryptosporidium* inactivation with this chlorine/chloramine combination).

Ozone and GAC Treatment

It is important to note that GAC, by itself, will not remove pathogens. Therefore, some systems, particularly in Europe, use GAC following ozone disinfection. In this configuration, ozone provides a strong disinfectant and the GAC is used to control biodegradable ozonation by-products through biological activity and to remove precursors of chlorination/chloramination by-products through adsorption. Many of the biodegradable ozonation by-products can be completely removed, and depending on the EBCT and water quality conditions, the biodegradable organic carbon (BDOC) can be decreased to the levels in the water prior to ozonation. GAC has not been shown to be efficient, however, for removing bromate using feasible design criteria in full-scale applications. This is discussed in greater detail in Section 4.2.2.

Following ozone, GAC can be used in a steady-state mode where the GAC is replaced at a very low frequency (once every 3 to 10 years) and a 20 to 30 percent removal of DBP precursors can be expected. In an unsteady state mode, as described above, the GAC is replaced more often (more than once per year) in which higher removal (30 to 70 percent) of DBP precursors can be expected. In this evaluation of ozone and GAC, ozone is expected to provide inactivation of *Cryptosporidium*, and chloramines will be applied after the GAC to provide a distribution system residual. A free chlorine contact time of 5 minutes was assumed sufficient to provide post-GAC inactivation of heterotrophic plate count bacteria, prior to the application of ammonia.

In this evaluation, it was assumed that the ozone and GAC act somewhat independently for the inactivation and removal of water quality contaminants. For example, ozone can be used to inactivate *Cryptosporidium*; GAC does not appreciably remove microbial contaminants. Ozone forms bromate; GAC does not adsorb bromate in feasible full-scale applications. Ozone does not remove precursors for organically-based DBP compounds (THMs and HAAs); GAC adsorbs these compounds. It is recognized, however, that ozone creates biodegradable organic components which can be adsorbed by GAC, thereby reducing the DBP formation potential through biodegradation. The amount of this removal compared to direct adsorption of organic material is relatively small and within the error of the estimates projected by the expert panel for GAC adsorption, alone.

3.2.4 Membrane Treatment

For simplicity, membrane treatment is divided into two categories in this evaluation:

1. Membrane filtration (e.g., microfiltration, ultrafiltration), which removes particles, protozoan cysts (*Giardia* and *Cryptosporidium*), and some viruses. Membrane filtration does not remove dissolved organic material, hardness, or ionic compounds (e.g., bromide) to any significant degree.

2. Membrane softening (e.g., nanofiltration, reverse osmosis), which removes particles, protozoan cysts, dissolved organic carbon, hardness, viruses and some ions (e.g., bromide). These "tighter" membranes must be preceded by particle removal to reduce fouling. Recently, the use of nanofiltration and reverse osmosis for dissolved organic carbon removal is challenging the traditional use for softening. RO membranes provide more complete rejection of salt (e.g., chloride bromide) than NF membranes.

Membrane filtration and membrane softening differ in many aspects. In general, capital costs for membrane softening are at least twice those for membrane filtration and much higher operating pressures are required for membrane softening (80 to 200 psi) as compared to membrane filters (15 to 30 psi). Therefore, the higher quality water produced by membrane softening comes at a price.

Membrane Filtration

Membrane filtration is being evaluated in a wide array of drinking water applications. The largest facility with an operating history in the United States is a 5 mgd facility in San Jose, CA. Larger facilities are under design, construction, and are being put on-line. Design of a 28 mgd facility is underway with planned operation in 2000 in Del Rio, Texas. Nevertheless, the use of membrane filtration for large plants (> 40 to 50 mgd) has not been demonstrated and the feasibility is uncertain. Most MF/UF installations showing demonstrated performance have modular units in the 1 to 1.5 mgd capacity range. Therefore, large plants require a large number of treatment modules, which significantly increases facility complexity.

The major advantage of membrane filtration is that, in the absence of coagulation, it does not produce a chemically-treated waste product. Consequently waste disposal is simpler. Further, the cost of membrane filtration is competitive with complete conventional treatment. The feasibility of membrane filtration, however, is dependent upon the source water. It performs best on low turbidity waters and waters low in TOC. Because membrane filters do not remove dissolved compounds, additional pretreatment (i.e., coagulation, flocculation and possibly sedimentation or flotation) must precede this technology if removal of organic carbon is necessary. This may reduce the cost efficiency of membrane filtration compared to conventional treatment.

Because membrane filters do not remove TOC or bromide, and because some virus inactivation still is required after treatment, the use of ozone disinfection followed by a chloramine residual in the distribution system will allow for the maximum flexibility in source water quality diverted from the Delta. In this evaluation, it was assumed that microfilter (MF) or ultrafilter (UF) membranes would follow existing, conventional sedimentation. Assuming 1 log and 2 log virus removal credits for sedimentation coupled with MF and UF, respectively, additional 3 log (MF) and 2 log (UF) virus inactivations will be required by ozone to meet regulatory requirements. The CT requirements for 1 and 2 log virus inactivation by ozone are similar to that required for 0.5 log and 1.5 log *Giardia* inactivation, respectively. Therefore, bromate formation still is a concern using a membrane filtration/ozone/chloramine treatment strategy. Consequently, it was assumed that an ozonation pH of 6.5 would be required to maximize the flexibility in source water bromide concentrations diverted from the Delta.

Instead of using ozone, it is possible to use free chlorine following MF or UF to provide virus inactivation. The use of chlorine, however, introduces source water limitations based upon TTHM and HAA5 concentrations. Consequently, ozone was evaluated for disinfection rather than free chlorination following membranes. In addition, it may be possible to demonstrate a 4 log virus removal using UF, thereby eliminating any need for supplemental primary disinfection. This would have to be demonstrated to the satisfaction of the primacy agency.

Membrane Softening for DOC and Bromide Removal

There are a few membrane softening plants used for potable water treatment throughout the country, mostly in Florida. The largest membrane softening application for drinking water in the United States is 12 mgd. Slightly larger facilities have been constructed for groundwater recharge in California.

NF/RO membrane provides distinct advantages compared to MF/UF in that microbial contaminants (*Giardia, Cryptosporidium* and some viruses), dissolved organic carbon and bromide are all removed. There are two major issues which affect the feasibility of NF/RO membrane treatment in California. One is the disposal of membrane concentrate and the other is the volume of concentrate "wasted" from the system, which is much larger than that "wasted" by MF/UF systems. In a water-short regions such as California, the reject of 15 percent of the source water volume may be considered unacceptable. Further, this reject is highly concentrated with dissolved ions, and therefore disposal options, other than the ocean (if this can be environmentally permitted) are limited. Consequently, these considerations must be carefully weighed when determining whether it is feasible to implement NF/RO treatment.

For softening membranes, it is assumed that existing conventional treatment available at the CUWA treatment facilities, followed by cartridge filters, will provide sufficient pretreatment. Research and full-scale operations suggest that NF treatment can achieve at least 90 and 50 percent removal of TOC and bromide, respectively. It is recognized that RO could provide even higher levels of bromide removal (up to 90 percent), but NF was used as the limiting case in this evaluation. Further, it was assumed that membranes would be treating the entire flow. It is recognized that many facilities by-pass a portion of the membrane influent to achieve a target value for specific parameters (e.g., total dissolved solids) to lower costs and reduce corrosivity. This refinement, however, is beyond the scope of this effort as the extent of blending desired is site-specific.

Application of NF/RO is considered in combination with post-membrane chlorination for both primary and secondary disinfection in this evaluation because of the generally good quality (low TOC and TDS) of the treated water. Uniform formation conditions (UFC) were used to simulate the distribution system conditions (Summers et al., 1996); 24 hour contact time, pH 8.0, temperature of 20° C and a free chlorine residual of 1 mg/L after 24 hours.

3.3 CONCEPTUAL UNIT COSTS FOR TECHNOLOGIES

The technologies presented in this chapter have unique capital and operation and maintenance (O & M) costs. In this section, conceptual unit costs for specific technologies are provided. The estimates show a range of incremental costs, on a $/acre-ft (AF) basis (e.g., the increased unit cost for water treatment), for enhanced coagulation, ozone disinfection, granular activated carbon (GAC), membrane filtration (MF/UF), and membrane softening (NF/RO).

A range is provided to demonstrate that there is a spectrum of costs associated with a given technology, which is highly dependent upon factors such as design criteria, system size, and other site-specific factors. It must be emphasized that the costs presented here are incremental costs, and do not include costs for other aspects of treatment. For example, the membrane treatment costs do not include pretreatment, which will be considerable for NF/RO treatment. It is possible that conventional treatment including filtration can provide adequate pretreatment for NF/RO, but the consistency of the pretreated water is critical for the success of the NF/RO technology.

The range of costs presented are based upon the expert panel's experience with systems around the country and are consistent with costs prepared for the USEPA during their development of the D/DBP Rule. These technology costs were peer-reviewed during the regulatory negotiation in 1992-1993 and were deemed acceptable by water industry representatives. Further, the costs were updated for the 1997 deliberations, and membrane costs were modified to reflect the substantial improvements in technology since 1992.

The expert panel did not generate independent cost estimates for CUWA members, as such costs are extremely site-specific and such an evaluation is not with the scope of this effort. The costs presented in this Section were compared to costs developed by the Metropolitan Water District of Southern California for all technologies, with the exception of membrane filtration. When Metropolitan's estimates are converted to unit costs ($/AF), the values fall within the range of costs presented here.

Table 3.3 provides unit costs for the technologies on a $/AF basis. These conceptual costs include amortized capital costs (e.g., 20 year design period, 8 percent interest) added to annual O & M costs. Again, these costs assume treatment of the entire facility flow, without bypassing and blending.

Table 3.3

Conceptual Incremental Unit Cost Treatment

Treatment	Incremental Cost $/Ac-Ft
Enhanced Coagulation	16-34
Ozone	26-42
Granular Activated Carbon	100-210
MF/UF Membranes	140-250
NF/RO Membranes	340-650

It is important to note that costs for controlling pH are not provided in the above table. These costs are highly site-specific but can add \$5 to \$10/Ac-Ft to incremental costs. In addition, it is important to reemphasize that all incremental costs are highly dependent upon many site-specific factors. A sample of potential factors affecting costs is presented in Table 3.4.

Table 3.4

Some Factors Affecting Incremental Treatment Costs

Technology	Example Factors Affecting Incremental Costs
Enhanced Coagulation	1. System size 2. Existing coagulant dosage 3. Required Coagulant dosage/pH 4. Existing and feasible sludge disposal method
Ozonation	1. System size 2. Oxygen feed source 3. Ozone dosage and pH conditions 4. Energy costs
Granular Activated Carbon	1. System size 2. GAC reactivation frequency 3. Method of reactivation/replacement 4. Energy costs
MF/UF Treatment	1. System size 2. Operating philosophy 3. System configuration 4. Backwash disposal
NF/RO Treatment	1. System size 2. Operating philosophy 3. Energy costs 4. Concentrate disposal option

4.0 EVALUATION OF SOURCE WATER QUALITY AND TREATMENT EFFICIENCY

4.1 WATER QUALITY IMPACTS AND VARIABILITY

In this section, water quality constraints are described which will allow implementation of specific treatment processes to meet potential regulatory goals. In general, the water quality constraints will be described in terms of two measurable surrogate parameters which affect DBP formation; TOC and bromide. In evaluating these water quality variables and interpreting the results, it is important to recognize that:

1. TOC is a heterogeneous mixture, and is comprised of humic and fulvic acids and other naturally-occurring organic material which varies from source to source and from location to location within a source. Consequently, TOC from different regions of the Delta will not have an identical impact on DBP formation. In this effort, it was necessary to assume that TOC could be a unifying variable for organic DBP precursor material, even given the inherent variability in the material which comprises this parameter.

2. The extent to which bromide participates in DBP reactions is dependent upon its oxidation state as well as its relative concentration with other competing oxidants (e.g., chlorine). The following analysis is not stoichiometrically-based, but rather is empirical in nature based upon measured formation rates and other data available to the expert panel.

3. The formation of DBPs is dependent upon many other water quality parameters beyond TOC and bromide, alone. Some of these include temperature and pH. The expert panel focused on TOC and bromide because it was assumed that management alternatives for the Delta had the opportunity to affect these variables, and therefore their control will influence subsequent DBP formation through treatment processes.

In the following presentation, bromide concentrations are provided in $\mu g/L$. It is recognized that bromide is often related to chloride concentration, as both are present in salt water which can intrude into the Delta system. If chloride concentrations relevant to stated bromide concentrations are of interest, the following conversion (Krasner et.al. 1994) can be used:

$$Cl^- (mg/L) = \frac{Br^- (\mu g/L) + 4.96}{3.27}$$

4.2 DISINFECTION BY-PRODUCT FORMATION

4.2.1 Halogenated Organic By-Products

To assist in assessing the formation of DBPs from treated water from the Delta, a TTHM formation model developed for the Metropolitan Water District of Southern California was used (Malcolm Pirnie Inc., 1993). The model was developed from 648 data observations under bench-scale conditions using various blends of water diverted from the Delta. A chlorine-to-TOC dose ratio of 1:1 and free chlorine contact times of 60 and 120 minutes (to yield 1 and 2 log *Giardia* inactivation, respectively) were used in the analysis. A pH of 7.0, a temperature of 20° C and bromide concentration values of 50, 100, 150, 200 and 300 μg/L were also used. These conditions were within the experimental boundaries of the model. A more detailed description of the model is provided in Appendix A. The predicted TTHM values are summarized in Table 4.1.

The TTHM values were compared to the data supplied by the CUWA members, those in the open literature, and with the experience of the expert panel. A summary of the data provided by the CUWA members is included in Appendix B. The available data and the expert panel's experience agreed well with values in Table 4.1.

HAAs are also formed under these reaction conditions. The Stage 1 and Stage 2 proposed TTHM MCLs of 80 and 40 μg/L, and HAA5 MCLs of 60 and 30 μg/L, respectively, yield a mass concentration TTHM-to-HAA5 ratio of 1:0.75. The DBP data supplied to the expert panel by the CUWA members indicate that the TTHM values exceed the HAA5 concentrations by greater than this ratio of 1:0.75 in 84% of the 160 cases where paired TTHM and HAA5 data were available. Other data from both research and full-scale applications in waters containing at least 50 μg/L of bromide confirm these findings (Summers, et. al., 1996, Cheng, et. al., 1995, Shukairy, et.al., 1994). Thus, it was concluded that TTHMs are the DBP of regulatory concern for this evaluation of organic DBP precursor removal. It is important to note, however, that HAA5 represents only five of the nine HAA compounds and three of the four remaining are mixed bromo-chloro compounds which have been shown to have significant levels of formation in bromide containing waters (Cowman and Singer, 1996). If HAA6 or even HAA9 were to become regulated, then the controlling parameters and values could be affected. Further, for source water bromide levels

TABLE 4.1

PROJECTED TTHM FORMATION FROM TREATED WATER

		TTHM Formation (μg/L)	
Treated TOC (mg/L)	Bromide (μg/L)	1 hr. contact	2 hr. contact
2.0	50	23	28
	100	26	31
	150	28	33
	200	31	36
	300	36	43
2.25	50	26	31
	100	29	34
	150	31	38
	200	34	41
	300	40	48
3.0	50	34	41
	100	38	45
	150	41	49
	200	45	54
	300	53	63
3.25	50	37	44
	100	40	48
	150	44	53
	200	48	57
	300	57	68
3.9	50	43	52
	100	47	57
	150	52	62
	200	56	67
	300	66	79
4.55	50	49	59
	100	54	65
	150	59	71
	200	64	77
	300	76	90
5.2	50	55	66
	100	61	72
	150	66	79
	200	72	86
	300	85	101
5.4	50	57	68
	100	62	75
	150	68	82
	200	75	89
	300	87	104
6.0	50	62	74
	100	68	81
	150	75	89
	200	81	97
	300	95	114

considerably lower than 50 μg/L, it is recognized that HAA5 may control over TTHM (Cowman and Singer, 1996). These low bromide values were not considered relevant for this study.

A 20 percent safety factor on THM and HAA5 production was used in determining the source water conditions which would result in the target DBP concentrations following treatment. Thus a target TTHM concentration value of 64 μg/L (80% of 80 μg/L) was used for Stage 1 evaluations and 32 μg/L (80% of 40 μg/L) was used for Stage 2 evaluations.

4.2.2 Bromate Formation and Removal

Bromate Formation

The formation of bromate by ozone has come into focus only recently. The ultimate MCL for this compound is of critical importance to facilities which have bromide in their source water and are currently using, or anticipating the use of, ozone for drinking water treatment. Even small concentrations of bromide (< 50 μg/L) can result in measurable concentrations of bromate after ozonation. Therefore, the expert panel carefully evaluated available data from the CUWA members, other available literature, and ongoing research on bromate formation to evaluate potential source water constraints. Based upon these data, the expert panel arrived at initial conclusions regarding potential source water bromide concentrations which would be required to limit bromate formation within the potential regulatory scenarios in Chapter 2.

Unfortunately, bromate formation is strongly dependent upon the nature of the experimental system design (e.g., bench versus pilot or full-scale). In addition, bromate formation depends upon ozone dosage and residual, which is often specific for full-scale facilities, making the direct comparison of these data difficult. Therefore, a bromate model (Ozekin, 1994) was utilized to systematically evaluate the impact of ozone dose, bromide, TOC and pH on the formation of bromate and thereby supplement the available literature (Shukairy et.al., 1994), data supplied by the Alameda County Water District, Contra Costa Water District, Santa Clara Valley Water District, and Metropolitan Water District of Southern California, and the expert panel's experience. The model was developed from data from several source waters including water diverted from the Delta, including results from source waters containing bromide concentrations between 70 μg/L and 440 μg/L. A contact time of 12 minutes was chosen and the concentrations of TOC, bromide, ozone dose and pH were varied over representative ranges as discussed in Chapter 3. At each pH, three ozone: TOC ratios were estimated to provide the following levels of inactivation; 1 log *Giardia*, 2 log *Giardia* and 1 log *Cryptosporidium*. The dose of ozone estimated for these inactivations decreases with decreasing pH as a higher ozone residual is maintained at the lower pHs. The results of the modeling supported the initial conclusions reached by the Panel based upon the available literature and review of the CUWA data. A more detailed description of the model is provided in Appendix A.

Figure 4.1 illustrates bromate formation as a function of source water bromide and ozonation pH. Relationships are shown for 1 and 2 log *Giardia* inactivation for both 5 and 10 μg/L bromate standards, and 1 log *Cryptosporidium* inactivation for a 5 μg/L bromate requirement.

Bromate Removal

Bromate removal after ozonation has been studied for the following technologies:

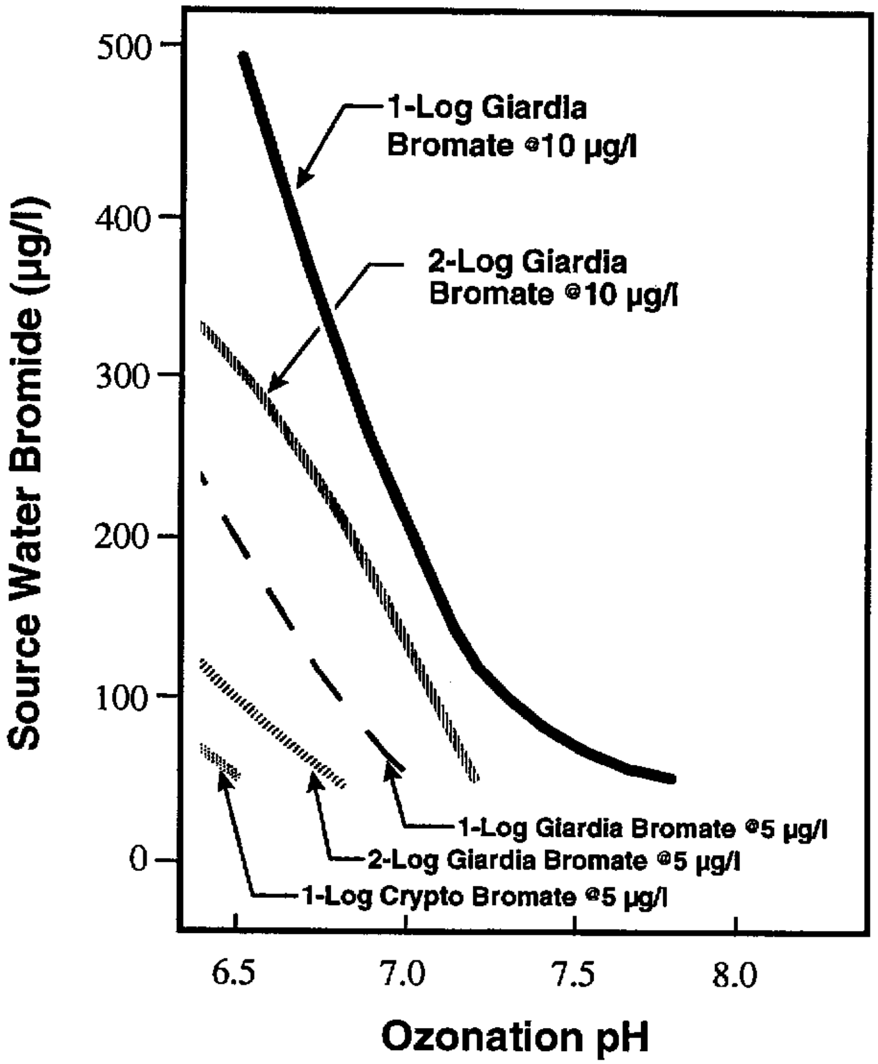
- Ferrous salt coagulation
- Reduction on a GAC surface
- UV Irradiation

It is important to recognize that research on bromate removal mechanisms is relatively new and has only been conducted for about the last five years. Consequently, the technologies presented below have been evaluated on a laboratory scale and published literature on full-scale applications is not available. It is premature to consider that these bromate removal technologies could be implemented reliably and cost-effectively on a full-scale basis.

Ferrous Salt Coagulation

Based on results of an AWWARF project conducted at the University of Colorado and currently in press, ferrous salts have been evaluated as a bromate removal technique with pre-ozonation. Up to 50 to 70 percent removal was reported though filterability problems (turbidity and particle breakthrough) were experienced. Ferric addition in conjunction with ferrous salts somewhat circumvented these filterability problems, though the issue has not yet been sufficiently evaluated. Bromate levels after ozonation ranging

Figure 4.1
Projected Bromide & Ozonation pH Requirements to Meet Potential Regulatory Scenarios for Microbial Inactivation and Bromate



Notes
1. Partially based on modeling equations of ozonation *(Ozekin, 1994)*.
2. Approximate value only.

H:\34(54)\01\graphics\fig4-1.ppt

from 20 to 50 $\mu g/L$ were reduced to below 10 $\mu g/L$. Consequently, it is not certain whether a 5 $\mu g/L$ limit could be met (this depends, in part, on levels exiting the ozone contactor).

Reduction on a GAC Surface

Bromate removal in a GAC contactor is expected to be a two step process in which the bromate is first adsorbed onto the GAC and subsequently is reduced to bromide. Almost complete bromate removal can be expected on a fresh GAC bed. The adsorption and chemical reduction, however, rapidly reaches a steady state with a reduction in removal percentage of bromate from the influent water. The time to reach a steady state varies as a function of empty bed contact time (EBCT). In general, the rapid breakthrough shown to date would result in very short reactivation frequencies that would be difficult to implement on full-scale.

Expected bromate removals are based upon rapid small-scale column test (RSSCT) experiments without biological activity. The effect of biological activity on bromate removal is not known. Additional research is being currently conducted to study these effects.

UV Irradiation

UV irradiation from medium pressure mercury lamps has been found to be effective in the removal of bromate. Limited bench top continuous flow experiments have been performed thus far (Siddiqui and Amy, 1994). A contact time of less than 10 minutes combined with at a UV dose of 600 $mW\text{-}sec/cm^2$ was found to reduce 50 to 100 $\mu g/L$ of bromate to less than 2 $\mu g/L$. Although this technology has been effective on a bench scale, the cost-effectiveness and reliability of UV in large scale application has not been demonstrated or completely evaluated. This technology has not been applied for any purposes at drinking water facilities the size of those operated by the CUWA members.

4.3 SOURCE WATER QUALITY FOR REGULATORY SCENARIOS

In the following discussion, source water quality in terms of TOC and bromide is estimated based upon the implementation of specific treatment technology (defined in Chapter 3) and the potential regulatory outcome (described in Chapter 2). Source water concentrations of TOC were evaluated between 2 and 7 mg/L. The 7 mg/L value represents the 90^{th} percentile for TOC concentrations diverted from the Delta. Bromide concentrations were evaluated up to 300 μg/L, as this was also considered a practical maximum in this evaluation. The data presented here are summarized in Section 4.5 both in tabular and graphical form.

4.3.1 Stage 1 D/DBP Rule and IESWTR

Enhanced Coagulation

For enhanced coagulation, source water TOC concentrations in the range of 3 to 7 mg/L and bromide concentrations of 50, 100, 150, 200 and 300 μg/L were evaluated. As discussed in Chapter 3, an alum dose of 40 mg/L at a coagulation pH of 7.0, and possibly as low as 6.5, was projected to be required to meet the TOC removal requirements. These TOC removal requirements, which are a function of influent alkalinity and TOC concentrations, and the resulting effluent TOC concentrations are shown in Table 4.2.

TABLE 4.2

DETERMINATION OF TREATED WATER TOC FOR ENHANCED COAGULATION

Influent TOC (mg/L)	Required Removal (%)	Treated TOC (mg/L)
3	25	2.25
4	25	3.0
5	35	3.25
6	35	3.9
7	35	4.55

To assess the TTHMs formed from the chlorination of effluents with this TOC range, the results in Table 4.1 can be utilized to draw the following projections:

1. For a 1 log *Giardia* inactivation using free chlorine for 60 minutes following enhanced coagulation, it was projected that the following water quality conditions would permit compliance with the stage 1 TTHM target of 64 μg/L in the regulatory scenario:

Raw Water TOC Concentration, mg/L	Bromide Concentration, μg/L
<7	<150-200
<6	<200
<5	<300

2. For a 2 log *Giardia* inactivation using free chlorine for 120 minutes following enhanced coagulation, it was projected that the following water quality conditions would permit compliance with the stage 1 TTHM target of 64 μg/L in the regulatory scenario:

Raw Water TOC Concentration, mg/L	Bromide Concentration, μg/L
<7	<50-100
<6	<150
<5	<200
<4	<300

For both of the above scenarios, certain combinations of raw water TOC and bromide concentrations that lie between the bounded concentration ranges are also projected to meet the target DBP values. For example, raw TOC concentrations between 6 and 5 mg/L and bromide concentrations between 200 and 300 μg/L, are projected to meet the DBP target values under a 1 log *Giardia* inactivation.

<u>Ozone Disinfection</u>

Bromate formation is the limiting DBP (as opposed to TTHM and HAA5) for the ozone treatment and disinfection strategy specified in this evaluation. It is the opinion of the expert panel that the controlling source water quality parameter for the formation of bromate, in the context of this evaluation, is bromide. It is recognized that higher concentrations of TOC will result in higher ozone dosages to achieve a given CT, and, as a result, may increase the concentration of bromate formed depending upon ozone residual, bromide concentration and potentially other parameters such as contactor design. Higher ozone dosages as a result of higher TOC also result in increased capital and operational costs for ozone treatment. Further, TOC can also be limiting to the extent that the biodegradable material, formed by the reaction between ozone and naturally-occurring organic matter (NOM), is not completely controlled through biofiltration, thereby creating an undesirable regrowth potential in the distribution system. The extent to which regrowth will be a problem is a function of the distribution system design, as well as disinfectant residuals maintained and other water quality parameters which are agency-specific. Nevertheless, sufficient data were not available to isolate the impact of TOC on bromate formation, in the absence of variation in bromide, pH and other water quality factors.

Based upon the data supplied by the CUWA members and other bromate formation studies and the model results, the expert panel concluded:

1. A bromate standard of 10 μg/L is restrictive at ambient pH values. At pH 7.8 (ambient for some pre-ozonated waters) it is projected that a bromide level of 50 μg/L or less would be needed to meet a bromate standard of 10 μg/L for 1 log *Giardia* inactivation. This bromate standard could not be met for ozone dosages providing 2 log *Giardia* inactivation at ambient pH.

2. Lowering the pH of ozonation is an effective means of reducing bromate formation. If the ozonation pH were lowered to 6.5, then a 10 μg/L level of bromate may be achievable with:

   - 1 log *Giardia* inactivation in the bromide range of less than 500 μg/L.
   - 2 log *Giardia* inactivation in the bromide range of less than 300 μg/L.

3. The potential for reliably meeting bromate standards using the bromate removal technologies currently being evaluated is unknown at this time. Although some technologies show promise, many have been demonstrated only on bench scale and the understanding of full-scale feasibility is limited. Consequently, the expert panel does not propose the use of bromate removal techniques as a well-understood and currently feasible and reliable method for increasing the allowable source water concentrations for bromide.

4. Limiting TOC concentrations were not estimated because of the limited availability and robustness of the data illustrating the impact of TOC on bromate formation, in the presence of bromide. It should be recognized, however, that higher TOC concentrations translate to higher ozone dosages to meet a given disinfection criterion and thereby can result in higher bromate formation. This is empirically validated in reviewing bromate formed during settled water ozonation as opposed to raw water ozonation. In general, when TOC concentrations are lower at a given facility, ozone dosages to achieve a given disinfection requirement are lower, and measured bromate concentrations are lower. Lower pH in settled water also helps reduce bromate concentrations.

The expert panel recognizes that there are variations in bromate production data and therefore looked for indications relating to threshold behavior. That is, evaluating source water bromide concentrations which result in a clear increase in bromate concentrations for a given set of ozonation conditions. Given some variation in the formation of bromate reported at lower source water bromide concentrations (< 50 μg/L), the expert panel took a position of plausible conservatism.

GAC and Membrane Treatment

It was the opinion of the expert panel that, given the relative flexibility that enhanced coagulation and ozone disinfection provided to meet the near-term regulatory scenario, CUWA members would not implement GAC or membrane treatment for this potential regulatory outcome. Consequently, source water quality limitations were not developed for these technologies in the near-term regulatory scenario.

4.3.2 Stage 2 D/DBP Rule and LT2SEWTR

Enhanced Coagulation

Using the same approach taken for the stage 1 D/DBP Rule and IESWTR, the following projections can be made for source water quality when using enhanced coagulation to achieve the potential long-term regulatory outcome:

1. For a 1 log *Giardia* inactivation using free chlorine for 60 minutes following enhanced coagulation, it was projected a raw water TOC concentration < 3.0 mg/L and a bromide concentration < 150 μg/L would permit compliance with the Stage 2 TTHM target of 32 μg/L in the regulatory scenario.
2. For a 2 log *Giardia* inactivation using free chlorine for 120 minutes following enhanced coagulation, it was projected that a raw water TOC concentration < 3.0 mg/L and a bromide concentration <50 μg/L would permit compliance with the TTHM target concentration of 32 μg/L in the regulatory scenario.

Ozone Disinfection

The estimates illustrated in Figure 4.1 were again used to evaluate potential source water limitations using ozone disinfection in the long-term regulatory scenario. The expert panel arrived at the following conclusions:

1. A bromate standard of 5 μg/L is very restrictive at pH values above 7. At pH 7.8 (ambient for some pre-ozonated waters) it is projected that this standard will not be met for any of the potential microbial inactivation requirements.
2. If the ozonation pH were lowered to 6.5, then a 5 μg/L level of bromate may be achievable with:
   - 1 log *Giardia* inactivation in the bromide range of less than 200 μg/L.
   - 2 log *Giardia* inactivation in the bromide range of 100 to 150 μg/L.

- 1 log *Cryptosporidium* inactivation with a bromide concentration of less than 50 μg/L.

3. The potential for reliably meeting bromate standard using the bromate removal technologies currently being evaluated is unknown at this time. Although some technologies show promise, many have been demonstrated only on bench scale and the understanding of full-scale feasibility is limited. Consequently, the expert panel did not propose the use of bromate removal techniques as a well-understood and currently feasible and reliable method for increasing the allowable source water concentrations for bromide.

4. Limiting TOC concentrations were not estimated because of the limited availability and robustness of the data illustrating the impact of TOC on bromate formation, in the presence of bromide. It should be recognized, however, that higher TOC concentrations translate to higher ozone dosages to meet a given disinfection criterion and thereby can result in higher bromate formation. This is empirically validated in reviewing bromate formed during settled water ozonation as opposed to raw water ozonation. In general, when TOC concentrations are lower at a given facility, ozone dosages to achieve a given disinfection requirement are lower, and measured bromate concentrations are lower. Lower pH in settled water also helps reduce bromate concentrations.

GAC Treatment

In assessing the use of GAC to meet the Stage 2 TTHM target of 32 μg/L, several constraints were used. The values in Table 4.1 suggest that the treated water TOC concentration must be below about 2.5 mg/L to approach this TTHM target within the range of bromide concentrations evaluated. To achieve this level of TOC in the finished water then the GAC influent TOC must be below 5.0 mg/L at a breakthrough (C/C_0) of 0.5, (see Table 3.2). As shown in Table 4.3, an EBCT of 20 minutes or greater is needed to achieve this effluent concentration while maintaining run times greater than 60 days (Summers et al., 1994, Hooper et al., 1996).

TABLE 4.3

ESTIMATED TIME TO 50 PERCENT BREAKTHROUGH AT DIFFERENT GAC EMPTY BED CONTACT TIMES

Influent TOC	Effluent TOC	Time to 50% Breakthrough (days)		
		EBCT (min) 15	EBCT (min) 20	EBCT (min) 30
3	1.5	62	83	124
4	2.0	47	68	93
5	2.5	38	50	75
6	3.0	32	42	63
7	3.5	27	36	54

The assumption of 10 to 15 percent TOC removal by the coagulation process prior to GAC yields a maximum raw water TOC of 5 mg/L for the GAC use scenario.

Using the results in Table 4.1 the following projections can be made based on the above analysis:

1. For a 1 log *Giardia* inactivation using free chlorine for 60 minutes following conventional coagulation and GAC, it was projected that a raw water TOC concentration of < 5 mg/L and a bromide concentration of < 150 μg/L would permit compliance with the Stage 2 TTHM target of 32 μg/L in the regulatory scenario.

2. For a 2 log *Giardia* inactivation using free chlorine for 120 minutes following coagulation and GAC, it was projected that a raw water TOC concentration of < 5 mg/L and a bromide concentration of <50 μg/L would permit compliance with the stage 2 TTHM target of 32 μg/L in the regulatory scenario.

Higher GAC influent TOC concentrations can be used with breakthroughs (C/C_0) lower than 0.5 to achieve effluent TOCs lower than 2.5 mg/L. For example an influent TOC of 6 mg/L and a C/C_0 of 0.4 yields a GAC effluent of 2.4 mg/L. The run times are below 60 days, however, even at an EBCT of 30 minutes. The run time at a C/C_0 of 0.4 is about 20 percent shorter than that at 0.5 (Summers and Hooper, 1997 unpublished data).

As discussed in Section 3.2.3, ozone can be used in combination with GAC to enhance disinfection and provide a good medium to remove biodegradable organic carbon (BDOC) formed by the application of ozone. Because of the particular constituents of concern in this evaluation, it was assumed that ozone and GAC operate somewhat independently for microbial inactivation and removal of water quality contaminants. This particular treatment scenario allows GAC to be used when *Cryptosporidium* inactivation is required.

For GAC in combination with ozone, source water TOC can increase up to at least 7 mg/L (the 90th percentile for water diverted from the south Delta). Bromide concentrations using

ozone at a pH of 6.5 are limited to <200, 100 to <150, and <50 μg/L for 1 log *Giardia*, 2 log *Giardia*, and 1 log *Cryptosporidium* inactivations, respectively.

The source water for this combined treatment is limited by the ozonation process for bromide. For TOC values approaching 7 mg/L there is a concern that the TTHMs formed in the five minutes of contact with free chlorine will exceed the Stage 2 target. However, there are few TTHM formation data available at contact times as short as this. In addition there is concern that the GAC will be able to adequately control BDOC. High levels of ozonation by-products in the distribution system can lead to microbial regrowth, although currently these compounds are not regulated.

Membrane Treatment

As discussed in Chapter 3, two types of membrane treatment can be considered; membrane filtration and membrane softening. Because both of these processes represent "absolute barriers" to *Giardia* and *Cryptosporidium*, the source water quality does not vary based upon the extent of protozoan removal required. Based upon this understanding, the following projections were made:

1. For microfiltration, ozone, and chloramine treatment, it was assumed that ozone would be required to provide 3 log virus inactivation. This corresponds to CT values which are similar to 1.5 log *Giardia* inactivation. To provide the greatest degree of flexibility for source water bromide concentrations, it was assumed that ozonation would be conducted at pH 6.5. Referring to Figure 4.1, this results in a limiting source water bromide concentration of < 150 μg/L. A specific limit for source water TOC was not estimated for this treatment scheme. For TOC values approaching 7 mg/L (the 90th percentile for water diverted from the south Delta) there is a concern that biological filtration will be able to adequately control BDOC. High levels of ozonation by-products in the distribution system can lead to microbial regrowth, although currently these compounds are not regulated.

2. For ultrafiltration, ozone, and chloramine treatment, it was assumed that ozone would be required to provide 2 log virus inactivation. This corresponds to CT values which are similar to 0.5 log *Giardia* inactivation. To provide the greatest degree of flexibility for source water bromide concentrations, it was assumed that ozonation would be conducted at pH 6.5. This results in a limiting source water bromide concentration of < 300 $\mu g/L$. A specific limit for source water TOC was not estimated for this treatment scheme. For TOC values approaching 7 mg/L (the 90[th] percentile for water diverted from the south Delta) there is a concern that biological filtration will be able to adequately control BDOC. High levels of ozonation by-products in the distribution system can lead to microbial regrowth, although currently these compounds are not regulated.

3. For the application of nanofiltration followed by free chlorine addition for distribution system residual maintenance, TOC is limited by the extent to which TTHMs are formed in the distribution system. Under these conditions, the treated water TOC should be below 1 mg/L and the bromide level below 0.15 mg/L, as predicted by uniform formation conditions (Summers et. al., 1996). Assuming a 90 percent TOC removal and a 50 percent bromide removal by nanofiltration, a source water TOC of up to 10 mg/L is estimated at all source water bromide levels examined (< 300 $\mu g/L$).

4.4 IMPACT OF OTHER POTENTIAL REGULATORY OUTCOMES

4.4.1 Introduction

This section describes the impact of other potential regulatory outcomes on treatment requirements and/or allowable source water quality. It was not possible for the expert panel to evaluate all of the potential scenarios and the most plausible were discussed in Chapter 2. This section discusses broad trends based upon regulatory outcomes that were conceived during the regulatory negotiations, as affected by recent developments.

4.4.2 Lower MCLs and/or Maximum MCLs for Halogenated Organic Compounds

Plausibility: The current placeholder values could possibly go lower based on new health effects research. First, THM and HAA levels might be lowered. EPA has been conducting research on reproductive effects that may be associated with various THM and HAA species. Given the intense concern expressed during reg-neg over the New Jersey epidemiology studies and the potential associations with neural tube defects, lower MCLs than the 40 μg/L and 30 μg/L would be plausible. In addition, a recently released study based in California developed an association between TTHM, individual THM compounds, and spontaneous abortion. Because this is considered an acute affect, this increases emphasis for considering a maximum value for DBPs, rather than a running annual average. Second, the current bromate MCL is based on what was considered to be the Practical Quantitation Level (PQL). Much effort is being focused on improving the method which could lead to a lower MCL, especially given the toxicology which suggests the high carcinogenic potency of bromate. Third, HAA regulatory levels are currently based on five species. There are, however, four other species that can form in the presence of bromide. Such compounds could dramatically increase the total HAA. Due to the apparently greater potency, it is possible that the MCL for total HAAs may decrease, though they may increase.

Impacts: Lower MCLs, or maximum rather than running annual average values, for THM or HAA will require either TOC or bromide to be reduced. A lower bromate PQL would require lower ozonation pH, depending on the actual level. But a very low level (e.g., less than 1 μg/L) could make use of ozone prohibitive.

4.4.3 MCLs For Individual DBP Species

Plausibility: A wide variation in relative potency of individual species within a given class has been observed. For example, bromodichloromethane is much more potent than chloroform, and has been associated with spontaneous abortion in a California based study. Its metabolism is more rapid leading to higher tissue concentrations, it has a greater capacity for binding proteins and lipids and the mutagenic response is much greater. These types of observations, particularly associated with bromine substitution in the place of chlorine-intensifying toxicity, lends credence to regulating individual species rather than broad chemical classes. Further, EPA recently proposed increasing the MCLG for chloroform from zero to 300 μg/L, thereby recognizing threshold behavior for carcinogens. These differences provide emphasis to regulating individual DBPs.

Implications: Low MCLs for species such as bromodichloromethane could preclude the use of chlorine for primary disinfection in waters containing measurable amounts of bromide. Membrane filtration, which requires some inactivation of virus, would require an alternative disinfectant to chlorine (e.g., ozone). Enhanced coagulation would be of marginal benefit. GAC would still be relevant though it would need to be evaluated in light of the proposed levels.

4.4.4 DBPs Other Than THMs and HAAs Are Regulated

Plausibility: While there are a variety of DBPs, resources for health effects research are currently directed on the brominated analogues of the haloacids and trihalomethanes, not new compounds. Regulations for DBPs such as chloral hydrate, chloropicrin, haloketones or halocetonitriles are not anticipated.

Implications: It is not possible to evaluate the impacts of what appear to be less plausible regulatory outcomes, based upon the likelihood of health effects data supporting such regulation. In general, the more DBPs that are regulated, the greater the constraints on treatment technology and source water quality.

4.4.5 Regulating for a Minimum Total Risk; the "Risk Bubble"

Plausibility: Each technology results in a different mixture of DBPs in terms of relative concentrations. An individual MCL approach does not recognize this and does not allow for DBP - DBP tradeoffs. For example, chlorine will produce greater concentration of chlorinated, brominated and mixed bromo-chloro organics than ozone. Ozone, however, will produce more bromate and oxygenated compounds (e.g., aldehydes, ketones, carboxylic acids). In order to determine the lowest risk associated with the treatment options, it has been argued that a more comprehensive approach is needed, one that considers the wide array of by-products produced, not simply focused on THMs or HAAs. To this end, various approaches have been proposed and have recently been re-discussed in the stakeholder meetings. It has also emerged as part of the comparative risk framework currently being considered by EPA.

Implications: A mixtures approach may allow for greater flexibility in technology choice.

4.4.6 Implication of a Reproductive Endpoint

Plausibility: As there are some indications that reproductive health effects are associated with certain DBPs and that the exposures of interest (e.g., spontaneous abortion) are short-term rather than long-term (i.e., cancer). The current practice of running annual averages of quarterly samples for calculating compliance may not be appropriate. More frequent monitoring and enforcing of maximum levels could be required. Individual MCLs may also be prompted.

Implication: Going from running averages to maximum acute levels may decrease the range and variability of source water quality permissible. This would provide greater restrictions on the ability of all unit processes to meet water quality requirements and would lower the allowable TOC and bromide concentrations, and the allowable variability, depending upon the maximum values established.

4.4.7 Summary of Alternative Regulatory Scenarios

As with the wide array of issues being addressed as part of the overall Delta process, there is no single 'best' solution in formulation of future drinking water regulations -- there are a variety of trade-offs which need to be considered. It will be important that CUWA continue to keep these issues before the negotiated rulemaking committee.

4.5 SUMMARY

4.5.1 Summary of Source Water Quality Constraints

Table 4.4 summarizes projected source water quality requirements for TOC and bromide, depending upon the technology applied. In reviewing the values presented in this table, it is evident that there are various water quality constraints for TOC and bromide depending upon the technology used, the DBP concentrations allowed, and the level of microbiological inactivation required. As stated previously, which technology is implemented is agency-specific, and is dependent upon a host of constraints related to cost, permitting issues and residual disposal.

TABLE 4.4

SUMMARY OF SOURCE WATER QUALITY CONSTRAINTS [1]

TREATMENT SCENARIO/ DISINFECTION STRATEGY		MICROBIAL INACTIVATION REQUIRED					
		1 Log *Giardia* Inactivation		2 Log *Giardia* Inactivation		1 Log *Cryptosporidium* Inactivation [2]	
		TOC (mg/L)	Bromide (μg/L)	TOC (mg/L)	Bromide (μg/L)	TOC (mg/L)	Bromide (μg/L)
Potential Near-Term Regulatory Scenario							
Enhanced coagulation with free chlorine/chloramines		<7	<150-200	<7	<50-100		
		<6	<200	<6	<150		
		<5	<300	<5	<200		
				<4	<300		
Ozonation with Chloramines	at pH 7.8	N/E[3]	<50	N/E[3]	N/A[4]		
	at pH 6.5	N/E[3]	<500	N/E[3]	<300		
Potential Long-Term Regulatory Scenario							
Enhanced coagulation with free chlorine/chloramines		<3.0	<150	<3.0	<50	N/A[5]	N/A[5]
Ozonation with chloramines	at pH 7.8	N/E[3]	N/A[4]	N/E[3]	N/A[4]	N/E[3]	N/A[4]
	at pH 6.5	N/E[3]	<200	N/E[3]	<100 to 150	N/E[3]	<50
Granular Activated Carbon (GAC)		<5	<150	<5	<50	N/A[5]	N/A[5]
GAC With Ozone at pH 6.5		N/E [3]	<200	N/E[3]	<100-150	N/E[3]	<50
Membrane Treatment	MF with Ozone	N/E[3]	<150	N/E[3]	<150	N/E[3]	<150
	UF with Ozone	N/E[3]	<300	N/E[3]	<300	N/E[3]	<300
	Nanofiltration	<10 mg/L	<300	<10 mg/L	<300	<10 mg/L	<300

Notes:

1. Source water quality constraints are based upon achieving: 80 μg/L of TTHM, 60 μg/L of HAA5, and 10 μg/L of bromate for Stage 1 and 40 μg/L of TTHM, 30 μg/L of HAA5, and 5 μg/L of bromate for Stage 2, using the treatment and disinfection conditions presented in Chapter 3.
2. 1 log *Cryptosporidium* inactivation is not a part of the potential near-term regulatory scenario.
3. N/E = Not estimated. Limiting TOC concentrations were not estimated because of the availability and robustness of the data illustrating the impact of TOC on bromate formation, in the presence of bromide. It should be recognized, however, that higher TOC concentrations translate to higher ozone dosages to meet a given disinfection criterion and thereby can result in higher bromate formation. It is important to note that when ozone disinfection is used for treatment, the allowable TOC is not unlimited. There are concerns regarding the ability of biological filters or GAC to remove BDOC to adequate levels as TOC approaches 7 mg/L (the 90th percentile for water diverted from the Delta). In general, ozone disinfection is more effective and reliable as TOC decreases.
4. N/A = Not achievable. Bromide concentrations would have to be considerably less than 50 μg/L to achieve a bromate concentration of 5 or 10 μg/L. Data to determine the necessary bromide concentration relevant to this study were not available.
5. N/A = Not achievable. At this time, it is considered that free chlorine can not inactivate *Cryptosporidium* at dosages practical in water treatment.

4.5.2 Summary of Compliance Choices

Instead of presenting the data in a table which summarizes the allowable TOC and bromide concentrations as a function of different treatment processes for a given regulatory scenario, it is often helpful to graphically illustrate the technology that can be implemented, as a function of source water TOC and bromide, for a given regulatory scenario. That is, illustrate the area in which a given technology will allow compliance with a regulatory outcome, using a two-dimensional graphic illustrating bromide on the X-axis and TOC on the Y-axis. Therefore, the applicability of technologies in a given regulatory scenario as TOC or bromide increase can be visualized. A comparison of relationships for different regulatory scenarios illustrates how this "compliance forecast" changes when regulations change. It is important to note that the boundaries between technologies are not hard lines, but rather "transitional" regions. The absolute water quality boundaries which trigger the need for a different technology are extremely utility specific, and also are variable within a utility, itself, as criteria which effect technology selection other than water quality change.

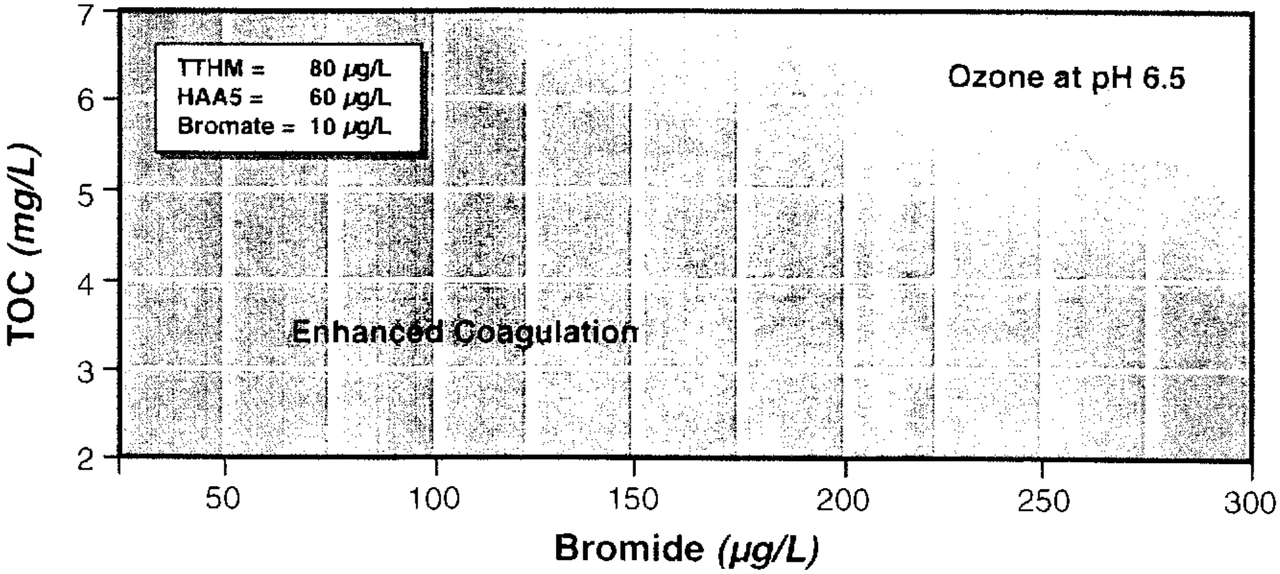
Figure 4.2 illustrates the compliance forecast for the Stage 1 D/DBP Rule and IESWTR, for 1 and 2 log inactivations of *Giardia*. This figure illustrates that enhanced coagulation and ozone treatment can be used to meet the requirements up to TOC and bromide concentrations of 7 mg/L and 300 μg/L, respectively. In this figure, the colored area represents the region in which it is feasible to use the associated technology for combinations of TOC and bromide. For example, the yellow area describes the region in which ozone at pH 6.5 would be used for specific combinations of TOC and bromide, as opposed to enhanced coagulation. The gradual transition, and region of uncertainty, for combinations of TOC and bromide which require different technologies are also illustrated. The regulatory allowance to provide prechlorination with enhanced coagulation, which increases DBP production, has the impact of reducing the feasible region for enhanced coagulation. Which technology is selected in this transition zone is highly utility specific.

Figure 4.3 illustrates the compliance forecast for the potential Stage 2 D/DBP Rule and LT2ESWTR, for inactivations of 1 log *Giardia*, 2 log *Giardia*, and 1 log *Cryptosporidium*. In this figure, regions of technology application for enhanced coagulation, GAC, ozone and membranes (recall that the maximum bromide concentration for

Figure 4.2

Compliance Forecast for Stage 1 D/DBP Rule

1 Log Giardia Inactivation



2 Log Giardia Inactivation

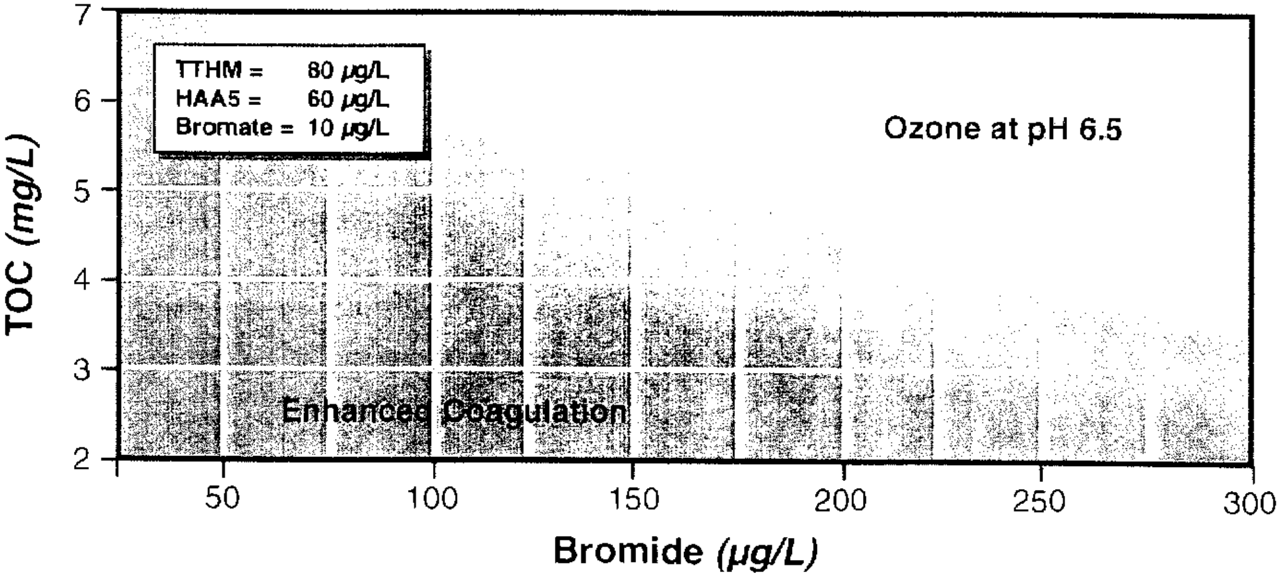
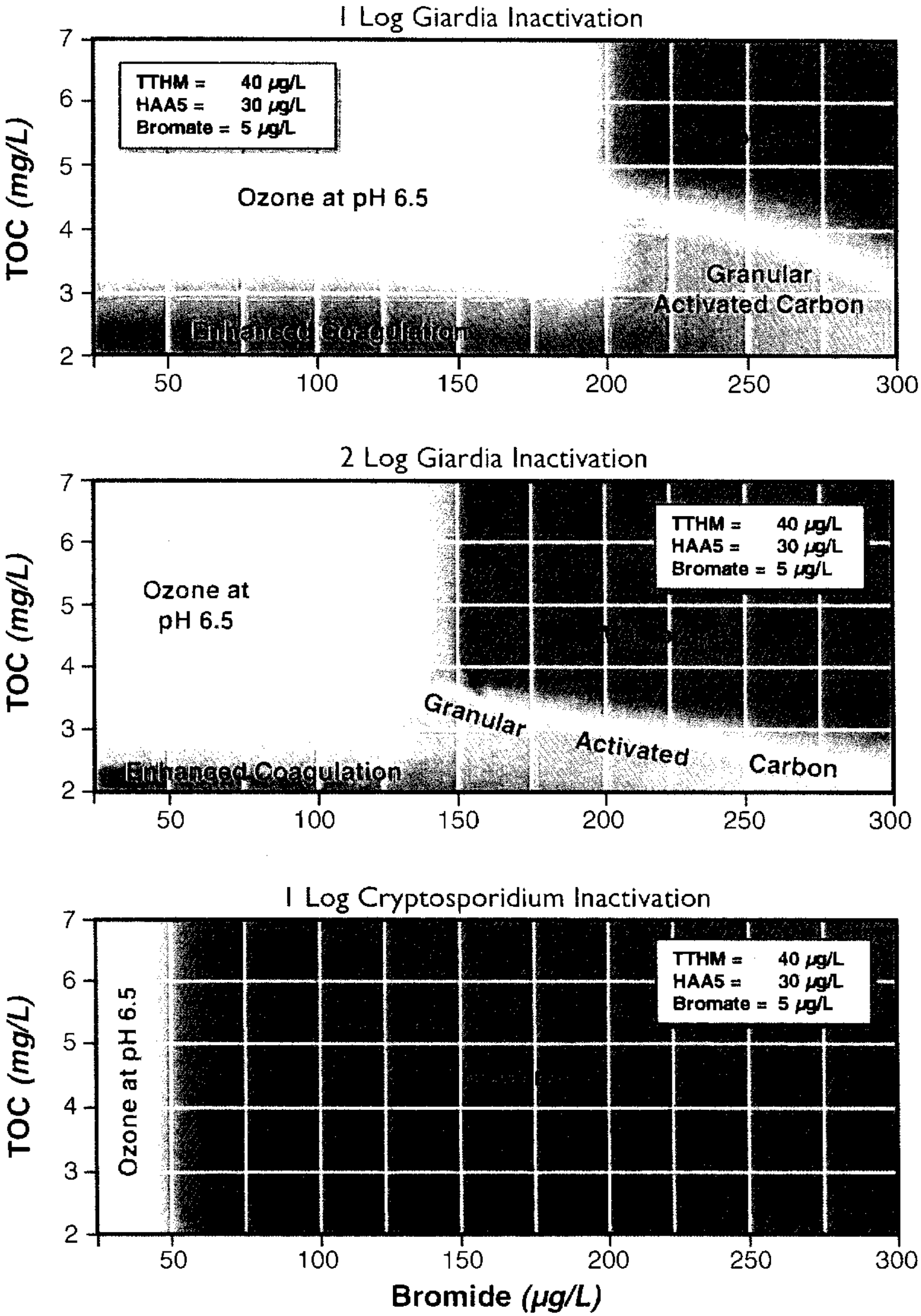


Figure 4.3

Compliance Forecast for Stage 2 D/DBP Rule



microfiltration coupled with ozone is 150 μg/L) are illustrated. Individual systems may determine that other water quality benefits merit the use of more expensive technologies for certain water quality regions that are shown with less expensive technologies (e.g., ozone as opposed to enhanced coagulation; membranes as opposed to GAC). The figure was prepared to show "least cost" technology application, based upon the range of conceptual costs presented in Section 3.3. It is important to note that the region of feasibility for membranes in Figure 4.3 does not differentiate among MF/UF or NF/RO membranes. In general, only MF is somewhat limited for bromide when using ozone for virus inactivation. Table 4.4 summarizes these source water bromide limitations for MF.

It is evident that as the level of microbial inactivation increases, the technologies which may be used to meet the applicable regulation decreases. Of particular interest is that for a Stage 2 D/DBP Rule and LT2ESWTR which requires 1 log inactivation of *Cryptosporidium*, membrane technology plays a significant role in compliance choices.

As stated in Chapter 3, it is recognized that the above source water quality constraints are based upon the design criteria proposed, such as ozone:TOC dose ratios, ozone contact time, and single, multi-chamber contactor configuration. Other facility configurations, such as two-stage ozonation (e.g., ozone added at raw and settled water) and longer ozone contact times may yield different, and possibly more liberal, source water quality constraints. The source water quality constraints presented here are based upon typical ozone system designs throughout the country.

4.5.3 Concluding Remarks

The expert panel is aware of the significance of bromate in establishing limiting bromide levels in this evaluation. There are many factors that contribute to the uncertainty surrounding the projected numbers, including relatively few studies which have evaluated bromate formation in low bromide waters (< 50 μg/L), variations in treatment conditions which may reduce bromate formation (e.g., using both pre- and post-ozonation to reduce ozone dosages at any single location), and potentially lower CT values for ozone. It is the selected level of 5 μg/L in the long-term regulatory scenario, however, that most keenly influences the analysis. The rationale for this level (i.e., advances in detection limit, the weight of the carcinogenic evidence, the precedence for THM and HAA5 limits in Stage 2 at half the Stage 1 levels) in this analysis may be modified by a variety of factors including:

- A bromate versus brominated organic compound trade-off (i.e., addressing the difference between DBPs formed with ozone versus those formed with chlorine).
- Evidence of a cancer threshold for bromate (investigations underway).

On the other hand, there are other potential regulatory outcomes involving 1) further lowering the MCLs for DBPs, 2) the regulation of individual DBP species (rather than the groups of compounds represented by TTHM and HAA5 due to the potentially more severe health effects associated with brominated compounds), 3) regulating other DBPs beyond TTHMs and HAA5, including the addition of other HAAs (there are nine total) as analytical methods are developed and refined, 4) a comparative risk framework which balances all of the risk attributable to the DBPs formed, rather than providing specific MCLs for each group, and 5) concerns over reproductive and developmental effects that may be associated with DBPs, which may lower the regulatory levels and/or the permissible maximum concentration (i.e., annual averaging may no longer be the basis for determining compliance).

Given this understanding, if flexibility were provided to all agencies to implement either enhanced coagulation or ozone to meet the potential long-term regulatory scenario, then it is projected that a TOC of < 3.0 mg/L and a bromide of < 50 μg/L in water diverted from the Delta would be necessary. The TOC value is constrained by the formation of total trihalomethanes when using enhanced coagulation for TOC removal and free chlorine to inactivate *Giardia*. The bromide value is constrained by the formation of bromate when using ozone to inactivate *Cryptosporidium*. Looking only at the potential near-term regulatory scenario provides significantly more flexibility, with source water TOC concentrations ranging between 4 and 7 mg/L (the 90^{th} percentile value in water diverted from the Delta) and bromide ranging between 50-100 and 300 μg/L, depending upon the extent of *Giardia* inactivation required (the near-term scenario does not include *Cryptosporidium* inactivation).

Similarly, the use of either GAC or membrane treatment in the long-term regulatory scenario broadens the allowable source water quality. For GAC, a source water TOC value of 5 mg/L is acceptable with bromide ranging between 50 and 150 μg/L, depending upon *Giardia* inactivation.

If *Cryptosporidium* inactivation is required, however, ozone must be coupled with GAC. This allows the source water TOC concentration to increase to at least 7 mg/L (the 90th percentile value for waters diverted from the Delta), although bromide is constrained to < 50 μg/L even at an ozone pH of 6.5.

The use of microfiltration or ultrafiltration, coupled with ozone for primary disinfection and chloramines for secondary disinfection, is an "absolute barrier" for protozoan (*Giardia* and *Cryptosporidium*) removal. Viruses, however, must still be inactivated. This treatment scheme allows source water TOC concentrations to increase to at least 7 mg/L. The bromide concentration is again limited by bromate formation under ozone addition for virus inactivation, and is < 150 μg/L microfiltration and < 300 μg/L for ultrafiltration (less virus inactivation is required for ultrafiltration). If nanofiltration is used with free chlorination, source water quality can range up to 10 mg/L for TOC for all bromide concentrations evaluated (< 300 μg/L).

It is important to note that when ozone disinfection is used for treatment, the allowable TOC is not unlimited. There are concerns regarding the ability of biological filters or GAC to remove BDOC to adequate levels as TOC approaches 7 mg/L (the 90th percentile for water diverted from the Delta). In general, ozone disinfection is more effective and reliable as TOC decreases.

Finally, the feasibility of implementing either GAC or membranes in California, given cost considerations, environmental permitting constraints, and limited residual disposal options, is uncertain.

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APPENDIX A
PREDICTIVE MODELS FOR DISINFECTION BY-PRODUCTS

A.1 THM PREDICTIVE EQUATIONS

Malcolm Pirnie, Inc. (1993) undertook a study on the formation of DBPs in chlorinated waters over a wide range of TOC and bromide concentrations for the Metropolitan Water District of Southern California. A 5 by 5 matrix of discrete samples containing incremental increases in TOC and bromide concentrations were prepared and evaluated. For this study, water was synthesized using low-TOC, low bromide Sacramento River water and high-TOC agricultural drainage water. High-bromide concentrations were achieved by adding sodium bromide.

The database used in this study, consisting of more than 900 observations, was constructed based upon the results of the source water quality monitoring program and the chlorination experiments from the 5 by 5 matrix. One portion of the database represented THM formation in jar-treated waters and another portion represented THM formation in 0.45 μm membrane filtered raw water.

Three sets of THM predictive equations were developed during this study using a non-linear power function format including total organic carbon (TOC), ultraviolet absorbance at 254 nm (UV-254), chlorine dose, bromide concentration, reaction time, temperature and pH as independent variables. The final TTHM predictive equation was based upon a portion of the database representing THM formation in 0.45 μm membrane filtered raw water (approximately 650 observations). Predictive capabilities of this equation were compared with THM formation in the jar-treated water (approximately 250 observations). The final TTHM equation developed was:

$$\begin{aligned} TTHM = \quad & 7.21\ TOC^{0.004}\ UV254^{0.534}\ (ClDOSE\text{-}7.6{*}NH_3\text{-}N)^{0.224}\ TIME^{0.255} \\ & (Br+1)^{2.01} \\ & (pH-2.6)^{0.719}\ TEMP^{0.480} \end{aligned}$$

$[r^2 = 0.96, F = 2010, p < 0.001]$

This equation was developed at TOC concentrations ranging between 1.1 and 7.6 mg/L, bromide between 10 and 800 μg/L, contact times between 1 and 48 hours, and chlorine doses between 1.0 and 16.4 mg/L. The values for UV-254 to be input into the TTHM equation were predicted using a relationship between TOC and UV-254 developed in the study as follows:

$$\text{UV-254} = -0.0224 + (0.0374)(\text{TOC})$$
$$(r^2 = 0.92)$$

Using free chlorine as a disinfectant, a chlorine-to-TOC ratio of 1:1 and contact times of 1 and 2 hours were projected to yield 1 and 2 log *Giardia* inactivation, respectively. A temperature of 20 ° C and pH of 7 was also input to this equation to yield the values in Table 4.1 in the body of this report.

A.2 BROMATE PREDICTIVE EQUATION

The bromate model of Ozekin and Amy (Ozekin, 1994) was utilized to systematically evaluate the impact of ozone dose, bromide, DOC and pH on the formation of bromate. The model was developed from data from several source waters including waters diverted from the Delta. Source water bromide concentrations ranged between 70 and 440 μg/L with bromate concentrations ranging between 2 and 314 μg/L.

The model used has the following form:

$$BrO_3 = 1.63 \times 10^{-6}\, DOC^{-1.26}\, pH^{5.82}\, (O_3\ \text{dose})^{1.57}\, Br^{0.73}\, \text{time}^{0.28}$$

A contact time of 12 minutes was chosen and the concentrations of DOC, bromide, ozone dose and pH were varied over a representative range as input to the above equation. Temperature was held constant at 20 ° C.

It is important to note that the model was only used to support conclusions reached by the expert panel prior to using the model. The bromate model was evaluated to investigate threshold behavior regarding formation at specific levels and to support the initial conclusions reached by the expert panel. The results of the modeling should not be overemphasized. The results of the modeling supported the initial conclusions reached by the Panel based upon the available literature and review of the CUWA data.

APPENDIX B

CUWA MEMBER TREATMENT DATA

Data was provided by the CUWA members, including those resulting from the operation of their treatment facilities as well as bench and pilot studies. There are variations in these data which are unique to each treatment system. For example, some systems supplied data representing ozonation of only raw water, while others supplied data with both pre- and post-ozonation. The expert panel recognizes that there are unique aspects of process operation which can affect the ultimate formation of DBPs. For this study, however, the expert panel defined "unifying criteria" in Chapter 3 for enhanced coagulation and ozone which allow a comparison of these processes and a systematic method by which to evaluate the impact of water quality constraints on DBP formation. This appendix contains the data supplied by the CUWA members.

Utility ID: *ACWD* (ACWD, CCWD, EBMUD, MWD, SCVWD)

1. Study ID: (Optimization Study 9/95, etc.)

2. Source water: (River, lake, groundwater, etc.)

3. Source water ID: (State Project water, blend of...., etc.)

5. Describe level of study: (Indicate with an "X")
- Bench-scale
- Pilot-scale
- Full-scale

In this data sheet, "Filt." refers to data collected after coagulation, flocculation, sedimentation, and filtration.

6. Indicate with an "X" if data reported as "Filt." are from samples collected after sedimentation only:
or after sedimentation and filtration:

WATER QUALITY DATA: CONVENTIONAL

Date	Time	TOC (mg/L)		UV-254 (1/cm)		Bromide (µg/L)		Turbidity (NTU)		Temperature (deg. C)		Disinfection By-products					
												TTHM (µg/L)		HAA5 (µg/L)		HAA6 (µg/L)	
		Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.
5/30/95		4.3	2.7					16.2		66.4							
6/6/95		4.3	2.0			40.0		29.0		65.9			28.9				
6/13/95		3.6	1.8			42.0		14.1		67.3			40.2				
6/20/95		3.5	1.9			60.0		15.6		66.3			44.0		48.0		
6/27/95		3.8	2.0			80.0		13.4		76.7			49.6				
7/4/95		4.2	2.3					17.4		73.3			45.2				
7/11/95		4.1	2.1			68.0		23.0		72.3			43.0				
7/18/95		3.8	1.9			50.0		19.5		73.5			45.9				
7/25/95			2.4			72.0		21.2		72.6			48.0				
8/1/95		4.1	2.2			65.0		13.3		78.3			48.0				
8/8/95		3.6	1.9			60.0		11.5		76.2			49.8				
8/15/95		3.1	2.0			60.0		11.4		77.0			58.9				
8/22/95		3.2	2.2			55.0		10.6		75.6			58.9				
8/29/95						50.0		11.5		71.2							
9/5/95		3.4	2.0			81.0	<20	12.5		70.5			61.1		37.0		44.0
9/12/95		4.1	3.3			42.0	12.0	2.3		68.9			66.9				
9/19/95		4.0	3.2			50.0	<20	2.2		68.4			85.9		58.0		65.0
9/26/95		4.0	2.8			53.0	10.0	8.3		67.9							
10/3/95		4.1	2.8			49.0	17.0	5.0		64.1			55.4		43.0		49.0
10/10/95		4.3	3.0			44.0	<40	4.4		62.6			72.0				
10/17/95		4.2				43.0		6.6		63.0							
10/24/95		3.9	2.8			47.0	14.0	4.3		61.9							
10/31/95		3.8	2.5			45.0	12.0	6.5		61.7			58.6		35.0		40.0
11/7/95		3.8	2.6	0.19	0.07	47.0	13.0	5.3		59.9			72.1				
11/14/95		4.3	3.1	0.18		39.0	12.0								46.0		52.0
11/21/95		3.4	3.3	0.19	0.10	42.0	16.0										
11/28/95				0.14	0.10	86.0	18.0						55.5		23.0		28.0
12/5/95		4.4	3.4	0.13	0.09			1.6		58.5			73.1				
12/12/95		4.6	4.0	0.12	0.08	39.0	<20	2.2		58.0					56.0		62.0
12/19/95		4.7	3.7	0.14	0.10	38.0	<20	3.9		55.8			73.3				
12/26/95		3.1	2.0	0.12	0.09	97.0	24.0	7.6		52.5					31.0		38.0
1/2/96		3.3	2.1	0.13	0.09	150	36.0	3.6		53.8			64.6				
1/9/96		6.4	3.7	0.24	0.10	110	31.0	4.8		52.7			75.2		54.0		63.0
1/16/96		6.4	3.5	0.27	0.11	87	24.0	4.0		51.4			80.0				
1/23/96		3.0	2.4	0.18	0.16			9.3		50.7							
1/30/96		3.5	3.2	0.20	0.10			20.0		51.4			77.8				
2/6/96		5.6	3.6	0.20	0.11								75.0				
2/13/96		5.6	3.6	0.17	0.08								76.1				
2/20/96		5.8	3.6	0.13	0.31								86.0				
2/27/96		5.8	3.0	0.20	0.11								72.8				
3/5/96		0.0	3.1	0.22	0.09		14.0						80.7		54.0		57.0
3/12/96		5.6	3.1	0.21	0.10		<20										
3/19/96		5.5	3.4	0.22	0.10		<20						61.3		49.0		62.0
3/26/96		5.3	3.1	0.21	0.09		14.0						81.3				
4/2/96				0.20	0.08								57.2		31.0		38.0
4/9/96				0.21	0.08								94.7				
4/16/96		4.4	3.0	0.20	0.10		<10.0								59.0		68.0
4/23/96		4.2	2.8	0.21	0.09		29.0						71.4				
4/30/96			2.4		0.09		34.0						76.7		41.0		52.0
5/7/96		3.7	2.6	0.20	0.09		41.0						73.3				
5/14/96		3.6	2.8	0.21	0.09		45.0						85.0		43.0		55.0
5/21/96					0.09												
5/28/96		3.8	2.1	0.22			20.4						52.3		34.0		41.0
6/4/96		3.6	2.3	0.22	0.08		24.6						70.4				
6/11/96			1.9		0.08		17.2						80.1		38.0		43.0
6/18/96			1.8	0.19	0.08		10.6						53.9				
6/25/96			1.9		0.08		25.2						43.9				
7/2/96		3.2	2.0				20.4						64.8				
7/9/96							13.7										

preozone

Utility ID:		ACWD	(ACWD, CCWD, EBMUD, MWD, SCVWD)
1. Study ID:		Routine Monitoring	(Optimization Study 8/95, etc.)
2. Source water:		River	(River, lake, groundwater, etc.)
3. Source water ID:		South Bay Aqueduct	(State Project water, blend of...., etc.)

4. If blended source water indicate sources and proportions:

Source	%

5. Describe level of study:		Bench-scale	In this data sheet, "Filt." refers to data collected
(Indicate with an "X")		Pilot-scale	after coagulation, flocculation, sedimentation, and
	X	Full-scale	filtration.

6. Indicate with an "X" if data reported as "Filt." are from samples collected after sedimentation only:
or after sedimentation and filtration:

WATER QUALITY DATA: PRE-OZONE

Date	Time	TOC (mg/L)			UV-254 (1/cm)			Alkalinity (mg/L as CaCO3)			Hardness (mg/L as CaCO3)						Bromide (ug/L)			Chloride (mg Cl-/L)			Turbidity (NTU)		
		Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Total			Calcium			Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.
											Raw	Ozon.	Filt.	Raw	Ozon.	Filt.									
1/3/95		5.8	5.4	3.4				82		84	132									108.0			8.77		0.05
1/10/95		5.6		2.9				74		80	104									70.0			30.00		0.06
1/17/95		5.9	5.7	3.3				139		136	162						100.0			41.0			68.80		0.04
1/24/95		5.9	5.9	3.6				140		162	168						80.0			33.0			60.70		0.05
1/31/95		6.0	6.4	3.5				170		158	154						70.0			25.0			56.00		0.04
2/7/95		5.6	5.6	3.3				152		92	180									26.0			36.50		0.04
2/14/95		5.7	5.4	3.4				158		160	140						71.0			61.0			29.70		0.05
2/21/95		5.8	5.3	3.6				152		168	142						72.0			40.0			24.30		0.05
2/28/95		5.6	5.4	3.7				158		180	144						56.0			42.0			10.80		0.03
3/7/95		5.8	5.4	3.7				122		120	138						83.0			61.0			6.20		0.05
3/14/95		6.1	5.8	3.1				110		126	144						50.0			34.0			17.10		0.06
3/21/95		5.8	5.1	3.2				102		98	120						90.0			45.0			21.20		0.06
3/28/95		6.1	6.3	3.2				128		130	136						40.0			41.0			61.50		0.06
4/4/95			5.4	3.3				94		94	110						170.0			90.0			9.00		0.06
4/11/95		5.9	5.7	3.7				96		112	120						200.0			75.0			17.00		0.04
4/18/95		5.6	6.3	3.2				106		112	128						110.0			41.0			16.80		0.04
4/25/95		5.8	5.7	3.4				90		94	140						120.0			82.0			12.17		0.06
5/2/95		5.3	5.1	3.2				112		106	128						87.0			144.0			10.78		0.03
5/9/95		5.1	5.0	2.8				78		88	108						90.0			47.0			8.68		0.04
5/16/95		4.7	4.3	2.4				70		72	88						60.0			34.0			11.23		0.05
5/23/95		5.0	4.7	2.2				64		72	80						40.0			35.0			23.00		0.04
5/30/95		4.3	3.8	1.9				56		58	62									30.0			15.95		0.06
6/6/95		4.8	4.4	1.8				44		44	62						40.0			24.0			28.67		0.04
6/13/95		3.9	3.4	1.6				44		44	50						42.0			26.0			13.17		0.03
6/20/95		3.7	3.3	1.8				38		46	56						60.0			60.0			14.93		0.06
6/27/95		3.9	3.7	1.8				48		52	66						80.0			58.0			14.10		0.06
7/4/95		4.0	2.7	1.9				42		50	56									40.0			16.47		0.02
7/11/95		3.7	3.2	1.6				44		48	60						64.0			28.0			20.62		0.04
7/18/95		3.6	2.4	1.5				40		44	47						50.0			25.0			17.78		0.04
7/25/95		4.0	3.1	1.9				45		53	56						72.0			19.0			18.32		0.05
8/1/95		4.6	2.6	1.8				49		51	54						65.0			18.0			14.20		0.06
8/8/95				1.5				50		52	48						60.0			26.0			12.73		0.07
8/15/95		3.2	1.3	1.5				48		50	52						60.0			25.0			12.13		0.05
8/22/95		3.1	1.8	1.6				54		59	60						55.0			47.0			10.67		0.06
8/29/95		3.1	2.6	1.4				55		61	54						50.0			23.0			10.62		0.05
9/5/95		3.7	3.6	1.5				58		66	60						61.0	<5	<20	25.0			12.37		0.06
9/12/95		4.4	2.2	2.3				106		132	127						42.0		<40	28.0			1.94		0.05
9/19/95		4.5	2.7	2.1				112		128	114						50.0		<20	31.0			1.88		0.06
9/26/95		4.2	4.2	2.3				96		106	100						53.0		<20	30.0			8.40		0.06
10/3/95		4.1	4.4	2.4				89		94	110						48.0		<40	52.0			4.91		0.07
10/10/95		4.5	3.7	2.8				103		108	104						44.0		<40	38.0			3.88		0.06
10/17/95		4.2	3.1	2.5				102		109	111						43.0		<20	129.0			6.65		0.06
10/24/95		3.9	3.7	2.3				94		104	102						47.0		12.0	18.0			3.77		0.07
10/31/95			2.9	2.1				96		94	96						46.0		<20	21.0			4.36		0.07
11/7/95			2.6	2.2			0.09	88		92	98						47.0		<20	20.0			4.70		0.07
11/14/95		4.2	2.6	2.5			0.07	114		120	130						39.0		10.0	5.0			3.15		0.06
11/21/95		4.4	3.2	2.8			0.07	106		124	124						42.0		<20	12.0			2.83		0.07
11/28/95							0.09	54		58	86						86.0		<20	37.0			8.81		0.08
12/12/95		4.6	4.3	3.3			0.07	156		168	172						39.0		<20	14.0			2.64		0.06
12/19/95		4.8	3.7	3.3			0.07	137		141	160						38.0		<20	13.0			4.22		0.06
12/26/95		3.3	3.3	1.7			0.06	84		90	90						97.0		<20	26.0			5.85		0.06
1/2/96		3.4	4.0	1.9			0.07	66		70	82						150.0		<20	50.0			4.83		0.07
1/9/96		6.4	4.6	2.9			0.07	79		82	104						110.0		47.0	44.0			5.37		0.07
1/16/96		6.2	4.0	2.8			0.13	72		90	140						87.0		<20	50.0			4.48		0.07
1/23/96		5.8	6.6	3.5			0.06	76		89	82									40.0			10.10		0.06
1/30/96		5.8	4.3	2.7			0.07	110		122	130									28.0			21.00		0.06
2/6/96		5.8	3.3	3.4			0.08	147		153	160									21.0			13.70		0.07
2/13/96		5.4	3.8	3.4			0.03	80		92	168									11.0			13.00		0.06
3/12/96		5.5	5.0	3.0			0.09	88		96	134						21.0		<20	10.0			33.20		0.06
3/19/96		5.4	5.2	2.8			0.10	96		100	142						17.0		<20	14.0			17.10		0.07
3/26/96		5.2	4.8	2.6			0.06	88		89	122						41.0		<20	13.0			14.00		0.07
4/2/96		3.3	3.2				0.09	54		59	74						94.0		<20	37.0			16.20		0.05
4/9/96		3.6	3.7	2.2			0.09	58		62	96									54.0			5.90		0.06
4/16/96		4.0	3.7	2.4			0.10	62		68	102						95.0		11.0	30.0			5.70		0.07
4/23/96		4.0	4.1	2.2			0.09	70		76	100						110.0		<10	54.0			7.00		0.06
4/30/96		3.7	3.9	1.9			0.09	60		54	98						120.0		<10.0	60.0			13.60		0.06
5/7/96		3.7	3.7	1.9			0.09	50		52	90						140.0		27.0	60.0			7.30		0.05
5/14/96		3.7	3.6	1.9			0.09	42		51	84						130.0		<20	61.0			7.10		0.06
5/21/96								52		55	102									46.0			5.90		0.07
5/28/96		3.8	3.0	1.7			0.09	68		64	106						79.0		<1	28.0			21.70		0.08
6/4/96		3.5	3.4	1.8			0.08	50		54	76						75.2		<1	18.0			15.80		0.07
6/11/96		3.4	3.3	1.5			0.09	54		66	56						56.0		<3	81.0			19.60		0.07
6/18/96		3.8	3.7	1.6			0.06	58		73	82						58.6		<3	32.0			39.00		0.07
6/25/96		3.2	3.0	1.6				63		74	102						52.7		13.6	13.0			19.70		0.08

Utility ID:

1. Study ID:

2. Source w

3. Source w

5. Describe
(indicate w

6. Indicate

WATER QU

TREATMENT CONDITIONS

Date	pH ()			Temperature (deg. C)			Bromate (ug/L)			Disinfection By-products: TTHM (ug/L)			HAA5 (ug/L)			HAA6 (ug/L)			Ozonation Conditions: Ozone dose (mg/L)	Ozone residual (mg/L)	Contact time (min)	Ozone pH ()	Ozone temp. (deg. C)
	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.					
1/3/95	7.7		7.0	8.6								7.9			9			14	2.2	0.49		8.1	8.8
1/10/95	7.8		6.7	10.4								7.7						6	2.3	0.64		8.2	10.8
1/17/95	8.0		7.0	11.3								4.2			6			5	1.7	0.44		8.0	11.3
1/24/95	8.0		7.0	11.6								4.8						4	1.8	0.40		8.5	11.6
1/31/95	7.9		6.9	11.6								4.4						5	2.0	0.37		8.6	11.6
2/7/95	7.9		6.8	12.3								4.8						5	3.6	0.91		8.3	12.3
2/14/95	8.0		6.9	10.2								5.1			5			6	4.8	0.83		8.4	10.2
2/21/95	7.9		7.1	10.0								4.8						3	3.2	0.68		8.2	10.0
2/28/95	8.4		7.4	11.2								5.1			6			7	3.8	0.49		8.2	11.2
3/7/95	8.1		7.2	12.0														18	3.8	0.66		7.6	12.0
3/14/95	8.1		7.1	11.5								3.6			3			8	3.7	0.74		7.7	11.5
3/21/95	8.2		7.1	12.0					8.0			4.8						4	3.7	0.69		7.3	12.0
3/28/95	8.0		7.0	11.2								3.6			4			3	3.8	0.62		6.9	11.2
4/4/95	8.5		7.0	16.0					12.0			82.8						4	3.9	0.38		7.4	16.0
4/11/95	8.6		7.1	15.3								8.3			6			3	3.5	0.73		7.5	15.3
4/18/95	8.3		7.0	14.1					9.0			4.9						3	4.7	0.59		7.8	14.1
4/25/95	8.4		7.1	15.5					8.0			6.9						2	3.8	0.62		7.4	15.5
5/2/95	8.2		7.2	15.7								5.4							3.5	0.55		7.2	15.7
5/9/95	8.2		6.9	16.1								13.3							4.0	0.60		7.4	16.1
5/16/95	7.6		6.8	16.5								8.4							3.9	0.77		7.5	16.5
5/23/95	7.7		6.8	18.0								5.1							3.6	0.83		7.6	18.0
5/30/95	7.3		6.6	18.3								5.0							4.2	0.52		7.7	18.3
6/6/95	6.9		6.2	19.0								6.1							3.3	0.59		7.4	19.0
6/13/95	7.4		6.5	19.2								5.0							3.8	0.60		7.7	19.2
6/20/95	7.5		6.6	19.1					6.0			4.7			3				3.8	0.69		7.6	19.1
6/27/95	7.8		6.6	24.9					8.0			6.1							3.3	0.81		7.3	24.9
7/4/95	7.4		6.4	22.9					4.0			5.6							4.0	0.47		8.0	22.9
7/11/95	7.2		6.3	22.7								6.3			2				4.2	0.61		6.0	22.7
7/18/95	7.4		6.3	23.2					10.0			4.1							4.1	0.52		7.5	23.2
7/25/95	7.5		6.4	21.6					5.0			4.3			3				4.2	0.42		6.9	21.6
8/1/95	7.6		6.2	25.9					9.0			6.2							2.0	0.30		6.9	25.9
8/8/95	7.7		6.5	24.5					6.0			3.8			3				3.8	0.83		7.6	24.5
8/15/95	7.4		6.1	25.4					7.0			3.8							4.1	0.52		7.4	25.4
8/22/95	7.7		6.3	24.4					10.0						11				2.2	0.28		7.5	24.4
8/29/95	7.6		6.8	22.0					10.0													7.6	22.0
9/5/95	7.3		6.6	21.6				<5	11.0			3.3			10			14	2.2	0.94		7.7	21.6
9/12/95	8.0		6.9	19.4				8.0	15.0			32.8							4.1	1.20		7.6	19.4
9/19/95	8.0		7.0	21.1				21.0	14.0			13.8			4			6	6.5	0.65		8.1	21.1
9/26/95	7.5		6.8	18.9				<5	23.0										3.1	1.00		7.7	18.9
10/3/95	6.9		6.9	17.8				<5	6.0			6.1			4			5	2.7	0.82		7.8	17.8
10/10/95	6.9		6.9	16.8				<5	<5			5.8							2.6	0.78		7.7	16.8
10/17/95	7.6		6.9	17.1				8.0	<5										2.8	0.58		8.1	17.1
10/24/95	7.4		6.9	16.7				<5	<5										3.0	0.77		7.6	16.7
10/31/95	7.5		6.9	16.6				<5	<5			3.7			3			4	2.9	0.67		7.5	16.6
11/7/95	7.6		6.9	15.4				<5	<5			6.2							3.0	0.82		7.6	15.4
11/14/95	7.7		6.8	15.0				<5	<5						4			5	3.0	0.78		7.7	15.0
11/21/95	7.6		6.9	15.0				<5	<5										2.9	0.81		7.8	15.0
11/28/95	8.1		6.7	14.6				14.0	<5			3.8			4			5	3.5	0.68		7.8	14.6
12/12/95	7.7		7.0	14.6				<5							5			8	2.4	0.65		7.9	14.5
12/19/95	7.8		7.2	13.6				<5	<5			6.2							2.3	0.77		7.9	13.5
12/26/95	7.7		6.9	11.8				<5	<5						2			3	2.1	0.50		7.9	11.8
1/2/96	8.1		6.9	12.6				<5	6.0			4.6							2.1	0.48		7.7	12.6
1/9/96	7.5		6.6	11.2				<5	6.0			5.8			5			7	3.5	0.46		8.2	11.2
1/16/96	7.5		6.8	10.8				<5	<5			12.2							3.6	0.50		7.8	10.8
1/23/96	7.6		6.4	10.2					5.0										3.7	0.79		8.1	10.2
1/30/96	7.7		6.3	10.8								32.9							3.5	0.84		8.2	10.8
2/6/96	7.8		7.0	11.6								5.8							3.1	0.54		8.5	11.6
2/13/96	7.8		7.0	11.8								8.2							2.5	0.50		8.1	11.6
3/12/96	7.9		6.9	12.3				<5											4.1	0.86		8.3	12.3
3/19/96	7.9		7.0	12.7				<5	<5			8.7			5			6	3.0	0.66		7.5	12.7
3/26/96	7.9		6.8	13.2				<5	<5			5.4							4.1	0.61		7.6	13.2
4/2/96	7.7		6.4	15.3					<5			8.6			3			4	3.4	0.95		7.4	15.3
4/9/96	8.2		6.6	16.3					15.0			2.9							4.0	0.79		7.5	16.3
4/16/96	7.8		7.0	16.3				8.5							2			3	3.8	0.83		7.7	16.3
4/23/96	8.1		6.9	17.0				8.0	9.0			2.8							3.8	0.86			17.0
4/30/96	8.2		6.7	19.1				15.0	12.0			1.3			3			4	3.6	0.75			19.1
5/7/96	8.5		6.9	19.3				16.5	14.0			2.6							3.8	0.54			19.3
5/14/96	8.1		6.8	19.8				13.5	25.0			5.8			2			3	3.3	0.90			19.8
5/21/96	8.3		7.0	17.7					22.0										3.0	0.89			17.7
5/28/96	7.5		6.7	17.8				<4.5				3.1			2			3	2.7	0.61			17.8
6/4/96	7.6		6.4	24.0				12.57	<4.5			2.3							2.8	0.54			24.0
6/11/96	7.4		6.5	22.6				<4.5	<4.5			2.4			1			2	2.5	0.31			22.6
6/18/96	7.5		6.7	21.4				<4.5	<4.5			2.6							2.8	0.35			21.4
6/25/96	7.7		7.0	20.7				<4.5	<4.5			1.6							2.7	0.45			20.7

Utility ID: ACWD (ACWD, CCWD, EBMUD, MWD, SCVWD)

1. Study ID: Enh. Coagulation (from EC study data) (Optimization Study 9/95, etc.)

2. Source water: River (River, lake, groundwater, etc.)

3. Source water ID: South Bay Aqueduct (State Project water, blend of...., etc.)

5. Describe level of study: (indicate with an 'X')

	Bench-scale
	Pilot-scale
x	Full-scale

In this data sheet, "Filt." refers to data collected after coagulation, flocculation, sedimentation, and filtration.

6. Indicate with an 'X' if data reported as "Filt." are from samples collected after sedimentation only: x

or after sedimentation and filtration: x

WATER QUALITY DATA: CONVENTIONAL

Date	Time	TOC (mg/L)			Alkalinity (mg/L as CaCO3)		Hardness (mg/L as CaCO3)				Turbidity (NTU)		pH ()		Temperature (deg. C)	
		Raw	Filt.	Filt.	Raw	Filt.	Total		Calcium		Raw	Filt.	Raw	Filt.	Raw	Filt.
							Raw	Filt.	Raw	Filt.						
			(settled)	(filt)								(settled)				
		3.2	1.9		104		132				11.5	2.2	7.7		21.2	
		3.1	2.1		105		118				6.0167	1.1	8.1		20.3	
		3.7	2.8	2.4	112		120				4.65	1.7	7.6		17.3	
		4.0	2.7	2.8	127		150				2.1667	0.8	7.9		19.1	
		3.6	2.6	2.5	128		144				2.1167	2.3	7.9		19.9	
		5.8	4.0	3.4	152		142				24.333	6.9	7.9		10	
		5.6	4.2	3.7	158		144				11.933	4.4	8.4		11.1	
		5.8	4.1	3.7	127		134				8.2833	2.4	8.1		11.3	
		6.1	3.8	3.2	110		144				17.117	3.9	8.2		12.5	
		5.8	3.6	2.9	102		120				21.233	2.6	8.3		12.4	
		6.1	3.3		117		134				76.667	13.4	8		11.9	
		5.9	4.3	3.6	96		116				13.633	2.7	8.6		15	
		5.6	4.0	3.1	87		124				8.9667	2.6	8.7		14.6	
		5.8	4.2	3.5	98		118				11.55	3.4	8.5		15.5	
		5.3	3.7	3.4	105		126				10.783	3.3	8.3		15.7	
		5.1	3.7	2.8	78		108				8.6833	2.5	7.9		16.1	
		3.2	2.00		104		132				11.5	2.97	7.7		21.2	
		3.1	2.40		105		118				6.0167	1.53	8.1		20.3	
		3.7	3.10	2.40	112		120				4.65	1.88	7.6		17.3	
		4.0	2.80	2.80	127		150				2.1667	1.09	7.9		19.1	
		3.6	2.60	2.60	128		144				2.1167	1.00	7.9		19.9	
		5.8	3.70	3.40	152		142				24.333	3.02	7.9		10	
		5.6	4.20	3.50	158		144				11.933	2.98	8.4		11.1	
		5.8	4.10	3.50	127		134				8.2833	2.18	8.1		11.3	
		6.1	3.50	3.00	110		144				17.117	2.68	8.2		12.5	
		5.8	3.30	2.80	102		120				21.233	3.65	8.3		12.4	
		6.1	3.30		117		134				76.667	4.98	8		11.9	
		5.9	4.00	3.50	96		116				13.633	2.39	8.6		15	
		5.6	3.60	2.90	87		124				8.9667	2.18	8.7		14.6	
		5.8	3.70	3.10	98		118				11.55	2.92	8.5		15.5	
		5.3	3.50	3.20	105		126				10.783	2.30	8.3		15.7	
		5.1	3.40	2.70	78		108				8.6833	2.02	7.9		16.1	

indicate coagulants studied:

ID	Coagulant	Chemical formula	Units
1	Alum	$Al_2(SO_4)_3 \cdot 14\,H_2O$	mg/L
2	Ferric	$FeCl_3 \cdot 6\,H_2O$	mg/L
3			
4			

TREATMENT CONDITIONS

Cl2	Disinfection By-products				Coagulation Conditions					
Conditions	TTHM		HAA5		Coagulant	Dose	Acid	Base	Coag.	Coag.
Chlorine	(µg/L)		(µg/L)		ID		adjusted?	adjusted?	pH	temp.
dose	Raw	Filt.	Raw	Filt.	(see above)		(Y/N)	(Y/N)	()	(deg. C)
(mg Cl2/L)										
2.34		9		6	1	25.1				
2.40		8		6	1	11.8				
2.60		8		4	1	11.6				
2.35		9		5	1	12.8				
2.20		8		6	1	12.5				
1.43		5		5	1	28				
1.57		5		6	1	21.3				
1.49		5		5	1	16.8				
1.32		4		3	1	40				
1.10		5		4	1	31.1				
1.47		4		4	1	29.4				
1.47		8		6	1	24				
1.54		5		4	1	25				
1.60		7		7	1	23.1				
1.90		5		5	1	21.2				
2.00		13		4	1	21				
2.34		9.0		6.0	2	11.2				
2.40		7.6		6.0	2	11.1				
2.60		8.0		4.0	2	8.1				
2.35		8.7		5.0	2	15.9				
2.20		7.8		6.0	2	9.2				
1.43		4.8		5.0	2	16				
1.57		5.1		6.0	2	13.5				
1.49		5.0		5.0	2	10.2				
1.32		3.6		3.0	2	23.8				
1.10		4.8		4.0	2	13.6				
1.47		3.8		4.0	2	26.1				
1.47		8.3		6.0	2	16.7				
1.54		4.9		4.0	2	18.5				
1.60		6.9		7.0	2	18				
1.90		5.4		5.0	2	16.7				
2.00		13.3		4.0	2	18				

Utility ID: CCWD: Bollman WTP (ACWD, CCWD, EBMUD, MWD, SCVWD)

1. Study ID: Historical data 7/1/95-6/30/96 (Optimization Study 9/95, etc.)

2. Source water: Delta - Mallard Slough/Rock Slough (River, lake, groundwater, etc.)

3. Source water ID: Central Valley Project Water (State Project water, blend of...., etc.)

4. If blended source water indicate sources and proportions:

Source	%

5. Describe level of study: (indicate with an 'X')

- Bench-scale
- Pilot-scale
- X Full-scale

In this data sheet, "Filt." refers to data collected after coagulation, flocculation, sedimentation, and filtration.

6. Indicate with an 'X' if data reported as "Filt." are from samples collected after sedimentation only:
or after sedimentation and filtration: X

WATER QUALITY DATA: CONVENTIONAL

Date	Time	TOC (mg/L) Raw	TOC (mg/L) Filt.	UV-254 (1/cm) Raw	UV-254 (1/cm) Filt.	Alkalinity (mg/L as CaCO3) Raw	Alkalinity (mg/L as CaCO3) Filt.	Hardness (mg/L as CaCO3) Total Raw	Hardness Total Filt.	Hardness Calcium Raw	Hardness Calcium Filt.	Bromide (mg/L) Raw	Bromide Filt.	Ammonia (mg NH3-N/L) Raw	Ammonia Filt.	Chloride (mg Cl-/L) Raw	Chloride Filt.	TDS (mg/L) Raw	TDS Filt.	Turbidity (NTU) Raw	Turbidity Filt.	pH () Raw	pH Filt.
Jul-95						43.9	44.4	47.8	47.9			<0.1	<0.1	<0.1	0.32	21.3	21.3	90	120	3	0.05	7.8	8.8
Aug-95						42.3	42	47.1	46.6				<0.1			20.3	21.3		115	2.4	0.05	8.1	8.9
Sep-95						47.2	48.3	48.4	47.9				<0.1			16.1	16.3		110	2.4	0.05	8	9
Oct-95						52.4	54.2	53.1	54.8			<0.1	<0.1	<0.1	0.25	17.7	18	90	113	3.1	0.05	8.2	9
Nov-95						52.3	51.7	55.1	55.4				<0.1			20	20.4		120	5	0.05	8.4	8.9
Dec-95						54.7	55.5	62	61.3				<0.1			22.3	22.4		130	5.7	0.05	8	8.9
Jan-96						63.2	60.5	71.8	71.5			<0.1	<0.1	<0.1	0.28	29.6	29.8	130	160	6.8	0.05	8.5	9
Feb-96						67.7	67.4	78	75.7				<0.1			33.5	32		195	5.1	0.05	7.8	8.7
Mar-96						64.5	63.8	77.5	76.3				<0.1			34.3	34.3		195	5.5	0.05	8	8.9
Apr-96						63.8	64.3	84.3	82			<0.1	<0.1	<0.1	0.18	36.9	37.5	160	193	5	0.05	8	8.9
May-96						62.5	62.4	88.2	88.8				<0.1			44.8	45.7		210	5.4	0.05	8.2	8.8
Jun-96						54.6	55.8	71.5	73.8				<0.1			35.6	36.5		170	6.4	0.05	8.1	8.9

Temperature (deg. C)		Bromate (µg/L)		Microbial Parameters												Raw					
				Coliforms				Giardia		Crypto.		Viruses		HPC		Indicate disinfectant(s) used with an 'X'		Chlorine dose	Ammonia dose	Incububation time (h)	
				Total (#/100mL)		Fecal (#/100mL)		(cysts/100L)		(oocysts/100L)		(#/mL)		(CFU/mL)				(mg Cl2/L)	(mg NH3-N/L)		
Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	chlorine	chloramine			chlorine	chloramine
	24.8			44	0	7		0	0	0	0			960	0						
	25.2			6	0	3								1750	0						
	23.7			8	0	14								410	0						
	20.8			42	0	5								480	0						
	18.1			29	0	27								3600	0						
	14.3			21	0	3		0	0	0	0			13700	0						
	12.1			28	0	5		0	0	0	0			2100	0						
	14			31	0	16		<5.3		<5.3				160	0						
	15.1			700	0	10		0		0				63700	0						
	17.8			33	0	5		0		0				880	0						
	20.5			37	0	9		0	0	0	<1			1500	0						
	21.8			7	0	1								20400	10						

Chlorination conditions													Disinfection By-products							
			Filtered										TTHM (µg/L)		HAA5 (µg/L)		HAA6 (µg/L)		TOX (µg Cl-/L)	
Incub. temp.	pH	Residual	Indicate disinfectant(s) used with an 'X'		Chlorine dose	Ammonia dose	Incububation time (h)		Incub. temp.	pH	Residual		Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.
(deg. C)	()	(mg Cl2/L)	chlorine	chloramine	(mg Cl2/L)	(mg NH3-N/L)	chlorine	chloramine	(deg. C)	()	(mg Cl2/L)								
			X	X	1.7	0.37	0.24		24.8	7.2	1.2	<0.5	14.1				7.1		
			X	X	1.6	0.36	0.23		25.2	7.1	1.1		7.8				11.9		
			X	X	1.5	0.3	0.26		23.7	7.3	1.06		8.1				3.9		
			X	X	1.6	0.3	0.3		20.8	7.4	1.07	<0.5	9.8				5.4		
			X	X	1.6	0.33	0.26		18.1	7.4	1.07		14.7				5.1		
			X	X	1.7	0.33	0.54		14.3	7.3	1.07		12.6				6.7		
			X	X	1.8	0.33	0.58		12.1	7.2	1.1	<0.5	16				8.6		
			X	X	1.9	0.31	0.58		14	7.2	1.1		17				7.5		
			X	X	2	0.33	0.52		15.1	7.1	1.12		24.6				6.3		
			X	X	1.9	0.33	0.41		17.8	7.1	1.11	<0.5	24.3				9.8		
			X	X	1.8	0.33	0.31		20.5	7.2	1.17		20.3				12.6		
			X	X	1.8	0.29	0.24		21.8	7.2	0.95		19.3				13.7		

Note: Disinfection at Bollman is accomplished by a limited free chlorine contact time (see Filtered Incubation Time) followed by chloramination.
Typically 90-95% of the CT credit is achieved with free chlorine, the remainder being provided by chloramines

Indicate coagulants studied:

ID	Coagulant	Chemical formula	Units
1	Alum	Al2(SO4)3	mg/L
2			
3			
4			

TREATMENT CONDITIONS

Coagulation Conditions					
Coagulant ID (see above)	Dose	Acid adjusted? (Y/N)	Base adjusted? (Y/N)	Coag. pH ()	Coag. temp. (deg. C)
1	31.2	Y	N		
1	33.7	Y	N		
1	31.8	Y	N		
1	31.6	Y	N		
1	31.1	Y	N		
1	35.6	Y	N		
1	47.4	Y	N		
1	42.2	Y	N		
1	49.9	Y	N		
1	42.9	Y	N		
1	36.7	Y	N		
1	35.7	Y	N		

Contra Costa WD							
Randall-Bold WTP							
Sample	Bromate	Chloride	Bromide				
Date	(measured)	(daily avg)	(estimated)				
	(µg/L)	(mg/L)	(mg/L)				
2/23/93	<0.5	72	0.22				
4/6/93	<1.4	89	0.27				
5/21/93	10	55	0.17				
6/15/93	6	30	<0.1				
8/18/93	6	25	<0.1				
10/5/93	10.3	60	0.18				
11/17/93	30.4	142	0.43				
1/4/94	1.5	70	0.21				
2/9/94	4.6	70	0.21				
3/1/94	2.6	55	0.17				
4/5/94	7.3	77	0.23				
5/10/94	<3	57	0.17				
7/12/94	<5	112	0.34				
8/9/94	<5	133	0.4				
10/4/94	51	158	0.48				
10/10/94	33	118	0.36				
11/1/94	15	150	0.45				
12/6/94	13	162	0.49				
1/10/95	5.7	94	0.28				
2/14/95	17	60	0.18				
3/14/95	7.6	35	0.11				
4/4/95	18	105	0.32				
6/13/95	<5	40	0.12				
7/11/95	21	32	0.1				
8/8/95	7.8	32	0.1				
9/19/95	<5	16	<0.1				
10/3/95	<5	14	<0.1				
11/7/95	<5	16	<0.1				
12/12/95	<5	23	<0.1				
2/6/96	<5	40	0.12				
3/5/96	<5	117	0.35				
Note:	Ozone	dose	currently	optimized	for	coagulation,	
	not	bromate	production.				
Conservative	ozone	doses:	pre-ozone	2.5-3 ppm	(raw water		
			post-ozone	1ppm	(filtered)		
Plant CT operating	from 2-5						

Utility ID:	CCWD: Randall-Bold WTP	(ACWD, CCWD, EBMUD, MWD, SCVWD)	
1. Study ID:	Historical data 7/1/95-6/30/96	(Optimization Study 9/95, etc.)	4. If blended source water indicate sources and proportions:
2. Source water:	Delta (Rock Slough)	(River, lake, groundwater, etc.)	Source / %
3. Source water ID:	Central Valley Project Water	(State Project water, blend of...., etc.)	
	5. Describe level of study:	Bench-scale	
	(indicate with an 'X')	Pilot-scale	
	x	Full-scale	

WATER QUALITY DATA: CONVENTIONAL+OZONE

Date	Time	TOC (mg/L) Raw	TOC Settl.	TOC Ozon.	TOC Filt.	UV-254 (1/cm) Raw	UV-254 Settl.	UV-254 Ozon.	UV-254 Filt.	Alkalinity (mg/L as CaCO3) Raw	Alkalinity Settl.	Alkalinity Ozon.	Alkalinity Filt.
7/10/95		5.7								37			21
8/7/95		3.6								36			20
9/11/95		7.7								65			48
10/2/95		3								68			49
11/6/95		2.8								52			43
12/4/95		3								55			35
1/8/96		5.5								62			40
2/5/96		6.9								71			36
3/4/96		5.1								107			87
4/1/96		7.8								83			63
5/6/96										69			51
6/3/96		4.1								47			35

Date	Hardness (mg/L as CaCO3) Total Raw	Total Settl.	Total Ozon.	Total Filt.	Calcium Raw	Calcium Settl.	Calcium Ozon.	Calcium Filt.	Bromide (mg/L) Raw	Bromide Settl.	Bromide Ozon.	Bromide Filt.	Ammonia (mg NH3-N/L) Raw	Ammonia Settl.	Ammonia Ozon.	Ammonia Filt.	Chl (mg Raw	Chl Settl.
7/10/95	42			43					<0.1			<0.1	0.11			0.35	15	
8/7/95	39			46					<0.1			<0.1	<0.1			0.28	12	
9/11/95	61			56					<0.1			<0.1	<0.1			0.32	16	
10/2/95	63			49					<0.1			<0.1	<0.1			0.45	15	
11/6/95	50			42					<0.1			<0.1	<0.1			0.33	17	
12/4/95	57			55					<0.1			<0.1	0.15			0.44	19	
1/8/96	73			76					<0.1			<0.1	<0.1			0.46	28	
2/5/96	99			90					0.12			0.11	<0.1			0.51	42	
3/4/96	190			181					0.31			0.16	<0.1			0.41	92	
4/1/96	129			131					<0.1			0.13	<0.1			0.40	70	
5/6/96	110			115					0.22			0.19	0.15				60	
6/3/96	67			85					0.12			<0.1	<0.1			0.45	25	

Note: Form is set up for conventional filtration and intermediate ozone.
CCWD's Randall-Bold WTP has pre & post ozone and direct filtration.
Raw = Pre-oz
Filt = Post-oz
Settl. = Applied
N/A - not applicable (chlorination is only done after post-ozone process (after filtration))

Utility ID:
1. Study
2. Source
3. Source
WATER

Date	ride (l/L)		TDS (mg/L)				Turbidity (NTU)				pH ()			
	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.
7/10/95		12	80			110	9.68	6.78		0.032	7.45	6.74		6.56
8/7/95		12	70			110	10.87	3.14		0.022	7.43	7.21		6.48
9/11/95		14	110			90	4.59	2.19		0.025	7.57	7.14		6.81
10/2/95		17	100			120	3.60	2.40		0.027	7.68	7.25		7.03
11/6/95		21	90			120	2.52	4.46		0.015	7.73	7.21		7.31
12/4/95		21	100			130	2.67	2.79		0.022	7.62	7.46		7.36
1/8/96		33	140			180	5.20	6.20		0.026	7.52	7.05		6.61
2/5/96		61	200			300	6.25	17.25		0.020	7.6	7.12		7.04
3/4/96		110	390			390	4.06	6.23		0.082	7.88	7.14		7.01
4/1/96			260			330	3.83	3.08		0.019	6.93	7.24		7.36
5/6/96		62	250			290	9.25	10.30		0.018	7.83	6.81		6.71
6/3/96		73	120			140	9.55	5.74		0.020	7.59	7.09		7.18

Date	Temperature (deg. C)				Bromate (µg/L)				Coliforms Total (#/100mL)				Coliforms Fecal (#/100mL)				Gi (cyst	
	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.
7/10/95	24.1			23.9				21	190			0	7					
8/7/95	25.2			25.0				7.8	65			0	9				0	
9/11/95	23.7			23.0				<5	77			0	8					
10/2/95	22.7			22.0				<5	41			0	5					
11/6/95	18.0			17.0				<5	48			0	2					
12/4/95	16.5			15.2				<5	65			0	8					
1/8/96	13.0			12.0				<5	61			0	1				0	
2/5/96	14.0			12.8				<5	22			0	3				<1.6	
3/4/96	14.0			13.0				<5	40			0	0					
4/1/96	16.8			16.0				<5	36			0	4				0	
5/6/96	21.0			21.0				<5	42			0	16				0	
6/3/96	23.5			23.5				<5	28			0	0					

Utility ID:	
1. Study	
2. Source	
3. Source	
WATER	

Date	Microbial Parameters: dia (/100L) Ozon.	dia (/100L) Filt.	Crypto. (oocysts/100L) Raw	Crypto. Settl.	Crypto. Ozon.	Crypto. Filt.	Viruses (#/mL) Raw	Viruses Settl.	Viruses Ozon.	Viruses Filt.	HPC (CFU/mL) Raw	HPC Settl.	HPC Ozon.	HPC Filt.	Chlorination conditions, Filtered: Indicate disinfectant(s) used with an 'X' chlorine	chloramine	Chlorine dose (mg Cl2/L)	Ammonia dose (mg NH3-N/L)	Incububation time (h) chlorine	Incububation time (h) chloramine	Incub. temp. (deg. C)	pH ()	Residual (mg Cl2/L)	TTHM (µg/L) Raw	TTHM Settl.	TTHM Ozon.	TTHM Filt.
7/10/95		0				0					2100			1		X				3.07	22	9.07	1.00				0.9
8/7/95			0								880			4		X				3.97	23.2	9.00	0.97				<0.5
9/11/95											290			3		X	1.66	0.55		21.7	25	9.08	1.04				<0.5
10/2/95											510			0		X	1.79	0.60		27.1	23.8	9.41	1.06				<0.5
11/6/95											1350			0		X	1.71	0.56		20.3	17	9.05	0.96				<0.5
12/4/95		0				0					810			1		X	1.76	0.58		27.1	15.8	9.34	1.23				<0.5
1/8/96		0	0			0					520			2		X	1.82	0.68		32.5	12.5	8.89	1.10				<0.5
2/5/96			<1.6								880			0		X	1.92	0.67		32.5	12.2	8.92	1.04				<0.5
3/4/96											290			6		X	1.99	0.65		46.5	12.8	8.54	1.08				<0.5
4/1/96		0	0			0					510			1		X	1.77	0.64		20.3	15.6	8.68	1.08				<0.5
5/6/96		0	0			0					430			0		X	1.39	0.47		8.13	20.5	8.56	1.12				<0.6
6/3/96											2950			2		X	1.48	0.49		7.4	22.2	8.76	1.19				<0.5

Utility ID:

1. Study

2. Source

3. Source

Indicate coagulants studied:

ID	Coagulant	Chemical formula	Units
1	Alum		
2	Cat Poly		
3	Non-Ionic		
4			

WATER

TREATMENT CONDITIONS

Post-Ozone: Pre/Post; Stages 1/2/3; Per Stage

Date	Disinfection By-products											
	HAA5 (µg/L)				HAA6 (µg/L)				TOX (µg Cl-/L)			
	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.
7/10/95								<2				
8/7/95								<1				
9/11/95								5				
10/2/95								<1				
11/6/95								<1				
12/4/95								<1				
1/8/96								2				
2/5/96								<2				
3/4/96								<2				
4/1/96								15.6				
5/6/96								2.5				
6/3/96								<2				

Date	Coagulation Conditions						Ozonation Conditions				
	Coagulant ID (see above)	Dose	Acid adjusted? (Y/N)	Base adjusted? (Y/N)	Coag. pH ()	Coag. temp. (deg. C)	Ozone dose (mg/L)	Ozone residual (mg/L)	Contact time (min)	Ozone pH ()	Ozone temp. (deg. C)
7/10/95	1/2/3		N	N	6.74	24.1		.38/.23/.3	1.41	7.31	16.2
8/7/95	1/2/3	35 / 1.0 / 0.1	N	N	7.21	25.2	2.5 / 0.5	.34/.27/.3	1.83	6.56	23.9
9/11/95	1/2/3	35 / 1.0 / 0.0	N	N	7.14	23.7	1.81 / 0.3	.06/.05/.0	9.98	6.48	25.0
10/2/95	1/2/3	5.7/ 1.2 / 0.0	N	N	7.25	22.7	1.8 / 0.29	.07/.03/.0	12.48	6.81	23.0
11/6/95	1/2/3	9.5/ 1.03 /0.0	N	N	7.21	18.0	1.55 / 0.3	.10/.09/.0	9.36	7.03	21.5
12/4/95	1/2/3	9.9/1.05/0.0	N	N	7.46	16.5	1.9 / 0.4	.14/.10/.0	12.48	7.36	15.2
1/8/96	1/2/3	44.7/1.0/0.2	N	N	7.05	13.0	2.85 / 0.3	.12/.04/.0	14.98	6.81	12.0
2/5/96	1/2/3	49.8/1.0/0.2	N	N	7.12	14.0	3.12 / 0.4	.26/.18/.1	14.96	7.04	12.8
3/4/96	1/2/3	77.9/3.0/0.49	N	N	7.14	14.0	3.25 / 1.1	.19/.06/.0	21.39	7.01	13.0
4/1/96	1/2/3	5.5/0.93/0.1	N	N	7.24	18.8	2.9 / 0.54	.23/.14/.1	9.36	7.36	16.0
5/6/96	1/2/3	40 / 0.50 /0.0	N	N	6.81	21.0	2.40 / 0.4	.30/.24/.2	3.74	6.71	21.0
6/3/96	1/2/3	27 / 0.48/0.0	N	N	7.09	23.5	1.53 / 0.4	.26/.13/.1	3.40	7.16	23.5

Utility ID:		CCWD, Randall-Bold WTP	(ACWD, CCWD, EBMUD, MWD, SCVWD)	
1. Study ID:		Historical data 7/1/95-6/30/96	(Optimization Study 8/95, etc.)	
2. Source water:		Delta (Rock Slough)	(River, lake, groundwater, etc.)	
3. Source water ID:		Central Valley Project Water	(State Project water, blend of..., etc.)	
		4. Describe level of study:		Bench-scale
		(indicate with an "X")		Pilot-scale
			X	Full-scale (see footnotes)

WATER QUALITY DATA: CONVENTIONAL+OZONE

Date	Time	TOC (mg/L) Raw	Alkalinity (mg/L as CaCO3) Raw	Alkalinity Settl.	Alkalinity Ozon.	Alkalinity Filt.	Hardness (mg/L as CaCO3) Total Raw	Hardness Settl.	Hardness Ozon.	Hardness Filt.	Bromide (mg/L) Raw	Bromide Settl.	Bromide Ozon.	Bromide Filt.	Ammonia (mg NH3-N/L) Raw	Ammonia Settl.	Ammonia Ozon.	Ammonia Filt.	Chloride (mg Cl-/L) Raw	Chloride Settl.	Chloride Ozon.	Chloride Filt.	TDS (mg/L) Raw	TDS Settl.	TDS Ozon.	TDS Filt.	Turbidity (NTU) Raw	Turbidity Settl.	Turbidity Ozon.	Turbidity Filt.	pH () Raw	pH Settl.	pH Ozon.	pH Filt.	Temperature (deg. C) Raw	Temperature Settl.	Temperature Ozon.	Temperature Filt.	Bromate (µg/L) Raw	Bromate Settl.	Bromate Ozon.	Bromate Filt.	Raw
2/23/93			76				127			106	0.22				0.024			0.342	72								17.5	27.5		0.03	7.5	7.3		6.8	12.9							<5	
4/6/93			98				177			180	0.27				0			0.232	80								6.7	12.2		0.066	8.1	7.4		7	17.3							<1.4	
5/21/93			75				104			100	0.17				0.024			0.232	55								12	25.6		0.05	8.8	7.4		6.9	20.2							10	
6/15/93			65				68			58	<0.1				0.024			0.378	30								15.8	16.12		0.044	7.5	7.4		6.75	23.5							6	
8/18/93			50				51			51	<0.1				0.024			0.402	25								4.6	11.6		0.02	8.65	7.38		6.90	25.4							6	
10/5/93			83				85			72	0.18				0.02			0.4	60								4.57	7.75		0.096	9.1	7.19		6.63	23.4							10.3	
11/17/93			56				103			101	0.43				0			0.45	142								1.31	4.52		0.036	7.83	6.66		6.85	17.7							[illegible]	
12/8/93			68				89			89					0.012			0.293									1.36	2.7		0.046	7			7.3	12.8			14.3				6.1	
1/4/94			60				81			88	0.21				0.085			0.476	70								2.7	6		0.057	7.2			6.7	11.7			11.8				1.6	
2/8/94			66				96			89	0.21				0.012			0.430	70								1.7	6		0.053	7			6.3	12.4			12.2				4.8	
3/1/94			75				105			103	0.12				0			0.427	68								3.8	10.17		0.063	7	6.8		6.6	14.1			13.8				2.8	
4/5/94			66				135			131	0.23				0			*	77								2.6	11.4		0.071	7.87	7		6.9	17.8			17.6				7.3	
5/10/94			81				115			105	0.17				*			*	87								1.48	4.18		0.046	7.8	7.14		6.7	20.1			20.7				<3	
7/12/94			72				109			105	0.30				0.024			0.41	112								5.95	14		0.037	7.7	6.88		6.80	26.7			26.1				<5	
8/9/94			68				99			98	0.4				0.012			0.33	133								3	1.87		0.065	7.54	7.3		6.7	26			26.6				<5	
10/4/94			74				124			122	0.40				0.024			0.38	134								6.1	6.3		0.08	7.6	7.3		6.9	22.7			23.3				51	
10/10/94			75				104			106	0.36				0.012			0.451	118								4.8	4.3		0.052	7.8	7.3		6.9	22.4			22.7				33	
11/1/94			72				107			106	0.45				0.01			0.34	150								2.13	2.43		0.051	8.12	7.17		6.96	20.1			19.9				15	
12/6/94			77				138			134	0.49				0.01			0.44	162								2.38	3.01		0.031	7.8	7.4		7.2	13.4			13.4				13	
1/10/95			88				105			102	0.28				0.024			0.378	94								4.7	19		0.038	7.60	7.1		7	12			12				8.7	
2/14/95			70				118			136	0.18				*			*	40								10.7	22.7		0.028	7.36	6.78		6.66	12.8			12.9				17	
3/14/95			84				103			104	0.11				0.012			0.573	35								6.52	23.8		0.024	7.75	6.93		6.93	14			14.2				7.8	
4/4/95			100				170			165	0.32				*			*	105								7.23	2.85		0.031	7.60	6.94		6.65	18.3			18.8				18	
6/13/95			40				52			48	0.12				*			*	40								28	-		0.1	7.56			6.50	24.8			22.2				<5	
7/10/95		5.7	37			21	42			43	0.1			<0.1	0.11			0.35	32			12	90			110	9.88	8.78		0.032	7.48	6.74		6.56	24.1			23.9				21	190
8/7/95		3.8	38			30	39			45	0.1			<0.1	<0.1			0.28	32			12	70			110	10.87	3.14		0.022	7.43	7.21		6.48	25.2			25.0				7.8	65
9/11/95		7.7	55			46	61			56	<0.1			<0.1	<0.1			0.32	18			14	110			90	4.58	2.18		0.025	7.57	7.16		6.81	23.7			23.0				<5	77
10/2/95		3	56			49	63			49	<0.1			<0.1	<0.1			0.45	14			17	100			120	3.60	2.40		0.027	7.56	7.26		7.03	22.7			22.0				<5	41
11/6/95		2.8	52			43	90			42	<0.1			<0.1	<0.1			0.33	16			21	80			120	2.52	4.46		0.015	7.73	7.21		7.31	18.0			17.0				<5	46
12/4/95		3	55			35	87			65	<0.1			<0.1	0.15			0.44	23			21	100			130	2.87	2.78		0.022	7.82	7.40		7.36	16.5			15.2				<5	65
1/8/96		5.5	62			40	73			73	<0.1			<0.1	<0.1			0.46	26			33	140			180	6.20	6.20		0.026	7.52	7.05		6.81	13.0			12.0				<5	61
2/5/96		6.9	71			36	88			90	0.12			0.11	<0.1			0.51	42			61	200			300	6.25	17.25		0.020	7.8	7.12		7.04	14.0			12.8				<5	22
3/4/96		5.1	107			87	180			161	0.31			0.16	<0.1			0.41	92			110	390			390	4.06	6.23		0.062	7.88	7.14		7.01	14.0			13.0				<5	40
4/1/96		7.8	83			63	129			131	<0.1			0.13	<0.1			0.40	70				280			330	3.63	3.08		0.018	8.09	7.24		7.30	18.0			16.6				<5	36
5/6/96			69			51	110			115	0.22			0.19	0.35				60			92	260			290	8.25	10.30		0.018	7.63	6.81		6.71	21.0			21.8				<5	42
6/3/96		4.1	47			35	87			85	0.12			<0.1	<0.1			0.45	25			73	120			140	9.65	8.74		0.020	7.59	7.09		7.18	23.6			23.5				<5	29

Note: Form is set up for conventional filtration and intermediate ozone.

- CCWD's Randall-Bold WTP has pre & post ozone and direct filtration
- Raw = Pre-oz
- Filt = Post-oz
- Settl = Applied
- N/A - not applicable (chlorination is only done after post-ozone process (after filtration))
- At times, the plant has been operated in start-stop manner resulting in higher ozone doses (and bromate) than would have occurred if the plant were operated in a continuous manner (these periods are not marked but could be made available)

Utility ID

1. Study

2. Sourc

3. Sourc

WATE

Microbial Parameters

Date	Coliforms Total (#/100mL) Settl.	Coliforms Total (#/100mL) Ozon.	Coliforms Total (#/100mL) Filt.	Coliforms Fecal (#/100mL) Raw	Coliforms Fecal (#/100mL) Settl.	Coliforms Fecal (#/100mL) Ozon.	Coliforms Fecal (#/100mL) Filt.	Giardia (cysts/100L) Raw	Giardia (cysts/100L) Settl.	Giardia (cysts/100L) Ozon.	Giardia (cysts/100L) Filt.	Crypto. (oocysts/100L) Raw	Crypto. (oocysts/100L) Settl.	Crypto. (oocysts/100L) Ozon.	Crypto. (oocysts/100L) Filt.	Viruses (#/mL) Raw	Viruses (#/mL) Settl.	Viruses (#/mL) Ozon.	Viruses (#/mL) Filt.	HPC (CFU/mL) Raw	HPC (CFU/mL) Settl.	HPC (CFU/mL) Ozon.	HPC (CFU/mL) Filt.
2/23/93																							
4/6/93																							
5/21/93																							
6/15/93																							
8/16/93																							
10/5/93																							
11/17/93																							
12/6/93																							
1/4/94																							
2/8/94																							
3/1/94																							
4/5/94																							
5/10/94																							
7/12/94																							
8/9/94																							
10/4/94																							
10/10/94																							
11/1/94																							
12/6/94																							
1/10/95																							
2/14/95																							
3/14/95																							
4/4/95																							
4/13/95																							
7/10/95			0	7							0				0					2100			1
8/7/95			0	9				8				0								860			4
8/11/95			0	8																290			3
10/2/95			0	5																510			8
11/6/95			0	2																1350			0
12/4/95			0	0							0				0					810			1
1/8/96			0	1				0			0	0			0					520			2
2/5/96			0	3				<1.6				<1.6								660			0
3/4/96			0	8																290			0
4/1/96			0	4				0			0	8			0					510			1
5/6/96			0	16				8			0	8			0					430			0
6/3/96			0	8																2950			2

Chlorination conditions — Filtered

Date	Indicate disinfectant(s) used with an 'X': chlorine	Indicate disinfectant(s) used with an 'X': chloramine	Chlorine dose (mg Cl2/L)	Ammonia dose (mg NH3-N/L)	Incubation time (h) chlorine	Incubation time (h) chloramine	Incub. temp. (deg. C)	pH ()	Residual (mg Cl2/L)	TTHM (µg/L) Raw	TTHM (µg/L) Settl.	TTHM (µg/L) Ozon.
2/23/93		X	1.3	0.43		6.1	12.7	8.5	0.84			
4/6/93		X	1.3	0.43		4.8	16.8	8.6	0.77			
5/21/93		X	1.3	0.43		4.3	20.1	8.4	1.35			
6/15/93		X	1.1	0.37		3.7	22.8	8	1.17			
8/16/93		X	1.8	0.53		13.2	25.2	8.08	1.31			
10/5/93		X	1.3	0.433		4.1	23	8.01	1.18			
11/17/93		X	1.3	0.433		5.3	15.9	8.84	1.12			
12/6/93		X	1.3	0.6		27.1	13	8.9	1.18			
1/4/94		X	1.5	0.46		28.1	11.1	8.9	1.14			
2/8/94		X	1.5	0.53		28.1	11.8	8.8	1.1			
3/1/94		X	1.6	0.53		31.3	13.1	8.8	1.08			
4/5/94		X	1.5	0.51		10.3	17.4	8.7	1.13			
5/10/94		X	1.2	0.36		8.0	19.8	8.68	1.06			
7/12/94		X	1.8	0.5		24.7	23.7	8.68	1.29			
8/9/94		X	1.8	0.6		15.7	24.1	8.57	1.06			
10/4/94		X	1.35	0.45		5.1	23	8.5	1.18			
10/10/94		X	1.35	0.45		5.1	22.2	8.7	1.15			
11/1/94		X	1.35	0.45		5.1	18.3	8.76	1.03			
12/6/94		X	1.4	0.47		13.8	13.4	8.6	1.16			
1/10/95		X	1.4	0.47		27.1	11.1	8.8	1.18			
2/14/95		X	1.5	0.52		20.3	12	8.82	1.34			
3/14/95		X	1.6	0.52		36.2	13.3	8.74	1.08			
4/4/95		X	1.6	0.57		10.3	18.1	9.30	0.98			
4/13/95		X	1.6	0.47		4.3	21.3	8.88	1.25			
7/10/95		X				3.07	22	8.87	1.00			
8/7/95		X				3.07	23.2	9.00	0.97			
8/11/95		X	1.88	0.85		21.7	25	9.08	1.04			
10/2/95		X	1.79	0.80		27.1	23.8	9.41	1.08			
11/6/95		X	1.71	0.96		20.3	17	9.05	0.98			
12/4/95		X	1.78	0.58		27.1	15.8	9.34	1.23			
1/8/96		X	1.82	0.68		32.8	12.6	9.00	1.10			
2/5/96		X	1.82	0.67		32.5	12.2	8.92	1.04			
3/4/96		X	1.88	0.65		45.5	12.5	8.84	1.08			
4/1/96		X	1.77	0.64		20.3	15.4	8.88	1.08			
5/6/96		X	1.38	0.47		8.13	20.8	8.58	1.12			
6/3/96		X	1.48	0.49		7.4	22.2	8.78	1.18			

Note.
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Utility ID

1. Study

2. Source

3. Source

WATE

Indicate coagulants studied:

ID	Coagulant	Chemical formula	Units
1	Alum		
2	Cat Poly		
3	Non-Ionic		
4			

TREATMENT CONDITIONS

Pre/Post 1/2/3 Stage

Post-Ozone Stages Per

Date	Disinfection By-products Fin.	HAA6 (µg/L) Raw	HAA6 Settl.	HAA6 Ozon.	HAA6 Fin.	TOX (µg Cl-/L) Raw	TOX Settl.	TOX Ozon.	TOX Fin.	Coagulant ID (see above)	Coagulation Conditions Dose 1	Dose 2	Dose 3	Acid added (Y/N)	Base adjusted (Y/N)	Coag. pH 0	Coag. temp. (deg. C)	Ozonation Conditions Ozone dose (mg/L) Pre	Ozone dose Post	Ozone residual (mg/L) 1	Ozone residual 2	Ozone residual 3	Contact time (min)	Ozone pH 0	Ozone temp. (deg. C)
2/23/93										1/2/3	55	3	0.1	N	N	7.3	12.9	0.00	0.70	0.3	0.29	0.29	2.79	6.6	
4/6/93										1/2/3	37		0.14	N	N	7.4	17.3	2.00	1.00	0.51	0.28	0.28	2.05	7	
5/21/93										1/2/3	45	4		N	N	7.4	20.2	2.75	1.10	0.28	0.2	0.2	2.42	6.9	
6/15/93										1/2/3	24		0.12	N	N	7.4	23.5	2.00	0.80	0.79	0.16	0.19	1.09	6.75	
8/18/93										1/2/3	37	2	0.2	N	N	7.38	26.4			0.59	0.15	0.15	8.14	6.90	
10/5/93										1/2/3	26		0.2	N	N	7.16	23.4	1.76	0.80	0.35	0.1	0.1	1.86	6.63	
11/17/93										1/2/3	24		0.2	N	N	6.98	17.7	1.60	0.45		0.40	0.45	2.42	6.85	
12/8/93										1/2/3	20		0.03	N	N		12.9	1.50	0.40		0.20	0.14	12.48	7.3	14.3
1/4/94										1/2/3	23.8		0.2	N	N		11.7	1.50	0.35		0.18	0.18	13.37	8.7	11.6
2/9/94										1/2/3	30	2		N	N		12.4	1.50	0.35	0.13	0.05	0.03	12.91	8.3	12.2
3/1/94										1/2/3	30	2.1	0.073	N	N	6.6	14.1	2.60	0.45	0.16	0.09	0.04	14.4	8.8	13.6
4/5/94										1/2/3	38	1	0.08	N	N	7	17.8	2.50	0.65	0.13	0.09	0.08	7.49	8.9	17.8
5/18/94										1/2/3	34	0.7	0.09	N	N	7.14	20.1	1.75	0.30	0.36	0.15	0.12	4.18	8.7	20.7
7/12/94										1/2/3	31	0.8	0.075	N	N	6.98	28.7	3.60	0.35	0.15	0.05	0.04	11.35	8.88	28.1
8/8/94										1/2/3	23	0.68	0.08	N	N	7.3	28	2.60	0.40	0.12	0.04	0.02	8.01	8.7	28.4
10/4/94										1/2/3	14	1.7	0.075	N	N	7.3	22.7	2.58	0.40	0.27	0.23	0.15	2.34	6.9	23.3
10/10/94										1/2/3	14	1.7	0.075	N	N	7.3	22.4	1.78	0.40	0.27	0.28	0.19	2.34	6.8	22.7
11/1/94										1/2/3	14	1.7	0.075	N	N	7.17	20.3	1.50	0.40	0.1	0.15	0.16	2.34	6.96	19.8
12/6/94										1/2/3	18	1	0.075	N	N	7.4	13.4	2.00	0.40	0.33	0.21	0.14	4.24	7.2	13.4
1/10/95										1/2/3	30	1	0.1	N	N	7.1	12	2.00	0.43	0.22	0.08	0.06	12.49	7	17
2/14/95										1/2/3	71	3.36	0.26	N	N	6.78	12.5	3.00	0.65	0.1	0.07	0.08	9.36	6.64	12.6
3/14/95										1/2/3	40	1.13	0.11	N	N	6.83	14	2.00	0.40	0.18	0.1	0.07	16.64	6.93	14.2
4/4/95										1/2/3	67	1	0.11	N	N	6.84	16.3	2.50	0.60	0.27	0.09	0.09	7.40	6.65	16.9
6/13/95										1/2/3	30	1	0.1	N	N		24.8	2.50	0.60	0.32	0.12	0.24	1.97	6.58	22.2
7/10/95	0.0				<2					1/2/3				N	N	6.74	24.1			0.38	0.35	0.37	1.41	7.31	18.2
8/7/95	<0.5				<1					1/2/3	35	1	.1	N	N	7.21	25.2	2.50	0.50	0.34	0.27	0.3	1.83	6.56	23.9
9/11/95	<0.5				8					1/2/3	35	1	.05	N	N	7.14	23.7	1.81	0.31	0.06	0.05	0.04	9.86	6.46	25.0
10/2/95	<0.5				<1					1/2/3	16	1.2	.08	N	N	7.25	22.7	1.40	0.29	0.07	0.03	0.02	12.49	6.91	22.8
11/6/95	<0.5				<1					1/2/3	19.5	1.03	.05	N	N	7.21	16.8	1.55	0.30	0.16	0.08	0.08	9.39	7.03	21.5
12/4/95	<0.5				<1					1/2/3	19.0	1.09	.05	N	N	7.46	10.5	1.80	0.40	0.14	0.1	0.08	12.48	7.36	16.2
1/8/96	<0.5				3					1/2/3	44.7	1	.3	N	N	7.05	13.0	2.65	0.38	0.12	0.04	0.03	14.98	6.81	12.0
2/5/96	<0.5				<2					1/2/3	49.6	1	.2	N	N	7.12	14.6	3.12	0.45	0.28	0.16	0.12	14.68	7.04	12.8
3/4/96	<0.5				<2					1/2/3	77.6	3	.40	N	N	7.14	14.0	3.25	1.15	0.18	0.08	0.01	21.39	7.01	13.0
4/1/96	<0.5				15.6					1/2/3	49.6	.93	.10	N	N	7.24	19.6	2.80	0.54	0.23	0.14	0.13	8.36	7.36	18.8
5/6/96	<0.5				2.5					1/2/3	40	0.3	0.02	N	N	6.81	21.0	2.40	0.43	0.38	0.34	0.26	3.74	6.71	21.9
6/3/96	<0.5				<2					1/2/3	27	.46	.01	N	N	7.08	23.5	1.53	0.43	0.28	0.13	0.19	3.40	7.18	23.5

Note:

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Utility ID:	EBMUD	(ACWD, CCWD, EBMUD, MWD, SCVWD)	
1. Study ID:	EBMUD Alternate Source Study	(Optimization Study 9/95, etc.)	
2. Source water:	(American) River	(River, lake, groundwater, etc.)	
3. Source water ID:		(State Project water, etc.)	

5. Describe point of reference for which water quality data are being supplied, i.e. upstream and downstream of City of Sacramento combined sewage discharge, etc.

Nimbus Dam, American River

If entering data on seasonal changes in plant raw source water quality, use upstream column.

WATER QUALITY DATA: RAW

Date	Time	TOC (mg/L) Upstr.	TOC (mg/L) Down.	Alkalinity (mg/L as CaCO) Upstr.	Alkalinity (mg/L as CaCO) Down.	Hardness (mg/L as CaCO3) Total Upstr.	Hardness (mg/L as CaCO3) Total Down.	Bromide Upstr.	Bromide Down.	Ammonia (mg NH3-N/L) Upstr.	Ammonia (mg NH3-N/L) Down.	Chloride (mg Cl-/L) Upstr.	Chloride (mg Cl-/L) Down	TDS (mg/L) Upstr.	TDS (mg/L) Down.	Turbidity (NTU) Upstr.	Turbidity (NTU) Down.	pH () Upstr.	pH () Down.	Temperature (deg. C) Upstr.	Temperature (deg. C) Down.	Microbial Parameters Coliforms Total (#/100mL) Upstr.	Microbial Parameters Coliforms Total (#/100mL) Down.	Microbial Parameters Coliforms Fecal (#/100mL) Upstr.	Microbial Parameters Coliforms Fecal (#/100mL) Down.
1/17/89		2.4		32		33		<0.005		0.009		4		59		1.8		7.7		8		28		11	
2/14/89		1.8		31		32		<0.03		0.01		5		60		0.88		7.8		8		50		11	
3/13/89		2.8		33		35		<0.02		0.01		4		64		3.5		7.8		11		430		140	
4/17/89		1.6		27		28		<0.05		0.016		3		53		2.3		8.1		15		800		500	
5/15/89		1.9		24		25		<0.05		<0.005		3		50		1.5		7.8		18		210		30	
6/19/89		1.9		24		22		<0.05		0.04		2		45		1.1		7.8		18		170		30	
6/19/89		2.3		25		120						13		47		1.2						170		80	
6/19/89				120																		500		130	
7/17/89		1.4		21		22		<0.03		<0.005		2		46		0.7		7.5		24		1300		300	
8/14/89		35		24		21		<0.05		0.005		6		44		0.82		7.4		24.5		300		80	
9/25/89		1.4		21		20		<0.01				4		44		0.45		7.5		20		220		130	
11/13/89		1.7		21		21		0.01		<0.005		2		44		1.1		7.4		18		80		80	
12/11/89		1.3		29		24		<0.01		0.01		2		47		2.5		7.4		11		1100		800	
12/11/89																						2200		2200	
1/22/90		1.3		23		24		<0.01		<0.005		2		49		1.3		7.6		9		110		110	
2/20/90		1.8		25		28		<0.02		0.007		4		50		5.6		7.7		8		800		300	
3/5/90		1.3		36		32		0.01				5		57		1.6		7.8		11.5		17		4	
4/9/90		1.2		31		29		<0.01		<0.005		4		53		0.57		7.8		17.5		80		50	
5/21/90		1.4						0.01				3		54		0.64						280			
6/25/90		1.3		27		27		<0.05		0.03		3		51		0.38		7.5		17.5		80		80	
7/16/90		1.3						<0.01				4		48		0.5						11			
8/20/90		1.4						0.02				2		43		2.5									
9/17/90		1.4						0.01				2		39		0.95						80			
10/15/90		1.3		21		18		0.11				2		40		0.77		7.4		20		50		30	
10/15/90		1.8		22		20		<0.01								0.8						170		70	
11/28/90		1.5						<0.01				4		43		0.94						500			
12/17/90		1.5						<0.01				4		47		3.1						70			
1/7/91		1.2		25		21		<0.01				3		34		1.3		7.8				50		50	
1/7/91		1.3		27								4				1.6						110		110	
2/11/91		1.7		30		25		0.02				6		50		4.1		7.2		13		130		50	
3/11/91		2.3		27		32		0.01		0.01		4		58		3.4		7.8		12		1700		500	
3/11/91										0.08															
4/8/91		3.2		36		38		0.01		0.01		4		68				8.6		16		50		23	
5/20/91		1.9		32		32		0.01		<0.02		2		59		1.6		8.2		19.5		800		500	
6/17/91		1.9		28		28		<0.01				3		61		1.8		7.8		21.5		70		11	
6/17/91																								23	
7/8/91		1.3		28		25		<0.01				2		50		1.2		7.8		20.5		90		30	
7/8/91		1.7		32		31						3		51		1.5		8.4				500		80	
7/8/91												13				1.6									
8/19/91		1.5		27		23		<0.01				2		46		1.1		7.6		23.5		50		17	
8/19/91		1.6		28		24						3		49								80		23	
9/16/91				24		22		<0.01				4		55		0.6		7.6		24		350		30	
9/16/91												14													
10/15/91		1.6		25		21		0.07		0.02		3		45		1.1		7.4		20.5		110		80	
10/15/91								<0.01																	
11/18/91		1.4		27		25		0.02		0.01		3		48		1.2		7.6		16		130		23	
11/18/91								0.1																	
12/16/91		1.7		26		23		<0.05				2		44		0.79		7.6		11		70		70	

Utility ID:	MWD	(ACWD, CCWD, EBMUD, MWD, SCVWD)					
1. Study ID:	Jar Tests--range of %SPW/%CRW	(Optimization Study 9/95, etc.)	Indicate coagulants studied:				
			ID	Coagulant	Chemical formula	Units	
2. Source water:	Surface	(River, lake, groundwater, etc.)	1	Alum	$Al_2(SO_4)_3 \cdot 14\ H_2O$	mg/L	
			2	Polymer	Cationic	mg/L	
3. Source water ID:	SPW, CRW	(State Project water, blend of...., etc.)	3				
			4				
5. Describe level of study:	X	Bench-scale	In this data sheet, "Filt." refers to data collected	Doses include usually 3 (sometimes 2) mg/L polymer			
(indicate with an 'X')		Pilot-scale	after coagulation, flocculation, sedimentation, and				
		Full-scale	filtration.				
6. Indicate with an 'X' if data reported as "Filt." are from samples collected after sedimentation only:				X	60 min settling time		
or after sedimentation and filtration:							

WATER QUALITY DATA: CONVENTIONAL

TREATMENT CONDITIONS

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDJAR01	100		2.42	2.43	0.025		123		0.74	0.74	8.03		1	0			8.06
MWDJAR01	100		2.42	2.32	0.025	0.039	123		0.74	0.43	8.03		1	10			7.71
MWDJAR01	100		2.42	2.27	0.025	0.036	123		0.74	0.54	8.03		1	20			7.44
MWDJAR01	100		2.42	2.17	0.025	0.035	123		0.74	0.68	8.03		-1	30			7.30
MWDJAR01	100		2.42	2.02	0.025	0.013	121		0.74		8.03		1	40			7.24
MWDJAR01	100		2.42	1.95	0.025	0.038	123		0.74	0.90	8.03		1	50			6.89
MWDJAR01	100		2.42	1.86	0.025	0.034	123		0.74	0.82	8.03		1	60			6.81
MWDJAR01	100		2.42	1.88	0.025	0.036	123		0.74	0.27	8.03		1	70			6.72
MWDJAR06	100		2.25	2.20	0.019	0.019	132		0.65	0.62	8.29		1	0			8.29
MWDJAR06	100		2.25	2.12	0.019	0.013	132		0.65	0.56	8.29		1	10			7.88
MWDJAR06	100		2.25	1.97	0.019	0.011	132		0.65	0.51	8.29		1	20			7.67
MWDJAR06	100		2.25	1.95	0.019	0.009	132		0.65	0.43	8.29		1	30			7.49
MWDJAR06	100		2.25	1.83	0.019	0.007	132		0.65	0.62	8.29		1	40			7.33
MWDJAR06	100		2.25	1.67	0.019	0.004	132		0.65	0.79	8.29		1	50			7.24
MWDJAR06	100		2.25	1.88	0.019	0.004	132		0.65	0.74	8.29		1	60			7.00
MWDJAR06	100		2.25	1.67	0.019	0.003	132		0.65	0.90	8.29		1	70			6.93
MWDJAR06	100		2.25	1.61	0.019	0.002	132		0.65	1.00	8.29		1	80			6.84
MWDJAR06	100		2.25	1.56	0.019	0.001	132		0.65	1.20	8.29		1	90			6.75
MWDJAR06	100		2.25	1.52	0.019	0.001	132		0.65	1.40	8.29		1	100			6.67
MWDJAR06	100		2.25	1.47	0.019	0.001	132		0.65	1.30	8.29		1	110			6.57
MWDJAR07	100		2.39	2.41	0.036	0.038	132		0.42	0.34	8.34		1	0			8.15
MWDJAR07	100		2.39	2.28	0.036	0.033	132		0.42	0.34	8.34		1	10			7.88
MWDJAR07	100		2.39	2.11	0.036	0.032	132		0.42	0.36	8.34		1	20			7.71
MWDJAR07	100		2.39	1.99	0.036	0.028	132		0.42	0.32	8.34		1	30			7.56
MWDJAR07	100		2.39	1.94	0.036	0.025	132		0.42	0.34	8.34		1	40			7.46
MWDJAR07	100		2.39	1.78	0.036	0.023	132		0.42	0.42	8.34		1	50			7.38
MWDJAR07	100		2.39	1.76	0.036	0.023	132		0.42	0.49	8.34		1	60			7.25
MWDJAR07	100		2.39	1.60	0.036	0.023	132		0.42	0.57	8.34		1	70			7.22
MWDJAR07	100		2.39	1.68	0.036	0.027	132		0.42	0.59	8.34		1	80			7.10
MWDJAR07	100		2.39	1.63	0.036	0.021	132		0.42	0.60	8.34		1	90			7.06
MWDJAR07	100		2.39	1.65	0.036	0.019	132		0.42	0.67	8.34		1	100			6.98
MWDJAR08	100		2.45	2.56	0.030	0.033	122		0.40	0.40	8.18		1	0			7.98
MWDJAR08	100		2.45	2.44	0.030	0.031	122		0.40	0.32	8.18		1	10			7.85
MWDJAR08	100		2.45	2.26	0.030	0.031	122		0.40	0.25	8.18		1	20			7.72
MWDJAR08	100		2.45	2.14	0.030	0.026	122		0.40	0.28	8.18		1	30			7.61
MWDJAR08	100		2.45	2.06	0.030	0.025	122		0.40	0.68	8.18		1	40			7.52
MWDJAR08	100		2.45	2.03	0.030	0.026	122		0.40	0.33	8.18		1	50			7.45
MWDJAR08	100		2.45	2.01	0.030	0.024	122		0.40	0.34	8.18		1	60			7.35
MWDJAR08	100		2.45	2.00	0.030	0.031	122		0.40	0.35	8.18		1	70			7.26
MWDJAR08	100		2.45	1.87	0.030	0.020	122		0.40	0.50	8.18		1	80			7.17
MWDJAR08	100		2.45	1.79	0.030	0.020	122		0.40	0.68	8.18		1	90			7.06
MWDJAR08	100		2.45	1.78	0.030	0.019	122		0.40	0.55	8.18		1	100			6.98
MWDJAR09	90		2.55	2.55	0.055		119		0.71	0.62	7.97		1	0			7.97
MWDJAR09	90		2.55	2.51	0.055	0.046	119		0.71	0.40	7.97		1	10			7.66
MWDJAR09	90		2.55	2.46	0.055	0.036	119		0.71	0.34	7.97		1	20			7.48
MWDJAR09	90		2.55	2.23	0.055	0.041	119		0.71	0.41	7.97		1	30			7.34
MWDJAR09	90		2.55	2.19	0.055	0.031	119		0.71	0.33	7.97		1	40			7.21
MWDJAR09	90		2.55	2.00	0.055	0.034	119		0.71	0.42	7.97		1	50			6.89
MWDJAR09	90		2.55	1.92	0.055	0.032	119		0.71	0.42	7.97		1	60			6.85
MWDJAR09	90		2.55	2.01	0.055		119		0.71		7.97		1	70			6.79
MWDJAR09	90		2.55	1.98	0.055		119		0.71		7.97		1	80			6.62
MWDJAR09	90		2.55	1.87	0.055		119		0.71		7.97		1	90			6.58
MWDJAR09	90		2.55	1.95	0.055		119		0.71		7.97		1	100			6.50
MWDJAR09	90		2.55	1.84	0.055		119		0.71		7.97		1	110			6.41
MWDJAR09	90		2.55	1.87	0.055		119		0.71		7.97		1	120			6.18
MWDJAR10	90		2.58	2.52	0.055	0.046	125		0.64	0.55	8.22		1	0			8.26
MWDJAR10	90		2.58	2.42	0.055	0.036	125		0.64	0.60	8.22		1	10			7.74
MWDJAR10	90		2.58	2.23	0.055	0.041	125		0.64	0.66	8.22		1	20			7.49
MWDJAR10	90		2.58	2.04	0.055	0.031	125		0.64	0.48	8.22		1	30			7.28
MWDJAR10	90		2.58	2.12	0.055	0.034	125		0.64	0.78	8.22		1	40			7.15
MWDJAR10	90		2.58	1.83	0.055	0.032	125		0.64	0.86	8.22		1	50			6.98
MWDJAR10	90		2.58	2.01	0.055	0.027	125		0.64	0.75	8.22		1	60			7.15
MWDJAR10	90		2.58	2.03	0.055	0.030	125		0.64	0.63	8.22		1	70			7.04
MWDJAR10	90		2.58	1.95	0.055	0.026	125		0.64	0.68	8.22		1	80			6.88
MWDJAR10	90		2.58	1.92	0.055	0.027	125		0.64	0.88	8.22		1	90			6.82
MWDJAR10	90		2.58	1.76	0.055	0.036	125		0.64	1.30	8.22		1	100			6.75
MWDJAR10	90		2.58	1.82	0.055	0.028	125		0.64	1.30	8.22		1	110			6.77
MWDJAR11	90		2.67	2.63	0.053	0.048	128		0.49	0.45	8.33		1	0			8.40
MWDJAR11	90		2.67	2.60	0.053	0.037	128		0.49	0.56	8.33		1	10			7.89
MWDJAR11	90		2.67	2.44	0.053	0.039	128		0.49	0.60	8.33		1	20			7.64
MWDJAR11	90		2.67	2.21	0.053	0.025	128		0.49	0.46	8.33		1	30			7.41
MWDJAR11	90		2.67	2.22	0.053	0.026	128		0.49	0.72	8.33		1	40			7.21
MWDJAR11	90		2.67	2.00	0.053	0.024	128		0.49	0.70	8.33		1	50			7.08
MWDJAR11	90		2.67	1.77	0.053	0.022	128		0.49	0.78	8.33		1	60			6.93
MWDJAR11	90		2.67	1.72	0.053	0.023	128		0.49	0.78	8.33		1	70			6.83

Study ID	Water		TOC (mg/L)		UV-254 (1/cm)		Alkalinity (mg/L as CaCO3)		Turbidity (NTU)		pH ()		Coagulation Conditions				
	% CRW	% SPW	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Coagulant ID (see above)	Dose	Acid adjusted? (Y/N) blank=N	Base adjusted? (Y/N) blank=N	Coag. pH ()
MWDJAR11	90		2.67	1.66	0.053	0.026	128		0.49	0.15	8.33		1	80			6.72
MWDJAR11	90		2.67	1.67	0.053	0.022	128		0.49	1.10	8.33		1	90			6.62
MWDJAR12	90		2.95	3.00	0.042	0.043	120		0.67	0.30	8.23		1	0			8.20
MWDJAR12	90		2.95	2.76	0.042	0.032	120		0.67	0.28	8.23		1	10			7.80
MWDJAR12	90		2.95	2.63	0.042	0.031	120		0.67	0.22	8.23		1	20			7.66
MWDJAR12	90		2.95	2.50	0.042	0.031	120		0.67	0.21	8.23		1	30			7.44
MWDJAR12	90		2.95	2.35	0.042	0.029	120		0.67	0.23	8.33		1	40			7.26
MWDJAR12	90		2.95	2.33	0.042	0.029	120		0.67	0.23	8.23		1	50			7.23
MWDJAR12	90		2.95	2.12	0.042	0.032	120		0.67	0.24	8.23		1	60			7.16
MWDJAR12	90		2.95	2.01	0.042	0.029	120		0.67	0.20	8.23		1	70			7.08
MWDJAR12	90		2.95	1.95	0.042	0.029	120		0.67	0.25	8.23		1	80			7.01
MWDJAR12	90		2.95	1.90	0.042	0.027	120		0.67	0.23	8.23		1	90			6.88
MWDJAR12	90		2.95	1.86	0.042	0.028	120		0.67	0.29	8.23		1	100			6.82
MWDJAR12	90		2.95	1.82	0.042	0.027	120		0.67	0.27	8.23		1	110			6.79
MWDJAR12	90		2.95	1.74	0.042	0.028	120		0.67	0.47	8.23		1	120			6.76
MWDJAR12	90		2.95	1.70	0.042	0.028	120		0.67	0.56	8.23		1	130			6.67
MWDJAR12	90		2.95	1.71	0.042	0.026	120		0.67	0.52	8.23		1	140			6.61
MWDJAR12	90		2.95	1.62	0.042	0.026	120		0.67	0.45	8.23		1	150			6.47
MWDJAR12	90		2.95	1.61	0.042	0.027	120		0.67	0.49	8.23		1	160			6.40
MWDJAR12	90		2.95	1.54	0.042	0.027	120		0.67	0.55	8.23		1	170			6.37
MWDJAR12	90		2.95	1.62	0.042	0.028	120		0.67	1.30	8.23		1	180			6.23
MWDJAR12	90		2.95	1.57	0.042	0.026	120		0.67	1.30	8.23		1	190			6.18
MWDJAR12	90		2.95	1.69	0.042	0.052	120		0.67	3.80	8.23		1	200			6.12
MWDJAR13	90		2.25	2.26	0.034	0.035	126		0.77	0.77	8.30		1	0			8.28
MWDJAR13	90		2.25	2.08	0.034	0.023	126		0.77	0.48	8.30		1	10			7.90
MWDJAR13	90		2.25	1.86	0.034	0.021	126		0.77	0.40	8.30		1	20			7.72
MWDJAR13	90		2.25	2.00	0.034	0.019	126		0.77	0.38	8.30		1	30			7.56
MWDJAR13	90		2.25	1.92	0.034	0.018	126		0.77	0.46	8.30		1	40			7.43
MWDJAR13	90		2.25	1.86	0.034	0.018	126		0.77	0.45	8.30		1	50			7.33
MWDJAR13	90		2.25	1.80	0.034	0.018	126		0.77	0.58	8.30		1	60			7.20
MWDJAR13	90		2.25	1.76	0.034	0.015	126		0.77	0.57	8.30		1	70			7.14
MWDJAR13	90		2.25	1.66	0.034	0.013	126		0.77	0.58	8.30		1	80			7.06
MWDJAR13	90		2.25	1.62	0.034	0.013	126		0.77	0.53	8.30		1	90			6.98
MWDJAR13	90		2.25	1.52	0.034	0.012	126		0.77	0.67	8.30		1	100			6.94
MWDJAR13	90		2.25	1.51	0.034	0.012	126		0.77	0.78	8.30		1	110			6.88
MWDJAR14	90		2.31	2.48	0.033	0.033	127		0.58	0.54	8.20		1	0			8.22
MWDJAR14	90		2.31	2.45	0.033	0.025	127		0.58	0.55	8.20		1	10			7.95
MWDJAR14	90		2.31	2.38	0.033	0.023	127		0.58	0.44	8.20		1	20			7.71
MWDJAR14	90		2.31	2.21	0.033	0.021	127		0.58	0.48	8.20		1	30			7.52
MWDJAR14	90		2.31	2.09	0.033	0.020	127		0.58	0.67	8.20		1	40			7.40
MWDJAR14	90		2.31	1.98	0.033	0.018	127		0.58	0.39	8.20		1	50			7.31
MWDJAR14	90		2.31	1.77	0.033	0.017	127		0.58	0.68	8.20		1	60			7.27
MWDJAR14	90		2.31	1.74	0.033	0.015	127		0.58	0.77	8.20		1	70			7.13
MWDJAR14	90		2.31	1.67	0.033	0.017	127		0.58	0.82	8.20		1	80			7.06
MWDJAR14	90		2.31	1.60	0.033	0.015	127		0.58	0.70	8.20		1	90			6.93
MWDJAR14	90		2.31	1.55	0.033	0.015	127		0.58	0.95	8.20		1	100			6.84
MWDJAR14	90		2.31	1.52	0.033	0.014	127		0.58	1.00	8.20		1	110			6.77
MWDJAR14	90		2.31	1.49	0.033	0.015	127		0.58	1.00	8.20		1	120			6.60
MWDJAR14	90		2.31	1.46	0.033	0.016	127		0.58	1.00	8.20		1	130			6.53
MWDJAR14	90		2.31	1.48	0.033		127		0.58		8.20		1	140			
MWDJAR14	90		2.31	1.42	0.033		127		0.58		8.20		1	150			
MWDJAR14	90		2.31	1.33	0.033		127		0.58		8.20		1	160			
MWDJAR15	90		3.17	2.51	0.036	0.041	127		0.47	0.35	8.29		1	0			8.30
MWDJAR15	90		3.17	2.37	0.036	0.034	127		0.47	0.54	8.29		1	10			7.96
MWDJAR15	90		3.17	2.24	0.036	0.031	127		0.47	0.39	8.29		1	20			7.74
MWDJAR15	90		3.17	2.06	0.036	0.028	127		0.47	0.27	8.29		1	30			7.52
MWDJAR15	90		3.17	2.01	0.036	0.026	127		0.47	0.59	8.29		1	40			7.39
MWDJAR15	90		3.17	1.86	0.036	0.028	127		0.47	0.56	8.29		1	50			7.32
MWDJAR15	90		3.17	1.76	0.036	0.025	127		0.47	0.58	8.29		1	60			7.23
MWDJAR15	90		3.17	1.72	0.036	0.024	127		0.47	0.65	8.29		1	70			7.15
MWDJAR15	90		3.17	1.66	0.036	0.024	127		0.47	0.77	8.29		1	80			7.06
MWDJAR15	90		3.17	1.54	0.036	0.024	127		0.47	0.63	8.29		1	90			7.03
MWDJAR15	90		3.17	1.58	0.036	0.022	127		0.47	0.78	8.29		1	100			6.93
MWDJAR16	90		2.43	2.52	0.041	0.042	117		0.42	0.32	8.25		1	0			8.28
MWDJAR16	90		2.43	2.50	0.041	0.031	117		0.42	0.35	8.25		1	10			8.01
MWDJAR16	90		2.43	2.32	0.041	0.026	117		0.42	0.28	8.25		1	20			7.80
MWDJAR16	90		2.43	2.19	0.041	0.025	117		0.42	0.34	8.25		1	30			7.68
MWDJAR16	90		2.43	2.05	0.041	0.024	117		0.42	0.27	8.25		1	40			7.55
MWDJAR16	90		2.43	2.06	0.041	0.024	117		0.42	0.30	8.25		1	50			7.44
MWDJAR16	90		2.43	1.99	0.041	0.022	117		0.42	0.30	8.25		1	60			7.36
MWDJAR16	90		2.43	1.92	0.041	0.021	117		0.42	0.35	8.25		1	70			7.27
MWDJAR16	90		2.43	1.87	0.041	0.021	117		0.42	0.33	8.25		1	80			7.16
MWDJAR16	90		2.43	1.82	0.041	0.021	117		0.42	0.36	8.25		1	90			7.07
MWDJAR16	90		2.43	1.85	0.041	0.021	117		0.42	0.36	8.25		1	100			7.00
MWDJAR16	90		2.43	1.75	0.041	0.020	117		0.42	0.39	8.25		1	110			6.84
MWDJAR16	90		2.43	1.73	0.041	0.019	117		0.42	0.46	8.25		1	120			6.77
MWDJAR16	90		2.43	1.76	0.041	0.018	117		0.42	0.55	8.25		1	130			6.65
MWDJAR16	90		2.43	1.65	0.041	0.018	117		0.42	0.53	8.25		1	140			6.61
MWDJAR16	90		2.43	1.68	0.041	0.017	117		0.42	0.62	8.25		1	150			6.51
MWDJAR16	90		2.43	1.60	0.041	0.016	117		0.42	0.80	8.25		1	160			6.50
MWDJAR16	90		2.43	1.49	0.041	0.015	117		0.42	0.91	8.25		1	170			6.61
MWDJAR16	90		2.43	1.61	0.041	0.014	117		0.42	1.10	8.25		1	180			6.48
MWDJAR16	90		2.43	1.64	0.041	0.013	117		0.42	1.10	8.25		1	190			6.38
MWDJAR16	90		2.43	1.55	0.041	0.014	117		0.42	1.40	8.25		1	200			6.26
MWDJAR16	90		2.43	1.52	0.041	0.013	117		0.42	0.93	8.25		1	210			6.18
MWDJAR16	90		2.43	1.58	0.041	0.013	117		0.42	1.10	8.25		1	220			6.12
MWDJAR17	80		2.55	2.55	0.061		114		1.20	1.20	8.09		1	0			8.04
MWDJAR17	80		2.55	2.61	0.061	0.048	114		1.20	0.49	8.09		1	10			7.68
MWDJAR17	80		2.55	2.55	0.061	0.042	114		1.20	0.41	8.09		1	20			7.46
MWDJAR17	80		2.55	2.39	0.061	0.041	114		1.20	0.34	8.09		1	30			7.24
MWDJAR17	80		2.55	2.39	0.061	0.034	114		1.20	0.61	8.09		1	40			7.15
MWDJAR17	80		2.55	2.13	0.061	0.033	114		1.20	0.39	8.09		1	50			7.01

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDJAR17	80		2.55	2.02	0.061	0.034	114		1.20	0.44	8.09		1	60			6.95
MWDJAR17	80		2.55	1.96	0.061	0.042	114		1.20	1.10	8.09		1	70			6.60
MWDJAR17	80		2.55	1.84	0.061	0.032	114		1.20	0.95	8.09		1	80			6.51
MWDJAR17	80		2.55	1.74	0.061	0.031	114		1.20	0.85	8.09		1	90			6.43
MWDJAR17	80		2.55	1.64	0.061	0.033	114		1.20	1.40	8.09		1	100			6.27
MWDJAR17	80		2.55	1.67	0.061	0.033	114		1.20	1.20	8.09		1	110			6.17
MWDJAR17	80		2.55	1.62	0.061	0.033	114		1.20	1.30	8.09		1	120			6.14
MWDJAR18	80		2.45	2.59	0.054	0.061	121		0.78	0.68	8.22		1	0			8.23
MWDJAR18	80		2.45	2.66	0.054	0.045	121		0.78	0.66	8.22		1	10			7.85
MWDJAR18	80		2.45	2.54	0.054	0.039	121		0.78	0.60	8.22		1	20			7.61
MWDJAR18	80		2.45	2.32	0.054	0.036	121		0.78	0.65	8.22		1	30			7.45
MWDJAR18	80		2.45	2.35	0.054	0.041	121		0.78	0.54	8.22		1	40			7.35
MWDJAR18	80		2.45	2.22	0.054	0.032	121		0.78	0.67	8.22		1	50			7.23
MWDJAR18	80		2.45	1.95	0.054	0.034	121		0.78	0.82	8.22		1	60			6.97
MWDJAR18	80		2.45	1.97	0.054	0.032	121		0.78	0.76	8.22		1	70			7.00
MWDJAR18	80		2.45	1.77	0.054	0.031	121		0.78	0.78	8.22		1	80			6.90
MWDJAR18	80		2.45	1.83	0.054	0.034	121		0.78	0.75	8.22		1	90			6.88
MWDJAR18	80		2.45	1.76	0.054	0.035	121		0.78	0.73	8.22		1	100			6.82
MWDJAR18	80		2.45	1.75	0.054	0.037	121		0.78	1.00	8.22		1	110			6.77
MWDJAR19	80		2.70	2.87	0.049	0.048	122		0.57	0.55	8.38		1	0			8.46
MWDJAR19	80		2.70	2.65	0.049	0.031	122		0.57	0.69	8.38		1	10			7.83
MWDJAR19	80		2.70	2.44	0.049	0.027	122		0.57	0.60	8.38		1	20			7.64
MWDJAR19	80		2.70	2.22	0.049	0.025	122		0.57	0.56	8.38		1	30			7.32
MWDJAR19	80		2.70	2.04	0.049	0.023	122		0.57	0.59	8.38		1	40			7.18
MWDJAR19	80		2.70	2.02	0.049	0.021	122		0.57	0.78	8.38		1	50			7.13
MWDJAR19	80		2.70	1.97	0.049	0.021	122		0.57	0.75	8.38		1	60			6.89
MWDJAR19	80		2.70	1.85	0.049	0.018	122		0.57	0.81	8.38		1	70			6.79
MWDJAR19	80		2.70	1.78	0.049	0.018	122		0.57	0.97	8.38		1	80			6.71
MWDJAR19	80		2.70	1.88	0.049	0.015	122		0.57	0.89	8.38		1	90			6.67
MWDJAR19	80		2.70	1.77	0.049	0.015	122		0.57	0.84	8.38		1	100			6.56
MWDJAR19	80		2.70	1.88	0.049	0.016	122		0.57	1.50	8.38		1	110			6.53
MWDJAR2	100		2.53	2.90	0.042	0.045	133		0.85	0.90	8.38		1	0			8.45
MWDJAR2	100		2.53	2.89	0.042	0.036	133		0.85	0.71	8.38		1	10			8.02
MWDJAR2	100		2.53	2.68	0.042	0.030	133		0.85	0.53	8.38		1	20			7.72
MWDJAR2	100		2.53	2.51	0.042	0.027	133		0.85	0.40	8.38		1	30			7.46
MWDJAR2	100		2.53	2.19	0.042	0.029	133		0.85	0.64	8.38		1	40			7.34
MWDJAR2	100		2.53	2.30	0.042	0.028	133		0.85	0.57	8.38		1	50			7.26
MWDJAR2	100		2.53	2.03	0.042	0.017	133		0.85	0.78	8.38		1	60			6.96
MWDJAR2	100		2.53	1.99	0.042	0.018	133		0.85	1.10	8.38		1	70			6.85
MWDJAR2	100		2.53	1.90	0.042	0.018	133		0.85	1.20	8.38		1	80			6.84
MWDJAR2	100		2.53	1.90	0.042	0.020	133		0.85	1.30	8.38		1	90			6.81
MWDJAR20	80		2.79	2.87	0.053	0.055	114		0.54	0.38	8.21		1	0			8.15
MWDJAR20	80		2.79	2.46	0.053	0.040	114		0.54	0.37	8.21		1	10			7.45
MWDJAR20	80		2.79	2.60	0.053	0.044	114		0.54	0.25	8.21		1	20			7.58
MWDJAR20	80		2.79	2.39	0.053	0.038	114		0.54	0.26	8.21		1	30			7.42
MWDJAR20	80		2.79	2.28	0.053	0.035	114		0.54	0.34	8.21		1	40			7.30
MWDJAR20	80		2.79	2.20	0.053	0.036	114		0.54	0.30	8.21		1	50			7.21
MWDJAR20	80		2.79	2.13	0.053	0.036	114		0.54	0.20	8.21		1	60			7.19
MWDJAR20	80		2.79	2.03	0.053	0.032	114		0.54	0.23	8.21		1	70			7.10
MWDJAR20	80		2.79	1.97	0.053	0.034	114		0.54	0.26	8.21		1	80			7.01
MWDJAR20	80		2.79	1.95	0.053	0.033	114		0.54	0.37	8.21		1	90			6.97
MWDJAR20	80		2.79	1.83	0.053	0.032	114		0.54	0.27	8.21		1	100			6.82
MWDJAR20	80		2.79	1.79	0.053	0.031	114		0.54	0.63	8.21		1	110			6.80
MWDJAR20	80		2.79	1.74	0.053	0.031	114		0.54	0.39	8.21		1	120			6.74
MWDJAR20	80		2.79	1.70	0.053	0.027	114		0.54	0.43	8.21		1	130			6.62
MWDJAR20	80		2.79	1.62	0.053	0.032	114		0.54	0.53	8.21		1	140			6.48
MWDJAR20	80		2.79	1.68	0.053	0.030	114		0.54	0.58	8.21		1	150			6.53
MWDJAR20	80		2.79	1.61	0.053	0.030	114		0.54	0.53	8.21		1	160			6.42
MWDJAR20	80		2.79	1.63	0.053	0.048	114		0.54	0.60	8.21		1	170			4.33
MWDJAR20	80		2.79	1.47	0.053	0.032	114		0.54	1.20	8.21		1	180			6.19
MWDJAR20	80		2.79	1.55	0.053	0.033	114		0.54	1.40	8.21		1	190			6.10
MWDJAR20	80		2.79	1.52	0.053	0.027	114		0.54	1.50	8.21		1	200			6.08
MWDJAR21	80		2.43	2.42	0.036	0.038	121		0.83	0.73	8.22		1	0			8.23
MWDJAR21	80		2.43	2.42	0.036	0.028	121		0.83	0.69	8.22		1	10			7.94
MWDJAR21	80		2.43	2.29	0.036	0.025	121		0.83	0.52	8.22		1	20			7.60
MWDJAR21	80		2.43	2.09	0.036	0.023	121		0.83	0.32	8.22		1	30			7.47
MWDJAR21	80		2.43	2.04	0.036	0.021	121		0.83	0.46	8.22		1	40			7.35
MWDJAR21	80		2.43	1.97	0.036	0.019	121		0.83	0.57	8.22		1	50			7.28
MWDJAR21	80		2.43	1.80	0.036	0.017	121		0.83	0.51	8.22		1	60			7.30
MWDJAR21	80		2.43	1.77	0.036	0.017	121		0.83	0.57	8.22		1	70			7.28
MWDJAR21	80		2.43	1.73	0.036	0.015	121		0.83	0.67	8.22		1	80			7.13
MWDJAR21	80		2.43	1.72	0.036	0.014	121		0.83	0.77	8.22		1	90			7.06
MWDJAR21	80		2.43	1.70	0.036	0.014	121		0.83	0.72	8.22		1	100			6.96
MWDJAR21	80		2.43	1.69	0.036	0.013	121		0.83	0.98	8.22		1	110			6.95
MWDJAR22	80		2.41	2.53	0.038	0.038	121		0.78	0.71	8.15		1	0			8.25
MWDJAR22	80		2.41	2.31	0.038	0.029	121		0.78	0.50	8.15		1	10			7.92
MWDJAR22	80		2.41	2.23	0.038	0.027	121		0.78	0.68	8.15		1	20			7.71
MWDJAR22	80		2.41	2.04	0.038	0.021	121		0.78	0.55	8.15		1	30			7.52
MWDJAR22	80		2.41	1.96	0.038	0.019	121		0.78	0.50	8.15		1	40			7.43
MWDJAR22	80		2.41	1.90	0.038	0.018	121		0.78	0.38	8.15		1	50			7.30
MWDJAR22	80		2.41	1.81	0.038	0.018	121		0.78	0.79	8.15		1	60			7.03
MWDJAR22	80		2.41	1.74	0.038	0.017	121		0.78	0.85	8.15		1	70			6.90
MWDJAR22	80		2.41	1.68	0.038	0.016	121		0.78	0.80	8.15		1	80			6.83
MWDJAR22	80		2.41	1.64	0.038	0.016	121		0.78	0.76	8.15		1	90			6.76
MWDJAR22	80		2.41	1.58	0.038	0.015	121		0.78	0.81	8.15		1	100			6.72
MWDJAR22	80		2.41	1.56	0.038	0.015	121		0.78	0.93	8.15		1	110			6.70
MWDJAR22	80		2.41	1.42	0.038	0.015	121		0.78	0.95	8.15		1	120			6.55
MWDJAR22	80		2.41	1.33	0.038	0.016	121		0.78	0.95	8.15		1	130			6.50
MWDJAR23	80		2.51	2.56	0.050	0.055	121		0.43	0.45	8.32		1	0			8.33
MWDJAR23	80		2.51	2.43	0.050	0.042	121		0.43	0.58	8.32		1	10			7.92
MWDJAR23	80		2.51	2.25	0.050	0.035	121		0.43	0.44	8.32		1	20			7.65
MWDJAR23	80		2.51	2.12	0.050	0.030	121		0.43	0.50	8.32		1	30			7.49

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDJAR23	80		2.51	2.00	0.050	0.021	121		0.43	0.36	8.32		1	40			7.39
MWDJAR23	80		2.51	1.92	0.050	0.024	121		0.43	0.40	8.32		1	50			7.28
MWDJAR23	80		2.51	1.79	0.050	0.023	121		0.43	0.42	8.32		1	60			7.21
MWDJAR23	80		2.51	1.75	0.050	0.018	121		0.43	0.45	8.32		1	70			7.16
MWDJAR23	80		2.51	1.62	0.050	0.022	121		0.43	0.48	8.32		1	80			7.07
MWDJAR23	80		2.51	1.56	0.050	0.019	121		0.43	0.55	8.32		1	90			7.00
MWDJAR23	80		2.51	1.56	0.050	0.021	121		0.43	0.58	8.32		1	100			6.95
MWDJAR24	80		2.57	2.45	0.045	0.046	113		0.65	0.59	8.11		1	0			8.20
MWDJAR24	80		2.57	2.49	0.045	0.035	113		0.65	0.33	8.11		1	10			7.95
MWDJAR24	80		2.57	2.32	0.045	0.031	113		0.65	0.29	8.11		1	20			7.80
MWDJAR24	80		2.57	2.09	0.045	0.027	113		0.65	0.28	8.11		1	30			7.62
MWDJAR24	80		2.57	2.05	0.045	0.027	113		0.65	0.28	8.11		1	40			7.50
MWDJAR24	80		2.57	1.90	0.045	0.026	113		0.65	0.27	8.11		1	50			7.39
MWDJAR24	80		2.57	1.90	0.045	0.025	113		0.65	0.27	8.11		1	60			7.19
MWDJAR24	80		2.57	2.03	0.045	0.023	113		0.65	0.27	8.11		1	70			7.11
MWDJAR24	80		2.57	1.92	0.045	0.028	113		0.65	0.28	8.11		1	80			7.03
MWDJAR24	80		2.57	1.80	0.045	0.021	113		0.65	0.40	8.11		1	90			6.93
MWDJAR24	80		2.57	1.69	0.045	0.021	113		0.65	0.44	8.11		1	100			6.90
MWDJAR24	80		2.57	1.61	0.045	0.020	113		0.65	0.45	8.11		1	110			6.86
MWDJAR24	80		2.57	1.61	0.045	0.020	113		0.65	0.54	8.11		1	120			6.78
MWDJAR24	80		2.57	1.64	0.043	0.020	113		0.65	0.62	8.11		1	130			6.67
MWDJAR24	80		2.57	1.55	0.043	0.019	113		0.65	0.80	8.11		1	140			6.58
MWDJAR24	80		2.57	1.69	0.045	0.018	113		0.65	1.20	8.11		1	150			6.53
MWDJAR24	80		2.57	1.57	0.045	0.018	113		0.65	1.20	8.11		1	160			6.45
MWDJAR24	80		2.57	1.44	0.045	0.017	113		0.65	0.89	8.11		1	170			6.37
MWDJAR24	80		2.57	1.46	0.045	0.017	113		0.65	1.53	8.11		1	180			6.30
MWDJAR24	80		2.57	1.36	0.045	0.016	113		0.65	0.76	8.11		1	190			6.22
MWDJAR24	80		2.57	1.35	0.045	0.015	113		0.65	0.77	8.11		1	200			6.13
MWDJAR24	80		2.57	1.40	0.045	0.015	113		0.65	0.75	8.11		1	210			6.04
MWDJAR24	80		2.57	1.29	0.045	0.015	113		0.65	0.95	8.11		1	220			5.91
MWDJAR25	70		2.67	2.67	0.065		109		0.84	0.75	7.84		1	0			7.92
MWDJAR25	70		2.67	2.59	0.065	0.054	109		0.84	0.65	7.84		1	10			7.64
MWDJAR25	70		2.67	2.49	0.065	0.049	109		0.84	0.65	7.84		1	20			7.41
MWDJAR25	70		2.67	2.20	0.065	0.039	109		0.84	0.43	7.84		1	30			7.13
MWDJAR25	70		2.67	2.10	0.065	0.037	109		0.84	0.50	7.84		1	40			6.98
MWDJAR25	70		2.67	1.97	0.065	0.037	109		0.84	0.76	7.84		1	50			6.85
MWDJAR25	70		2.67	1.92	0.065	0.035	109		0.84	0.77	7.84		1	60			6.72
MWDJAR25	70		2.67	1.82	0.065	0.028	109		0.84	0.90	7.84		1	70			6.58
MWDJAR25	70		2.67	1.82	0.065	0.026	109		0.84	0.85	7.84		1	80			6.50
MWDJAR25	70		2.67	1.66	0.065	0.026	109		0.84	0.87	7.84		1	90			6.42
MWDJAR25	70		2.67	1.68	0.065	0.024	109		0.84	0.95	7.84		1	100			6.22
MWDJAR26	70		2.50	2.56	0.055	0.058	115		0.68	0.82	8.22		1	0			8.22
MWDJAR26	70		2.50	2.53	0.055	0.046	115		0.68	0.76	8.22		1	10			7.79
MWDJAR26	70		2.50	2.39	0.055	0.041	115		0.68	0.78	8.22		1	20			7.57
MWDJAR26	70		2.50	2.29	0.055	0.038	115		0.68	0.75	8.22		1	30			7.43
MWDJAR26	70		2.50	2.01	0.055	0.035	115		0.68	0.73	8.22		1	40			7.28
MWDJAR26	70		2.50	2.02	0.055	0.035	115		0.68	1.00	8.22		1	50			7.18
MWDJAR26	70		2.50	1.96	0.055	0.033	115		0.68	0.67	8.22		1	60			6.97
MWDJAR26	70		2.50	1.75	0.055	0.034	115		0.68	0.70	8.22		1	70			7.00
MWDJAR26	70		2.50	1.75	0.055	0.036	115		0.68	0.70	8.22		1	80			6.81
MWDJAR26	70		2.50	1.71	0.055	0.031	115		0.68	0.41	8.22		1	90			6.78
MWDJAR26	70		2.50	1.62	0.055	0.034	115		0.68	0.57	8.22		1	100			6.77
MWDJAR26	70		2.50	1.72	0.055	0.031	115		0.68	0.72	8.22		1	110			6.56
MWDJAR26	70		2.50	1.63	0.055	0.032	115		0.68	1.20	8.22		1	120			6.46
MWDJAR26	70		2.50	1.56	0.055	0.033	115		0.68	1.40	8.22		1	130			6.39
MWDJAR26	70		2.50	1.53	0.055	0.035	115		0.68	1.70	8.22		1	140			6.33
MWDJAR27	70		3.14	2.94	0.064	0.061	115		0.69	0.62	8.32		1	0			8.39
MWDJAR27	70		3.14	2.38	0.064	0.027	115		0.69	0.49	8.32		1	10			7.34
MWDJAR27	70		3.14	2.62	0.064	0.030	115		0.69	0.43	8.32		1	20			7.33
MWDJAR27	70		3.14	2.48	0.064	0.029	115		0.69	0.41	8.32		1	30			7.35
MWDJAR27	70		3.14	2.44	0.064	0.027	115		0.69	0.52	8.32		1	40			7.05
MWDJAR27	70		3.14	2.14	0.064	0.024	115		0.69	0.55	8.32		1	50			6.99
MWDJAR27	70		3.14	3.87	0.064	0.029	115		0.69	0.61	8.32		1	60			6.78
MWDJAR27	70		3.14	2.81	0.064	0.020	115		0.69	0.71	8.32		1	70			6.67
MWDJAR27	70		3.14	1.93	0.064	0.020	115		0.69	0.62	8.32		1	80			6.63
MWDJAR27	70		3.14	1.83	0.064	0.018	115		0.69	0.74	8.32		1	90			6.56
MWDJAR27	70		3.14	1.72	0.064	0.029	115		0.69	0.84	8.32		1	100			6.42
MWDJAR27	70		3.14	1.96	0.064		115		0.69	1.00	8.32		1	110			6.33
MWDJAR27	70		3.14	1.72	0.064	0.025	115		0.69	1.70	8.32		1	120			6.19
MWDJAR27	70		3.14	1.92	0.064	0.019	115		0.69	2.10	8.32		1	130			6.15
MWDJAR27	70		3.14	1.76	0.064	0.017	115		0.69	1.70	8.32		1	140			6.05
MWDJAR27	70		3.14	1.75	0.064	0.016	115		0.69	3.10	8.32		1	150			5.85
MWDJAR28	70		2.74	2.82	0.058	0.057	111		0.47	0.37	8.12		1	0			8.17
MWDJAR28	70		2.74	2.63	0.058	0.047	111		0.47	0.22	8.12		1	10			7.91
MWDJAR28	70		2.74	2.45	0.058	0.042	111		0.47	0.20	8.12		1	20			7.80
MWDJAR28	70		2.74	2.39	0.058	0.039	111		0.47	0.17	8.12		1	30			7.59
MWDJAR28	70		2.74	2.27	0.058	0.033	111		0.47	0.16	8.12		1	40			7.47
MWDJAR28	70		2.74	2.17	0.058	0.039	111		0.47	0.21	8.12		1	50			7.37
MWDJAR28	70		2.74	2.04	0.058	0.032	111		0.47	0.22	8.12		1	60			7.25
MWDJAR28	70		2.74	2.02	0.058	0.038	111		0.47	0.22	8.12		1	70			7.09
MWDJAR28	70		2.74	1.96	0.058	0.027	111		0.47	0.24	8.12		1	80			7.04
MWDJAR28	70		2.74	1.88	0.058	0.027	111		0.47	0.21	8.12		1	90			6.89
MWDJAR28	70		2.74	1.82	0.058	0.028	111		0.47	0.28	8.12		1	100			6.89
MWDJAR28	70		2.74	1.82	0.058	0.030	111		0.47	0.27	8.12		1	110			6.78
MWDJAR28	70		2.74	1.71	0.058	0.025	111		0.47	0.33	8.12		1	120			6.73
MWDJAR28	70		2.74	1.63	0.058	0.029	111		0.47	0.50	8.12		1	130			6.63
MWDJAR28	70		2.74	1.70	0.058	0.030	111		0.47	0.53	8.12		1	140			6.55
MWDJAR28	70		2.74	1.74	0.058	0.027	111		0.47	0.45	8.12		1	150			6.41
MWDJAR28	70		2.74	1.58	0.058	0.026	111		0.47	0.45	8.12		1	160			6.35
MWDJAR28	70		2.74	1.81	0.058	0.044	111		0.47	0.58	8.12		1	170			6.40
MWDJAR28	70		2.74	1.68	0.058	0.023	111		0.47	0.63	8.12		1	180			6.33
MWDJAR28	70		2.74	1.67	0.058	0.041	111		0.47	0.67	8.12		1	190			6.33

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDJAR29	70		2.50	2.51	0.040	0.040	115		0.68	0.68	8.20		1	0			8.20
MWDJAR29	70		2.50	2.44	0.040	0.030	115		0.68	0.58	8.20		1	10			7.92
MWDJAR29	70		2.50	2.25	0.040	0.026	115		0.68	0.52	8.20		1	20			7.69
MWDJAR29	70		2.50	2.12	0.040	0.023	115		0.68	0.44	8.20		1	30			7.51
MWDJAR29	70		2.50	1.97	0.040	0.020	115		0.68	0.54	8.20		1	40			7.48
MWDJAR29	70		2.50	1.91	0.040	0.020	115		0.68	0.72	8.20		1	50			7.39
MWDJAR29	70		2.50	1.80	0.040	0.019	115		0.68	0.77	8.20		1	60			7.06
MWDJAR29	70		2.50	1.76	0.040	0.018	115		0.68	0.86	8.20		1	70			6.99
MWDJAR29	70		2.50	1.76	0.040	0.018	115		0.68	0.61	8.20		1	80			6.93
MWDJAR29	70		2.50	1.67	0.040	0.017	115		0.68	0.50	8.20		1	90			6.90
MWDJAR29	70		2.50	1.62	0.040	0.016	115		0.68	0.60	8.20		1	100			6.87
MWDJAR29	70		2.50	1.60	0.040	0.015	115		0.68	0.78	8.20		1	110			6.80
MWDJAR29	70		2.50	1.49	0.040	0.015	115		0.68	1.00	8.20		1	120			6.72
MWDJAR29	70		2.50	1.47	0.040	0.017	115		0.68	1.10	8.20		1	130			6.63
MWDJAR29	70		2.50	1.47	0.040	0.016	115		0.68	1.00	8.20		1	140			6.58
MWDJAR29	70		2.50	1.41	0.040	0.018	115		0.68	1.10	8.20		1	150			6.40
MWDJAR29	70		2.50	1.39	0.040	0.014	115		0.68	1.20	8.20		1	160			6.33
MWDJAR29	70		2.50	1.37	0.040	0.014	115		0.68	1.20	8.20		1	170			6.27
MWDJAR3	100		2.50	2.55	0.040	0.037	134		0.42	0.35	8.41		1	0			8.40
MWDJAR3	100		2.50	2.30	0.040	0.029	134		0.42	0.49	8.41		1	10			7.84
MWDJAR3	100		2.50	2.10	0.040	0.029	134		0.42	0.49	8.41		1	20			7.63
MWDJAR3	100		2.50	2.00	0.040	0.025	134		0.42	0.41	8.41		1	30			7.39
MWDJAR3	100		2.50	1.94	0.040	0.023	134		0.42	0.60	8.41		1	40			7.32
MWDJAR3	100		2.50	1.85	0.040	0.022	134		0.42	0.61	8.41		1	50			7.13
MWDJAR3	100		2.50	1.78	0.040	0.022	134		0.42	0.78	8.41		1	60			6.93
MWDJAR3	100		2.50	1.65	0.040	0.019	134		0.42	0.86	8.41		1	70			6.90
MWDJAR3	100		2.50	1.60	0.040	0.020	134		0.42	1.10	8.41		1	80			6.84
MWDJAR30	70		2.44	2.51	0.042	0.042	116		0.8	0.58	8.14		1	0			8.12
MWDJAR30	70		2.44	2.36	0.042	0.032	116		0.8	0.61	8.14		1	10			7.81
MWDJAR30	70		2.44	2.20	0.042	0.027	116		0.8	0.50	8.14		1	20			7.53
MWDJAR30	70		2.44	2.04	0.042	0.024	116		0.8	0.50	8.14		1	30			7.36
MWDJAR30	70		2.44	1.96	0.042	0.022	116		0.8	0.70	8.14		1	40			7.29
MWDJAR30	70		2.44	1.83	0.042	0.021	116		0.8	0.52	8.14		1	50			7.23
MWDJAR30	70		2.44	1.92	0.042	0.019	116		0.8	0.58	8.14		1	60			7.00
MWDJAR30	70		2.44	1.86	0.042	0.019	116		0.8	0.64	8.14		1	70			6.86
MWDJAR30	70		2.44	1.88	0.042	0.017	116		0.8	0.72	8.14		1	80			6.82
MWDJAR30	70		2.44	1.84	0.042	0.016	116		0.8	0.84	8.14		1	90			6.79
MWDJAR30	70		2.44	1.83	0.042	0.015	116		0.8	1.10	8.14		1	100			6.74
MWDJAR30	70		2.44	1.79	0.042	0.015	116		0.8	0.95	8.14		1	110			6.70
MWDJAR30	70		2.44	1.27	0.042	0.019	116		0.8	0.75	8.14		1	120			6.51
MWDJAR30	70		2.44	1.26	0.042	0.018	116		0.8	1.10	8.14		1	130			6.43
MWDJAR30	70		2.44	1.24	0.042	0.017	116		0.8	0.87	8.14		1	140			6.36
MWDJAR30	70		2.44	1.24	0.042	0.016	116		0.8	1.30	8.14		1	150			6.31
MWDJAR30	70		2.44	1.13	0.042	0.015	116		0.8	1.20	8.14		1	160			6.27
MWDJAR31	70		2.60	2.56	0.053	0.053	114		0.45	0.40	8.29		1	0			8.30
MWDJAR31	70		2.60	2.44	0.053	0.052	114		0.45	0.55	8.29		1	10			7.91
MWDJAR31	70		2.60	2.22	0.053	0.036	114		0.45	0.50	8.29		1	20			7.66
MWDJAR31	70		2.60	2.10	0.053	0.033	114		0.45	0.35	8.29		1	30			7.52
MWDJAR31	70		2.60	2.00	0.053	0.031	114		0.45	0.33	8.29		1	40			7.32
MWDJAR31	70		2.60	1.94	0.053	0.029	114		0.45	0.53	8.29		1	50			7.27
MWDJAR31	70		2.60	1.87	0.053	0.028	114		0.45	0.42	8.29		1	60			7.20
MWDJAR31	70		2.60	1.81	0.053	0.026	114		0.45	0.48	8.29		1	70			7.08
MWDJAR31	70		2.60	1.72	0.053	0.024	114		0.45	0.48	8.29		1	80			7.00
MWDJAR31	70		2.60	1.62	0.053	0.023	114		0.45	0.48	8.29		1	90			6.96
MWDJAR31	70		2.60	1.62	0.053	0.023	114		0.45	0.52	8.29		1	100			6.86
MWDJAR31	70		2.60	1.58	0.053	0.021	114		0.45	0.50	8.29		1	110			6.72
MWDJAR31	70		2.60	1.52	0.053	0.021	114		0.45	0.67	8.29		1	120			6.68
MWDJAR31	70		2.60	1.47	0.053	0.020	114		0.45	0.63	8.29		1	130			6.59
MWDJAR31	70		2.60	1.50	0.053	0.020	114		0.45	0.73	8.29		1	140			6.52
MWDJAR31	70		2.60	1.46	0.053	0.019	114		0.45	0.77	8.29		1	150			6.46
MWDJAR31	70		2.60	1.40	0.053	0.018	114		0.45	0.71	8.29		1	160			6.39
MWDJAR31	70		2.60	1.26	0.053	0.018	114		0.45	1.00	8.29		1	170			6.55
MWDJAR31	70		2.60	1.30	0.053	0.017	114		0.45	1.10	8.29		1	180			6.43
MWDJAR31	70		2.60	1.17	0.053	0.017	114		0.45	1.10	8.29		1	190			6.34
MWDJAR31	70		2.60	1.12	0.053	0.016	114		0.45	1.40	8.29		1	200			6.23
MWDJAR32	70		2.49	2.51	0.048	0.047	106		0.52	0.44	8.06		1	0			8.07
MWDJAR32	70		2.49	2.36	0.048	0.047	106		0.52	0.37	8.06		1	10			7.90
MWDJAR32	70		2.49	2.18	0.048	0.040	106		0.52	0.26	8.06		1	20			7.73
MWDJAR32	70		2.49	1.96	0.048	0.042	106		0.52	0.32	8.06		1	30			7.51
MWDJAR32	70		2.49	2.09	0.048	0.035	106		0.52	0.29	8.06		1	40			7.48
MWDJAR32	70		2.49	2.04	0.048	0.030	106		0.52	0.29	8.06		1	50			7.41
MWDJAR32	70		2.49	1.81	0.048	0.027	106		0.52	0.25	8.06		1	60			7.27
MWDJAR32	70		2.49	1.80	0.048	0.022	106		0.52	0.30	8.06		1	70			7.14
MWDJAR32	70		2.49	1.74	0.048	0.022	106		0.52	0.33	8.06		1	80			7.04
MWDJAR32	70		2.49	1.73	0.048	0.022	106		0.52	0.30	8.06		1	90			6.97
MWDJAR32	70		2.49	1.67	0.048	0.023	106		0.52	0.37	8.06		1	100			6.86
MWDJAR32	70		2.49	1.67	0.048	0.023	106		0.52	0.42	8.06		1	110			6.83
MWDJAR32	70		2.49	1.60	0.048	0.021	106		0.52	0.39	8.06		1	120			6.80
MWDJAR32	70		2.49	1.59	0.048	0.019	106		0.52	0.49	8.06		1	130			6.75
MWDJAR32	70		2.49	1.62	0.048	0.018	106		0.52	0.53	8.06		1	140			6.66
MWDJAR32	70		2.49	1.52	0.048	0.018	106		0.52	0.56	8.06		1	150			6.65
MWDJAR32	70		2.49	1.55	0.048	0.018	106		0.52	0.70	8.06		1	160			6.51
MWDJAR32	70		2.49	1.56	0.048	0.017	106		0.52	0.61	8.06		1	170			6.41
MWDJAR32	70		2.49	1.41	0.048	0.017	106		0.52	0.65	8.06		1	180			6.34
MWDJAR32	70		2.49	1.39	0.048	0.017	106		0.52	0.78	8.06		1	190			6.13
MWDJAR32	70		2.49	1.50	0.048	0.015	106		0.52	0.85	8.06		1	200			6.06
MWDJAR32	70		2.49	1.37	0.048	0.015	106		0.52	0.85	8.06		1	210			5.90
MWDJAR32	70		2.49	1.33	0.048	0.015	106		0.52	1.10	8.06		1	220			5.86
MWDJAR33	60		2.72	2.69	0.074		104		1.70		8.03		1	0			7.91
MWDJAR33	60		2.72	2.62	0.074	0.062	104		1.70	0.53	8.03		1	10			7.59
MWDJAR33	60		2.72	2.50	0.074	0.055	104		1.70	0.66	8.03		1	20			7.38
MWDJAR33	60		2.72	2.40	0.074	0.048	104		1.70	0.64	8.03		1	30			7.17

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDJAR33	60		2.72	2.15	0.074	0.043	104		1.70	0.75	8.03		1	40			6.98
MWDJAR33	60		2.72	2.09	0.074	0.042	104		1.70	0.84	8.03		1	50			6.92
MWDJAR33	60		2.72	2.04	0.074	0.041	104		1.70	0.86	8.03		1	60			6.77
MWDJAR33	60		2.72	1.92	0.074	0.039	104		1.70	0.81	8.03		1	70			6.49
MWDJAR33	60		2.72	1.86	0.074	0.038	104		1.70	1.10	8.03		1	80			6.33
MWDJAR33	60		2.72	1.75	0.074	0.035	104		1.70	0.97	8.03		1	90			6.26
MWDJAR33	60		2.72	1.67	0.074	0.037	104		1.70	2.00	8.03		1	100			6.11
MWDJAR34	60		2.51	2.67	0.048	0.043	109		0.77	0.67	8.27		1	0			8.37
MWDJAR34	60		2.51	2.57	0.048	0.035	109		0.77	0.70	8.27		1	10			7.79
MWDJAR34	60		2.51	2.46	0.048	0.031	109		0.77	0.70	8.27		1	20			7.57
MWDJAR34	60		2.51	2.32	0.048	0.025	109		0.77	0.41	8.27		1	30			7.43
MWDJAR34	60		2.51	2.24	0.048	0.025	109		0.77	0.57	8.27		1	40			7.28
MWDJAR34	60		2.51	2.22	0.048	0.024	109		0.77	0.72	8.27		1	50			7.18
MWDJAR34	60		2.51	1.91	0.048	0.021	109		0.77	0.57	8.27		1	60			7.09
MWDJAR34	60		2.51	1.99	0.048	0.020	109		0.77	0.81	8.27		1	70			6.98
MWDJAR34	60		2.51	1.82	0.048	0.019	109		0.77	0.66	8.27		1	80			6.91
MWDJAR34	60		2.51	1.76	0.048	0.027	109		0.77	0.73	8.27		1	90			6.81
MWDJAR34	60		2.51	1.69	0.048	0.023	109		0.77	0.78	8.27		1	100			6.76
MWDJAR34	60		2.51	1.64	0.048	0.022	109		0.77	0.88	8.27		1	110			6.68
MWDJAR34	60		2.51	1.48	0.048	0.035	109		0.77	1.40	8.27		1	120			6.45
MWDJAR34	60		2.51	1.47	0.048	0.036	109		0.77	1.50	8.27		1	130			6.41
MWDJAR35	60		3.44	3.13	0.081	0.077	111		0.74	0.65	8.36		1	0			8.34
MWDJAR35	60		3.44	3.27	0.081	0.054	111		0.74	0.58	8.36		1	10			7.86
MWDJAR35	60		3.44	2.92	0.081	0.044	111		0.74	0.58	8.36		1	20			7.57
MWDJAR35	60		3.44	2.66	0.081	0.038	111		0.74	0.56	8.36		1	30			7.39
MWDJAR35	60		3.44	2.49	0.081	0.036	111		0.74	0.47	8.36		1	40			7.25
MWDJAR35	60		3.44	2.33	0.081	0.031	111		0.74	0.43	8.36		1	50			7.10
MWDJAR35	60		3.44	2.27	0.081	0.043	111		0.74	0.67	8.36		1	60			6.83
MWDJAR35	60		3.44	2.15	0.081	0.034	111		0.74	0.72	8.36		1	70			6.78
MWDJAR35	60		3.44	2.02	0.081	0.028	111		0.74	0.84	8.36		1	80			6.69
MWDJAR35	60		3.44	2.08	0.081	0.028	111		0.74	0.70	8.36		1	90			6.61
MWDJAR35	60		3.44	1.88	0.081	0.026	111		0.74	0.58	8.36		1	100			6.54
MWDJAR35	60		3.44	1.81	0.081	0.028	111		0.74	0.68	8.36		1	110			6.38
MWDJAR35	60		3.44	1.77	0.081	0.028	111		0.74	1.10	8.36		1	120			6.17
MWDJAR35	60		3.44	1.64	0.081	0.027	111		0.74	1.10	8.36		1	130			6.06
MWDJAR35	60		3.44	1.65	0.081	0.031	111		0.74	1.30	8.36		1	140			6.00
MWDJAR35	60		3.44	1.64	0.081	0.028	111		0.74	1.58	8.36		1	150			5.93
MWDJAR36	60		3.22	3.20	0.064	0.063	107		0.43	0.48	8.10		1	0			8.13
MWDJAR36	60		3.22	2.98	0.064	0.051	107		0.43	0.27	8.10		1	10			7.78
MWDJAR36	60		3.22	2.80	0.064	0.047	107		0.43	0.38	8.10		1	20			7.58
MWDJAR36	60		3.22	2.69	0.064	0.044	107		0.43	0.27	8.10		1	30			7.43
MWDJAR36	60		3.22	2.52	0.064	0.040	107		0.43	0.18	8.10		1	40			7.31
MWDJAR36	60		3.22	2.38	0.064	0.038	107		0.43	0.32	8.10		1	50			7.19
MWDJAR36	60		3.22	2.34	0.064	0.037	107		0.43	0.26	8.10		1	60			7.46
MWDJAR36	60		3.22	2.24	0.064	0.035	107		0.43	0.25	8.10		1	70			7.25
MWDJAR36	60		3.22	2.17	0.064	0.034	107		0.43	0.27	8.10		1	80			7.06
MWDJAR36	60		3.22	2.07	0.064	0.033	107		0.43	0.26	8.10		1	90			6.95
MWDJAR36	60		3.22	2.02	0.064	0.030	107		0.43	0.27	8.10		1	100			6.86
MWDJAR36	60		3.22	1.98	0.064	0.037	107		0.43	0.45	8.10		1	110			6.78
MWDJAR36	60		3.22	1.75	0.064	0.026	107		0.43	0.36	8.10		1	120			6.77
MWDJAR36	60		3.22	1.74	0.064	0.026	107		0.43	0.36	8.10		1	130			6.66
MWDJAR36	60		3.22	1.72	0.064	0.027	107		0.43	0.38	8.10		1	140			6.58
MWDJAR36	60		3.22	1.75	0.064	0.026	107		0.43	0.42	8.10		1	150			6.49
MWDJAR36	60		3.22	1.81	0.064	0.025	107		0.43	0.35	8.10		1	160			6.51
MWDJAR36	60		3.22	1.70	0.064	0.039	107		0.43	0.95	8.10		1	170			6.34
MWDJAR36	60		3.22	1.71	0.064	0.037	107		0.43	0.87	8.10		1	180			6.21
MWDJAR36	60		3.22	1.64	0.064	0.050	107		0.43	1.13	8.10		1	190			6.13
MWDJAR37	60		2.56	2.68	0.039	0.038	109		0.88	0.70	8.15		1	0			8.35
MWDJAR37	60		2.56	2.49	0.039	0.036	109		0.88	0.56	8.15		1	10			7.95
MWDJAR37	60		2.56	2.35	0.039	0.030	109		0.88	0.52	8.15		1	20			7.78
MWDJAR37	60		2.56	2.23	0.039	0.026	109		0.88	0.30	8.15		1	30			7.57
MWDJAR37	60		2.56	2.22	0.039	0.024	109		0.88	0.58	8.15		1	40			7.40
MWDJAR37	60		2.56	2.07	0.039	0.023	109		0.88	0.54	8.15		1	50			7.29
MWDJAR37	60		2.56	1.84	0.039	0.021	109		0.88	0.56	8.15		1	60			7.25
MWDJAR37	60		2.56	1.81	0.039	0.019	109		0.88	0.65	8.15		1	70			7.12
MWDJAR37	60		2.56	1.76	0.039	0.017	109		0.88	0.85	8.15		1	80			7.01
MWDJAR37	60		2.56	1.63	0.039	0.015	109		0.88	0.87	8.15		1	90			6.96
MWDJAR37	60		2.56	1.62	0.039	0.016	109		0.88	0.86	8.15		1	100			6.88
MWDJAR37	60		2.56	1.58	0.039	0.015	109		0.88	0.86	8.15		1	110			6.81
MWDJAR37	60		2.56	1.42	0.039	0.018	109		0.88	0.97	8.15		1	120			6.76
MWDJAR37	60		2.56	1.42	0.039	0.017	109		0.88	0.95	8.15		1	130			6.56
MWDJAR37	60		2.56	1.38	0.039	0.015	109		0.88	0.87	8.15		1	140			6.39
MWDJAR37	60		2.56	1.37	0.039	0.015	109		0.88	1.00	8.15		1	150			6.36
MWDJAR37	60		2.56	1.39	0.039	0.015	109		0.88	1.00	8.15		1	160			6.28
MWDJAR37	60		2.56	1.33	0.039	0.014	109		0.88	1.20	8.15		1	170			6.23
MWDJAR38	60		2.49	2.47	0.049	0.049	110		0.84	0.76	8.13		1	0			8.14
MWDJAR38	60		2.49	2.35	0.049	0.035	110		0.84	0.53	8.13		1	10			7.74
MWDJAR38	60		2.49	2.12	0.049	0.027	110		0.84	0.39	8.13		1	20			7.44
MWDJAR38	60		2.49	1.92	0.049	0.023	110		0.84	0.33	8.13		1	30			7.29
MWDJAR38	60		2.49	1.86	0.049	0.020	110		0.84	0.45	8.13		1	40			7.18
MWDJAR38	60		2.49	1.80	0.049	0.020	110		0.84	0.48	8.13		1	50			7.11
MWDJAR38	60		2.49	1.56	0.049	0.020	110		0.84	0.60	8.13		1	60			6.95
MWDJAR38	60		2.49	1.62	0.049	0.018	110		0.84	0.63	8.13		1	70			6.87
MWDJAR38	60		2.49	1.51	0.049	0.017	110		0.84	0.49	8.13		1	80			6.85
MWDJAR38	60		2.49	1.47	0.049	0.017	110		0.84	0.54	8.13		1	90			6.79
MWDJAR38	60		2.49	1.38	0.049	0.014	110		0.84	0.84	8.13		1	100			6.71
MWDJAR38	60		2.49	1.39	0.049	0.014	110		0.84	0.83	8.13		1	110			6.59
MWDJAR38	60		2.49	1.34	0.049	0.020	110		0.84	0.97	8.13		1	120			6.53
MWDJAR38	60		2.49	1.35	0.049	0.021	110		0.84	0.95	8.13		1	130			6.48
MWDJAR38	60		2.49	1.34	0.049	0.020	110		0.84	1.10	8.13		1	140			6.39
MWDJAR38	60		2.49	1.29	0.049	0.019	110		0.84	1.20	8.13		1	150			6.33
MWDJAR38	60		2.49	1.31	0.049	0.018	110		0.84	1.20	8.13		1	160			6.21

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDJAR39	60		2.68	2.69	0.059	0.057	109		0.48	0.45	8.26		1	0			8.22
MWDJAR39	60		2.68	2.48	0.059	0.042	109		0.48	0.51	8.26		1	10			7.87
MWDJAR39	60		2.68	2.31	0.059	0.039	109		0.48	0.37	8.26		1	20			7.65
MWDJAR39	60		2.68	2.15	0.059	0.035	109		0.48	0.31	8.26		1	30			7.52
MWDJAR39	60		2.68	1.98	0.059	0.031	109		0.48	0.38	8.26		1	40			7.36
MWDJAR39	60		2.68	1.87	0.059	0.030	109		0.48	0.37	8.26		1	50			7.29
MWDJAR39	60		2.68	1.80	0.059	0.026	109		0.48	0.42	8.26		1	60			7.12
MWDJAR39	60		2.68	1.74	0.059	0.026	109		0.48	0.54	8.26		1	70			7.02
MWDJAR39	60		2.68	1.66	0.059	0.025	109		0.48	0.48	8.26		1	80			6.95
MWDJAR39	60		2.68	1.61	0.059	0.023	109		0.48	0.58	8.26		1	90			6.88
MWDJAR39	60		2.68	1.60	0.059	0.022	109		0.48	0.68	8.26		1	100			6.79
MWDJAR39	60		2.68	1.60	0.059	0.025	109		0.48	0.77	8.26		1	110			6.83
MWDJAR39	60		2.68	1.50	0.059	0.023	109		0.48	0.76	8.26		1	120			6.75
MWDJAR39	60		2.68	1.57	0.059	0.023	109		0.48	1.00	8.26		1	130			6.62
MWDJAR39	60		2.68	1.43	0.059	0.021	109		0.48	0.80	8.26		1	140			6.42
MWDJAR39	60		2.68	1.41	0.059	0.021	109		0.48	0.92	8.26		1	150			6.38
MWDJAR39	60		2.68	1.34	0.059	0.021	109		0.48	0.92	8.26		1	160			6.27
MWDJAR4	100		2.55	2.67	0.043	0.040	123		0.85	0.20	8.23		1	0			8.08
MWDJAR4	100		2.55	2.68	0.043	0.038	123		0.85	0.40	8.23		1	10			7.83
MWDJAR4	100		2.55	2.54	0.043	0.034	123		0.85	0.30	8.23		1	20			7.60
MWDJAR4	100		2.55	2.44	0.043	0.031	123		0.85	0.26	8.23		1	30			7.49
MWDJAR4	100		2.55	2.31	0.043	0.029	123		0.85	0.21	8.23		1	40			7.37
MWDJAR4	100		2.55	2.26	0.043	0.029	123		0.85	0.33	8.23		1	50			7.27
MWDJAR4	100		2.55	2.09	0.043	0.027	123		0.85	0.21	8.23		1	60			7.21
MWDJAR4	100		2.55	2.04	0.043	0.030	123		0.85	0.22	8.23		1	70			7.05
MWDJAR4	100		2.55	1.95	0.043	0.026	123		0.85	0.25	8.23		1	80			6.97
MWDJAR4	100		2.55	1.92	0.043	0.027	123		0.85	0.31	8.23		1	90			6.91
MWDJAR4	100		2.55	1.84	0.043	0.025	123		0.85	0.25	8.23		1	100			6.82
MWDJAR4	100		2.55	1.85	0.043	0.027	123		0.85	0.55	8.23		1	110			6.75
MWDJAR40	60		2.57	2.53	0.042	0.046	101		3.10	0.52	8.05		1	0			8.03
MWDJAR40	60		2.57	2.41	0.042	0.042	101		3.10	0.33	8.05		1	10			7.85
MWDJAR40	60		2.57	3.35	0.042	0.035	101		3.10	0.34	8.05		1	20			7.68
MWDJAR40	60		2.57	2.16	0.042	0.032	101		3.10	0.24	8.05		1	30			7.54
MWDJAR40	60		2.57	2.04	0.042	0.030	101		3.10	0.27	8.05		1	40			7.33
MWDJAR40	60		2.57	1.80	0.042	0.028	101		3.10	0.24	8.05		1	50			7.26
MWDJAR40	60		2.57	1.76	0.042	0.026	101		3.10	0.20	8.05		1	60			7.13
MWDJAR40	60		2.57	1.66	0.042	0.024	101		3.10	0.32	8.05		1	70			7.02
MWDJAR40	60		2.57	1.66	0.042	0.022	101		3.10	0.38	8.05		1	80			6.96
MWDJAR40	60		2.57	1.59	0.042	0.021	101		3.10	0.33	8.05		1	90			6.89
MWDJAR40	60		2.57	1.57	0.042	0.021	101		3.10	0.38	8.05		1	100			6.75
MWDJAR40	60		2.57	1.49	0.042	0.022	101		3.10	0.45	8.05		1	110			6.74
MWDJAR40	60		2.57	1.48	0.042	0.021	101		3.10	0.54	8.05		1	120			6.70
MWDJAR40	60		2.57	1.47	0.042	0.020	101		3.10	0.61	8.05		1	130			6.65
MWDJAR40	60		2.57	1.39	0.042	0.019	101		3.10	0.69	8.05		1	140			6.54
MWDJAR40	60		2.57	1.39	0.042	0.019	101		3.10	0.70	8.05		1	150			6.46
MWDJAR40	60		2.57	1.36	0.042	0.018	101		3.10	0.75	8.05		1	160			6.39
MWDJAR40	60		2.57	1.53	0.042	0.017	101		3.10	0.80	8.05		1	170			6.30
MWDJAR40	60		2.57	1.61	0.042	0.017	101		3.10	1.20	8.05		1	180			6.19
MWDJAR40	60		2.57	1.50	0.042	0.016	101		3.10	1.20	8.05		1	190			6.13
MWDJAR41	50		2.64	2.78	0.079		94		0.85		8.13		1	0			7.98
MWDJAR41	50		2.64	2.69	0.079	0.065	94		0.85	0.56	8.13		1	10			7.47
MWDJAR41	50		2.64	2.50	0.079	0.058	94		0.85	0.65	8.13		1	20			7.25
MWDJAR41	50		2.64	2.40	0.079		94		0.85	0.50	8.13		1	30			7.05
MWDJAR41	50		2.64	2.23	0.079	0.040	94		0.85	0.50	8.13		1	40			6.93
MWDJAR41	50		2.64	2.13	0.079	0.041	94		0.85	0.70	8.13		1	50			6.82
MWDJAR41	50		2.64	2.15	0.079	0.040	94		0.85	0.58	8.13		1	60			6.73
MWDJAR41	50		2.64	1.97	0.079	0.031	94		0.85	0.80	8.13		1	70			6.61
MWDJAR41	50		2.64	1.96	0.079	0.031	94		0.85	1.00	8.13		1	80			6.44
MWDJAR41	50		2.64	1.85	0.079	0.030	94		0.85	0.98	8.13		1	90			6.19
MWDJAR42	50		2.37	2.52	0.061	0.054	103		0.75	0.78	8.17		1	0			8.15
MWDJAR42	50		2.37	2.32	0.061	0.034	103		0.75	0.57	8.17		1	10			7.49
MWDJAR42	50		2.37	2.19	0.061	0.031	103		0.75	0.68	8.17		1	20			7.32
MWDJAR42	50		2.37	2.00	0.061	0.027	103		0.75	0.51	8.17		1	30			7.12
MWDJAR42	50		2.37	1.91	0.061	0.025	103		0.75	0.86	8.17		1	40			7.03
MWDJAR42	50		2.37	1.79	0.061	0.028	103		0.75	0.85	8.17		1	50			6.88
MWDJAR42	50		2.37	1.77	0.061	0.024	103		0.75	1.10	8.17		1	60			6.69
MWDJAR42	50		2.37	1.83	0.061	0.028	103		0.75	1.30	8.17		1	70			6.60
MWDJAR42	50		2.37	1.80	0.061	0.028	103		0.75	1.50	8.17		1	80			6.51
MWDJAR42	50		2.37	1.66	0.061	0.024	103		0.75	1.40	8.17		1	90			6.49
MWDJAR42	50		2.37	1.72	0.061	0.026	103		0.75	1.50	8.17		1	100			6.41
MWDJAR42	50		2.37	1.58	0.061	0.028	103		0.75	1.50	8.17		1	110			6.26
MWDJAR43	50		3.18	3.41	0.081	0.079	106		0.87	0.74	8.32		1	0			8.37
MWDJAR43	50		3.18	3.03	0.081	0.058	106		0.87	0.86	8.32		1	10			7.82
MWDJAR43	50		3.18	2.78	0.081	0.046	106		0.87	0.72	8.32		1	20			7.58
MWDJAR43	50		3.18	2.50	0.081	0.039	106		0.87	0.66	8.32		1	30			7.36
MWDJAR43	50		3.18	2.26	0.081	0.036	106		0.87	0.51	8.32		1	40			7.22
MWDJAR43	50		3.18	2.29	0.081	0.036	106		0.87	0.51	8.32		1	50			7.13
MWDJAR43	50		3.18	2.28	0.081	0.038	106		0.87	0.61	8.32		1	60			6.71
MWDJAR43	50		3.18	2.10	0.081	0.036	106		0.87	0.67	8.32		1	70			6.70
MWDJAR43	50		3.18	2.02	0.081	0.032	106		0.87	0.76	8.32		1	80			6.58
MWDJAR43	50		3.18	2.08	0.081	0.034	106		0.87	0.73	8.32		1	90			6.54
MWDJAR43	50		3.18	2.05	0.081	0.032	106		0.87	0.76	8.32		1	100			6.49
MWDJAR43	50		3.18	2.07	0.081	0.030	106		0.87	1.20	8.32		1	110			6.33
MWDJAR43	50		3.18	1.92	0.082	0.030	106		0.87	1.10	8.32		1	120			6.24
MWDJAR43	50		3.18	2.11	0.081	0.027	106		0.87	1.40	8.32		1	130			6.13
MWDJAR43	50		3.18	1.77	0.081	0.026	106		0.87	2.00	8.32		1	140			5.99
MWDJAR43	50		3.18	2.02	0.081	0.025	106		0.87	1.40	8.32		1	150			5.93
MWDJAR44	50		3.11	3.17	0.066	0.070	103		1.30	0.51	7.99		1	0			8.14
MWDJAR44	50		3.11	2.20	0.066	0.049	103		1.30	0.28	7.99		1	10			7.76
MWDJAR44	50		3.11	2.78	0.066	0.045	103		1.30	0.27	7.99		1	20			7.50
MWDJAR44	50		3.11	2.64	0.066	0.041	103		1.30	0.24	7.99		1	30			7.36
MWDJAR44	50		3.11	2.42	0.066	0.036	103		1.30	0.25	7.99		1	40			7.20

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDIAR44	50		3.11	2.32	0.066	0.035	103		1.30	0.21	7.99		1	50			7.14
MWDIAR44	50		3.11	2.25	0.066	0.032	103		1.30	0.19	7.99		1	60			7.07
MWDIAR44	50		3.11	3.04	0.066	0.033	103		1.30	0.25	7.99		1	70			6.93
MWDIAR44	50		3.11	2.07	0.066	0.033	103		1.30	0.29	7.99		1	80			6.87
MWDIAR44	50		3.11	2.02	0.066	0.030	103		1.30	0.33	7.99		1	90			6.78
MWDIAR44	50		3.11	1.97	0.066	0.028	103		1.30	0.35	7.99		1	100			6.68
MWDIAR44	50		3.11	1.85	0.066	0.027	103		1.30	0.28	7.99		1	110			6.63
MWDIAR44	50		3.11	1.83	0.066	0.030	103		1.30	0.46	7.99		1	120			6.52
MWDIAR44	50		3.11	1.83	0.066	0.030	103		1.30	0.56	7.99		1	130			6.51
MWDIAR44	50		3.11	1.78	0.066	0.028	103		1.30	0.52	7.99		1	140			6.44
MWDIAR44	50		3.11	1.69	0.066	0.028	103		1.30	0.44	7.99		1	150			6.34
MWDIAR44	50		3.11	1.66	0.066	0.030	103		1.30	0.45	7.99		1	160			6.34
MWDIAR45	50		2.46	2.63		0.061	105		0.87	0.78	8.14		1	0			8.27
MWDIAR45	50		2.46	2.30		0.047	105		0.87	0.55	8.14		1	10			7.91
MWDIAR45	50		2.46	2.26		0.042	105		0.87	0.50	8.14		1	20			7.52
MWDIAR45	50		2.46	2.07		0.036	105		0.87	0.52	8.14		1	30			7.55
MWDIAR45	50		2.46	1.96		0.034	105		0.87	0.33	8.14		1	40			7.31
MWDIAR45	50		2.46	1.84		0.032	105		0.87	0.40	8.14		1	50			7.26
MWDIAR45	50		2.46	1.82		0.029	105		0.87	0.52	8.14		1	60			7.16
MWDIAR45	50		2.46	1.72		0.028	105		0.87	0.44	8.14		1	70			7.12
MWDIAR45	50		2.46	1.76		0.027	105		0.87	0.62	8.14		1	80			7.02
MWDIAR45	50		2.46	1.69		0.026	105		0.87	0.64	8.14		1	90			6.80
MWDIAR45	50		2.46	1.59		0.025	105		0.87	0.72	8.14		1	100			6.76
MWDIAR45	50		2.46	1.56		0.024	105		0.87	0.94	8.14		1	110			6.71
MWDIAR45	50		2.46	1.52		0.023	105		0.87	0.65	8.14		1	120			6.62
MWDIAR45	50		2.46	1.46		0.022	105		0.87	0.80	8.14		1	130			6.50
MWDIAR45	50		2.46	1.45		0.021	105		0.87	1.00	8.14		1	140			6.48
MWDIAR45	50		2.46	1.48		0.016	105		0.87	1.10	8.14		1	150			6.52
MWDIAR45	50		2.46	1.38		0.015	105		0.87	1.20	8.14		1	160			6.39
MWDIAR45	50		2.46	1.36		0.014	105		0.87	1.30	8.14		1	170			6.37
MWDIAR45	50		2.46	1.31		0.015	105		0.87	1.50	8.14		1	180			6.18
MWDIAR46	50		2.46	2.56	0.040	0.040	105		0.73	0.60	8.13		1	0			8.20
MWDIAR46	50		2.46	2.54	0.040	0.028	105		0.73	0.70	8.13		1	10			7.86
MWDIAR46	50		2.46	2.43	0.040	0.019	105		0.73	0.44	8.13		1	20			7.63
MWDIAR46	50		2.46	2.13	0.040	0.013	105		0.73	0.29	8.13		1	30			7.45
MWDIAR46	50		2.46	2.05	0.040	0.011	105		0.73	0.52	8.13		1	40			7.31
MWDIAR46	50		2.46	2.00	0.040	0.010	105		0.73	0.67	8.13		1	50			7.19
MWDIAR46	50		2.46	1.86	0.040	0.010	105		0.73	0.66	8.13		1	60			7.17
MWDIAR46	50		2.46	1.73	0.040	0.010	105		0.73	0.71	8.13		1	70			7.04
MWDIAR46	50		2.46	1.75	0.040	0.010	105		0.73	0.83	8.13		1	80			6.93
MWDIAR46	50		2.46	1.62	0.040	0.007	105		0.73	0.75	8.13		1	90			6.84
MWDIAR46	50		2.46	1.59	0.040	0.004	105		0.73	0.95	8.13		1	100			6.75
MWDIAR46	50		2.46	1.59	0.040	0.004	105		0.73	1.50	8.13		1	110			6.66
MWDIAR46	50		2.46	1.26	0.040	0.023	105		0.73	1.00	8.13		1	120			6.50
MWDIAR46	50		2.46	1.32	0.040	0.019	105		0.73	1.10	8.13		1	130			6.46
MWDIAR46	50		2.46	1.18	0.040	0.017	105		0.73	0.25	8.13		1	140			6.31
MWDIAR46	50		2.46	1.17	0.040	0.016	105		0.73	1.10	8.13		1	150			6.27
MWDIAR46	50		2.46	1.15	0.040	0.021	105		0.73	1.30	8.13		1	160			6.15
MWDIAR47	50		2.79	1.79	0.063	0.062	102		0.42	0.40	8.23		1	0			8.27
MWDIAR47	50		2.79	2.70	0.063	0.049	102		0.42	0.50	8.23		1	10			7.85
MWDIAR47	50		2.79	2.39	0.063	0.041	102		0.42	0.48	8.23		1	20			7.56
MWDIAR47	50		2.79	2.20	0.063	0.036	102		0.42	0.39	8.23		1	30			7.38
MWDIAR47	50		2.79	2.15	0.063	0.032	102		0.42	0.42	8.23		1	40			7.23
MWDIAR47	50		2.79	1.94	0.063	0.028	102		0.42	0.45	8.23		1	50			7.18
MWDIAR47	50		2.79	1.84	0.063	0.026	102		0.42	0.50	8.23		1	60			7.13
MWDIAR47	50		2.79	1.76	0.063	0.025	102		0.42	0.50	8.23		1	70			7.03
MWDIAR47	50		2.79	1.69	0.063	0.024	102		0.42	0.43	8.23		1	80			6.92
MWDIAR47	50		2.79	1.60	0.063	0.024	102		0.42	0.54	8.23		1	90			6.87
MWDIAR47	50		2.79	1.58	0.063	0.022	102		0.42	0.58	8.23		1	100			6.77
MWDIAR47	50		2.79	1.61	0.063	0.023	102		0.42	0.68	8.23		1	110			6.61
MWDIAR47	50		2.79	1.53	0.063	0.021	102		0.42	0.84	8.23		1	120			6.46
MWDIAR47	50		2.79	1.50	0.063	0.021	102		0.42	0.82	8.23		1	130			6.38
MWDIAR47	50		2.79	1.49	0.063	0.020	102		0.42	0.86	8.23		1	140			6.34
MWDIAR47	50		2.79	1.44	0.063	0.019	102		0.42	0.90	8.23		1	150			6.20
MWDIAR47	50		2.79	1.45	0.063	0.020	102		0.42	1.30	8.23		1	160			6.11
MWDIAR48		100	3.31	3.31	0.126		73		2.40	1.30	7.91		1	0			7.87
MWDIAR48		100	3.31	3.21	0.126	0.103	73		2.40	0.88	7.91		1	10			7.57
MWDIAR48		100	3.31	3.05	0.126	0.081	73		2.40	0.53	7.91		1	20			7.32
MWDIAR48		100	3.31	2.68	0.126	0.066	73		2.40	0.54	7.91		1	30			7.14
MWDIAR48		100	3.31	2.36	0.126	0.061	73		2.40	0.52	7.91		1	40			6.83
MWDIAR48		100	3.31	2.22	0.126	0.054	73		2.40	0.45	7.91		1	50			6.79
MWDIAR48		100	3.31	2.11	0.126	0.049	73		2.40	0.50	7.91		1	60			6.64
MWDIAR48		100	3.31	1.89	0.126	0.049	73		2.40	0.95	7.91		1	70			6.15
MWDIAR48		100	3.31	1.83	0.126	0.050	73		2.40	0.83	7.91		1	80			6.09
MWDIAR48		100	3.31	1.78	0.126	0.049	73		2.40	1.10	7.91		1	90			5.80
MWDIAR49	50		2.55	2.55	0.057	0.057	94		0.34	0.36	7.93		1	0			7.95
MWDIAR49	50		2.55	2.32	0.057	0.051	94		0.34	0.17	7.93		1	10			7.86
MWDIAR49	50		2.55	2.30	0.057	0.045	94		0.34	0.17	7.93		1	20			7.71
MWDIAR49	50		2.55	2.14	0.057	0.041	94		0.34	0.19	7.93		1	30			7.59
MWDIAR49	50		2.55	1.97	0.057	0.033	94		0.34	0.20	7.93		1	40			7.48
MWDIAR49	50		2.55	1.86	0.057	0.032	94		0.34	0.20	7.93		1	50			7.39
MWDIAR49	50		2.55	1.74	0.057	0.030	94		0.34	0.20	7.93		1	60			7.34
MWDIAR49	50		2.55	1.68	0.057	0.028	94		0.34	0.19	7.93		1	70			7.27
MWDIAR49	50		2.55	1.67	0.057	0.026	94		0.34	0.20	7.93		1	80			7.15
MWDIAR49	50		2.55	1.61	0.057	0.024	94		0.34	0.22	7.93		1	90			7.13
MWDIAR49	50		2.55	1.49	0.057	0.023	94		0.34	0.40	7.93			100			7.02
MWDIAR49	50		2.55	1.55	0.057	0.023	94		0.34	0.38	7.93			110			6.95
MWDIAR49	50		2.55	1.58	0.057	0.022	94		0.34	0.42	7.93		1	120			6.80
MWDIAR49	50		2.55	1.56	0.057	0.021	94		0.34	0.42	7.93		1	130			6.63
MWDIAR49	50		2.55	1.49	0.057	0.020	94		0.34	0.44	7.93		1	140			6.55
MWDIAR49	50		2.55	1.47	0.057	0.020	94		0.34	0.70	7.93		1	150			6.44
MWDIAR49	50		2.55	1.41	0.057	0.024	94		0.34	1.20	7.93		1	160			6.32

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDJAR49		100	2.33	2.36	0.077	0.074	73			0.85	8.07		1	0			8.07
MWDJAR49		100	2.33	2.20	0.077	0.064	73			0.57	8.07		1	10			7.65
MWDJAR49		100	2.33	2.19	0.077	0.050	73			0.75	8.07		1	20			7.41
MWDJAR49		100	2.33	2.03	0.077	0.046	73			0.56	8.07		1	30			7.24
MWDJAR49		100	2.33	1.84	0.077	0.043	73			0.72	8.07		1	40			7.15
MWDJAR49		100	2.33	1.75	0.077	0.040	73			0.75	8.07		1	50			7.05
MWDJAR49		100	2.33	1.72	0.077	0.040	73			0.53	8.07		1	60			7.00
MWDJAR49		100	2.33	1.78	0.077	0.037	73			0.47	8.07		1	70			6.87
MWDJAR49		100	2.33	1.42	0.077	0.035	73			0.47	8.07		1	80			6.73
MWDJAR49		100	2.33	1.41	0.077	0.035	73			0.57	8.07		1	90			6.66
MWDJAR49		100	2.33	1.54	0.077	0.030	73			0.56	8.07		1	100			6.58
MWDJAR49		100	2.33	1.31	0.077	0.028	73			0.60	8.07		1	110			6.45
MWDJAR49		100	2.33	1.30	0.077	0.031	73			0.45	8.07		1	120			6.38
MWDJAR49		100	2.33	1.25	0.077	0.029	73			0.60	8.07		1	130			6.23
MWDJAR49		100	2.33	1.20	0.077	0.028	73			0.65	8.07		1	140			6.14
MWDJAR5	100		2.37	2.40	0.048	0.048	131		0.76	0.58	8.23		1	0			8.23
MWDJAR5	100		2.37	2.27	0.048	0.043	131		0.76	0.57	8.23		1	10			7.88
MWDJAR5	100		2.37	2.19	0.048	0.038	131		0.76	0.47	8.23		1	20			7.77
MWDJAR5	100		2.37	2.32	0.048	0.036	131		0.76	0.59	8.23		1	30			7.66
MWDJAR5	100		2.37	2.07	0.048	0.033	131		0.76	0.61	8.23		1	40			7.52
MWDJAR5	100		2.37	1.96	0.048	0.029	131		0.76	0.46	8.23		1	50			7.44
MWDJAR5	100		2.37	1.94	0.048	0.028	131		0.76	0.78	8.23		1	60			7.36
MWDJAR5	100		2.37	1.84	0.048	0.026	131		0.76	0.77	8.23		1	70			7.25
MWDJAR5	100		2.37	1.77	0.048	0.025	131		0.76	0.82	8.23		1	80			7.16
MWDJAR5	100		2.37	1.75	0.048	0.024	131		0.76	0.85	8.23		1	90			7.05
MWDJAR5	100		2.37	1.68	0.048	0.015	131		0.76	0.86	8.23		1	100			7.06
MWDJAR5	100		2.37	1.65	0.048	0.015	131		0.76	1.30	8.23		1	110			6.97
MWDJAR50		100	3.90	4.45	0.110	0.109	77		1.7	1.50	8.00		1	0			8.00
MWDJAR50		100	3.90	3.69	0.110	0.072	77		1.7	0.79	8.00		1	10			7.44
MWDJAR50		100	3.90	3.17	0.110	0.049	77		1.7	0.39	8.00		1	20			7.15
MWDJAR50		100	3.90	2.81	0.110	0.037	77		1.7	0.38	8.00		1	30			6.99
MWDJAR50		100	3.90	2.38	0.110	0.032	77		1.7	0.31	8.00		1	40			6.92
MWDJAR50		100	3.90	2.25	0.110	0.029	77		1.7	0.66	8.00		1	50			6.89
MWDJAR50		100	3.90	2.16	0.110	0.024	77		1.7	0.60	8.00		1	60			6.66
MWDJAR50		100	3.90	2.06	0.110	0.020	77		1.7	0.58	8.00		1	70			6.45
MWDJAR50		100	3.90	1.99	0.110	0.020	77		1.7	0.63	8.00		1	80			6.31
MWDJAR50		100	3.90	2.00	0.110	0.021	77		1.7	0.67	8.00		1	90			6.14
MWDJAR50		100	3.90	2.03	0.110	0.018	77		1.7	1.10	8.00		1	100			5.93
MWDJAR50		100	3.90	1.80	0.110	0.020	77		1.7	0.90	8.00		1	110			5.70
MWDJAR51		100	3.09	3.17	0.097	0.103	81		0.85	2.30	7.80		1	0			7.86
MWDJAR51		100	3.09	2.94	0.097	0.077	81		0.85	0.33	7.80		1	10			7.58
MWDJAR51		100	3.09	3.28	0.097	0.072	81		0.85	0.36	7.80		1	20			7.38
MWDJAR51		100	3.09	2.97	0.097	0.066	81		0.85	0.40	7.80		1	30			7.14
MWDJAR51		100	3.09	2.42	0.097	0.054	81		0.85	0.29	7.80		1	40			7.06
MWDJAR51		100	3.09	2.25	0.097	0.049	81		0.85	0.45	7.80		1	50			7.00
MWDJAR51		100	3.09	2.15	0.097	0.051	81		0.85	0.30	7.80		1	60			6.97
MWDJAR51		100	3.09	2.32	0.097	0.044	81		0.85	0.36	7.80		1	70			6.77
MWDJAR51		100	3.09	2.31	0.097	0.040	81		0.85	0.31	7.80		1	80			6.66
MWDJAR51		100	3.09	2.33	0.097	0.039	81		0.85	0.38	7.80		1	90			6.57
MWDJAR51		100	3.09	2.08	0.097	0.036	81		0.85	0.32	7.80		1	100			6.43
MWDJAR51		100	3.09	1.94	0.097	0.040	81		0.85	0.62	7.80		1	110			6.35
MWDJAR51		100	3.09	1.74	0.097	0.038	81		0.85	0.35	7.80		1	120			6.33
MWDJAR51		100	3.09	1.91	0.097	0.035	81		0.85	0.30	7.80		1	130			6.25
MWDJAR52		100	2.78	2.94		0.080			0.78	0.77	7.72		1	0			7.91
MWDJAR52		100	2.78	2.38		0.061			0.78	0.40	7.72		1	10			7.70
MWDJAR52		100	2.78	2.40		0.051			0.78	0.36	7.72		1	20			7.33
MWDJAR52		100	2.78	2.09		0.048			0.78	0.31	7.72		1	30			7.14
MWDJAR52		100	2.78	1.95		0.040			0.78	0.33	7.72		1	40			7.11
MWDJAR52		100	2.78	1.82		0.034			0.78	0.32	7.72		1	50			6.92
MWDJAR52		100	2.78	1.75		0.031			0.78	0.37	7.72		1	60			6.88
MWDJAR52		100	2.78	1.64		0.028			0.78	0.47	7.72		1	70			6.84
MWDJAR52		100	2.78	1.52		0.026			0.78	0.64	7.72		1	80			6.71
MWDJAR52		100	2.78	1.49		0.025			0.78	0.50	7.72		1	90			6.63
MWDJAR52		100	2.78	1.47		0.025			0.78	0.54	7.72		1	100			6.58
MWDJAR52		100	2.78	1.43		0.024			0.78	0.50	7.72		1	110			6.45
MWDJAR52		100	2.78	1.36		0.023			0.78	0.52	7.72		1	120			6.34
MWDJAR52		100	2.78	1.29		0.023			0.78	0.65	7.72		1	130			6.25
MWDJAR52		100	2.78	1.34		0.024			0.78	1.00	7.72		1	140			6.07
MWDJAR53		100	2.25	2.40	0.065	0.066	79		1.10	0.38	7.98		1	0			7.98
MWDJAR53		100	2.25	2.24	0.065	0.046	79		1.10	0.48	7.98		1	10			7.58
MWDJAR53		100	2.25	1.98	0.065	0.031	79		1.10	0.40	7.98		1	20			7.33
MWDJAR53		100	2.25	2.06	0.065	0.021	79		1.10	0.38	7.98		1	30			7.13
MWDJAR53		100	2.25	1.59	0.065	0.017	79		1.10	0.42	7.98		1	40			7.07
MWDJAR53		100	2.25	1.75	0.065	0.016	79		1.10	0.46	7.98		1	50			6.97
MWDJAR53		100	2.25	1.45	0.065	0.013	79		1.10	0.59	7.98		1	60			6.69
MWDJAR53		100	2.25	1.38	0.065	0.009	79		1.10	0.74	7.98		1	70			6.61
MWDJAR53		100	2.25	1.29	0.065	0.008	79		1.10	0.69	7.98		1	80			6.54
MWDJAR53		100	2.25	1.43	0.065	0.007	79		1.10	0.69	7.98		1	90			6.46
MWDJAR53		100	2.25	1.21	0.065	0.006	79		1.10	0.90	7.98		1	100			6.33
MWDJAR53		100	2.25	1.19	0.065	0.006	79		1.10	0.90	7.98		1	110			6.29
MWDJAR54		100	2.92	3.21	0.087	0.092	72		0.52	0.55	7.87		1	0			7.90
MWDJAR54		100	2.92	2.91	0.087	0.070	72		0.52	0.78	7.87		1	10			7.64
MWDJAR54		100	2.92	1.33	0.087	0.051	72		0.52	0.39	7.87		1	20			7.54
MWDJAR54		100	2.92	1.55	0.087	0.043	72		0.52	0.52	7.87		1	30			7.35
MWDJAR54		100	2.92	2.05	0.087	0.039	72		0.52	0.47	7.87		1	40			7.15
MWDJAR54		100	2.92	1.91	0.087	0.037	72		0.52	0.45	7.87		1	50			7.11
MWDJAR54		100	2.92	1.63	0.087	0.030	72		0.52	0.52	7.87		1	60			6.87
MWDJAR54		100	2.92	1.49	0.087	0.025	72		0.52	0.49	7.87		1	70			6.85
MWDJAR54		100	2.92	1.55	0.087	0.022	72		0.52	0.45	7.87		1	80			6.72
MWDJAR54		100	2.92	1.42	0.087	0.018	72		0.52	0.57	7.87		1	90			6.55
MWDJAR54		100	2.92	1.44	0.087	0.015	72		0.52	0.64	7.87		1	100			6.49
MWDJAR54		100	2.92	1.38	0.087	0.014	72		0.52	0.56	7.87		1	110			6.37

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Coagulation Conditions				
	% CRW	% SPW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		Coagulant	Dose	Acid	Base	Coag.
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	ID		adjusted?	adjusted?	pH
													(see above)		(Y/N)	(Y/N)	()
															blank=N	blank=N	
MWDIARS4		100	2.92	1.30	0.087	0.014	72		0.52	0.63	7.87		1	120			6.12
MWDIARS4		100	2.92	1.27	0.087	0.013	72		0.52	0.64	7.87		1	130			6.08
MWDIARS4		100	2.92	1.22	0.087	0.014	72		0.52	0.61	7.87		1	140			5.93
MWDIARS4		100	2.92	1.25	0.087	0.014	72		0.52	0.98	7.87		1	150			5.69
MWDIARS4		100	2.92	1.23	0.087	0.021	72		0.52	1.30	7.87		1	160			5.51
MWDIARS5		100	2.68	2.65	0.086	0.083	62		0.72	0.55	7.82		1	0			7.77
MWDIARS5		100	2.68	2.43	0.086	0.061	62		0.72	0.42	7.82		1	10			7.52
MWDIARS5		100	2.68	2.24	0.086	0.051	62		0.72	0.74	7.82		1	20			7.35
MWDIARS5		100	2.68	2.00	0.086	0.040	62		0.72	0.24	7.82		1	30			7.18
MWDIARS5		100	2.68	1.76	0.086	0.036	62		0.72	0.29	7.82		1	40			7.12
MWDIARS5		100	2.68	1.76	0.086	0.032	62		0.72	0.30	7.82		1	50			7.20
MWDIARS5		100	2.68	1.58	0.086	0.030	62		0.72	0.28	7.82		1	60			7.08
MWDIARS5		100	2.68	1.40	0.086	0.029	62		0.72	0.24	7.82		1	70			6.97
MWDIARS5		100	2.68	1.45	0.086	0.027	62		0.72	0.25	7.82		1	80			6.84
MWDIARS5		100	2.68	1.40	0.086	0.024	62		0.72	0.31	7.82		1	90			6.67
MWDIARS5		100	2.68	1.34	0.086	0.023	62		0.72	0.23	7.82		1	100			6.50
MWDIARS5		100	2.68	1.47	0.086	0.024	62		0.72	0.74	7.82		1	110			6.45
MWDIARS5		100	2.68	1.31	0.086	0.024	62		0.72	0.44	7.82		1	120			6.20
MWDIARS5		100	2.68	1.34	0.086	0.021	62		0.72	0.63	7.82		1	130			5.95
MWDIARS5		100	2.68	1.33	0.086	0.022	62		0.72	0.50	7.82		1	140			5.83
MWDIARS5		100	2.68	1.30	0.086	0.022	62		0.72	0.72	7.82		1	150			5.52
MWDIARS5		100	2.68	1.32	0.086	0.021	62		0.72	0.72	7.81		1	160			5.30

Utility ID:	MWD	(ACWD, CCWD, EBMUD, MWD, SCVWD)
1. Study ID:	EC Study Data	(Optimization Study 9/95, etc.)
2. Source water:	SPW / CRW	(River, lake, groundwater, etc.)
3. Source water ID:		(State Project water, blend of...., etc.)

5. Describe level of study: (indicate with an 'X')		
	Bench-scale	In this data sheet, "Filt." refers to data collected
	Pilot-scale	after coagulation, flocculation, sedimentation, and
X	Full-scale	filtration.

6. Indicate with an 'X' if data reported as "Filt." are from samples collected after sedimentation only:

or after sedimentation and filtration:

WATER QUALITY DATA: CONVENTIONAL

Study ID	Water SPW	Water CRW	TOC (mg/L) Raw	TOC (mg/L) Filt.	UV-254 (1/cm) Raw	UV-254 (1/cm) Filt.	Alkalinity (mg/L as CaCO3) Raw	Alkalinity (mg/L as CaCO3) Filt.	Turbidity (NTU) Raw	Turbidity (NTU) Filt.	pH () Raw	pH () Filt.	Temperature (deg. C) Raw	Temperature (deg. C) Filt.	Fi... Indicate disinfectant used with an 'X': chlorine	chloramine	Chlorine dose (mg Cl2/L
MWDODP1	X		2.45	1.88	0.073	0.026	74		2.10		8.90		11.2		0.5 mg/L Cl2 thru floc basin; 1.7 mg/		
MWDODP1	X		2.41	1.86	0.069	0.020	74		2.10		8.20		10.3		0.5 mg/L Cl2 thru floc basin; 1.7 mg/		
MWDODP1	X		2.33	1.71	0.068	0.026	74		2.30		8.10		10.1		0.5 mg/L Cl2 thru floc basin; 1.7 mg/		
MWDODP1	X		2.28	1.70	0.064	0.024	74		2.00		8.00		10.9		0.5 mg/L Cl2 thru floc basin; 1.7 mg/		
MWDODP1	X		2.48	1.80	0.073	0.026	74		1.80		8.50		10.8		0.5 mg/L Cl2 thru floc basin; 1.7 mg/		
MWDODP2	X		2.26	1.35	0.070	0.027	78		0.93		7.95		11.5		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP2	X		2.31	1.43	0.068	0.028	78		1.60		7.96		10.8		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP2	X		2.34	1.59	0.065	0.030	78		1.50		8.03		11.0		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP2	X		2.21	1.42	0.069	0.028	78		1.20		7.92		11.2		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP3	X		2.47	2.31	0.036	0.036	131		0.98		8.30		12.0		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP3	X		2.51	2.08	0.036	0.027	131		0.80		8.41		12.0		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP3	X		2.31	1.90	0.033	0.024	131		0.88		8.34		11.5		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP4	X		2.05	1.10	0.033	0.014	131		0.76		8.33		12.0		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP5	X		2.27	2.24	0.076	0.071	81		1.40		8.60		11.7		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP5	X		2.42	1.98	0.078	0.070	81		1.30		8.63		11.7		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP5	X		2.78	1.95	0.087	0.044	70		1.90		7.97		9.3		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP5	X		2.43	1.82	0.074	0.044	81		1.40		8.69		11.7		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP5	X		2.71	1.81	0.079	0.036	75		1.48		8.46		10.9		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP5	X		2.64	1.65	0.074	0.028	75		1.20		8.41		11.2		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP5	X		2.76	1.63	0.083	0.023	70		1.80		7.91		9.1		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP5	X		2.28	1.59	0.068	0.039	81		1.60		8.70		11.8		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP5	X		2.62	1.62	0.077	0.027	75		1.30		8.53		11.1		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDODP6	X		2.65	1.88	0.072	0.030	76		2.10		8.44		11.0		1.0 mg/L Cl2, residual, 1 hr @ 25oC		
MWDODP6	X		2.62	1.68	0.080	0.024	76		2.00		8.37		10.9		1.0 mg/L Cl2, residual, 1 hr @ 25oC		
MWDODP6	X		2.67	1.51	0.078	0.018	70		2.10		8.01		9.2		1.0 mg/L Cl2, residual, 1 hr @ 25oC		
MWDODP6	X		2.70	1.25	0.066	0.012	76		1.90		8.37		11.0		1.0 mg/L Cl2, residual, 1 hr @ 25oC		
MWDODP6	X		2.62	1.38	0.074	0.019	75		1.20		8.46		11.1		1.0 mg/L Cl2, residual, 1 hr @ 25oC		
MWDODP6	X		2.76	1.24	0.076	0.014	70		2.20		7.97		9.2		1.0 mg/L Cl2, residual, 1 hr @ 25oC		
MWDODP6	X		2.67	1.19	0.080	0.022	76		1.80		8.31		10.9		1.0 mg/L Cl2, residual, 1 hr @ 25oC		
MWDOP1	92-99%		2.94	2.71	0.084	0.064	76		0.55		7.90		11.7		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP1	92-99%		2.77	2.55	0.086	0.082			0.50		7.83		12.1		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP1	92-99%		2.79	2.37	0.088	0.062	71		2.20		8.05		9.2		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP1	92-99%		2.59	2.17	0.083	0.060			1.50		7.96		10.2		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP1	92-99%		2.84	1.46	0.084	0.022	71		1.60		8.27		10.6		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP1	92-99%		2.60	1.42	0.083	0.027	72		1.50		8.14		11.3		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP1	92-99%		2.74	1.53	0.078	0.022			1.80		8.55		12.6		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP1	92-99%		3.30	2.02	0.091	0.036			3.10		9.22		14.9		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP1	92-99%		3.20	1.99	0.099	0.035	75		2.10		8.60		13.5		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP1	92-99%		3.43	2.03	0.103	0.039	77		1.75		8.51		14.3		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP1	92-99%		2.78	1.58	0.072	0.029	73		0.72		7.83		11.3		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP2	92-100%		3.46	3.01	0.108	0.099	80		1.60		8.36		17.4		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP2	92-100%		3.37	2.99	0.088	0.063			2.00		8.14		17.5		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP3	92-100%		3.26	1.93	0.111	0.036			1.55		8.34		16.6		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP3	92-100%		3.49	2.07	0.120	0.043	78		1.60		8.24		16.1		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP3	92-100%		3.53	2.07	0.111	0.040	79		1.80		8.18		16.6		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP3	92-100%		3.67	2.12	0.115	0.040			1.60		8.24		16.2		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP3	92-100%		3.05	1.85	0.100	0.036			2.10		7.99		21.1		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP3	92-100%		3.29	1.81	0.104	0.043	80		2.70		8.03		18.9		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP3	92-100%		3.20	1.85	0.102	0.033			2.90		8.09		18.8		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP3	92-100%		3.17	1.85	0.103	0.032	81		2.70		8.11		17.8		1.0 mg/L Cl2, 1 hr @ 25oC		
MWDOP4	X		3.54	3.60	0.106	0.097	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	3.80	0.106	0.100	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	3.50	0.106	0.091	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.86	0.106	0.067	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	3.01	0.106	0.073	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	3.01	0.106	0.082	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		

Study ID	Water		TOC		UV-254		Alkalinity		Turbidity		pH		Temperature				
	SPW	CRW	(mg/L)		(1/cm)		(mg/L as CaCO3)		(NTU)		()		(deg. C)				Fi
			Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	Raw	Filt.	dicate disinfectant		Chlorine
															used with an 'X'		dose
															chlorine	hloramin	(mg Cl2/L
MWDOP4	X		3.54	3.07	0.106	0.077	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	3.02	0.106	0.069	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.55	0.106	0.055	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.50	0.106	0.052	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.37	0.106	0.051	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.23	0.106	0.045	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.74	0.106	0.059	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.82	0.106	0.060	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.31	0.106	0.048	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.51	0.106	0.048	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.12	0.106	0.042	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.14	0.106	0.037	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.88	0.106	0.059	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.57	0.106	0.052	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.20	0.106	0.046	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.05	0.106	0.037	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	2.01	0.106	0.041	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	1.92	0.106	0.046	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP4	X		3.54	1.78	0.106	0.033	85		1.49		7.85		21.7		1 mg/L resid, 1 hr, 25 oC		
MWDOP5		X	2.44	2.12	0.039	0.031	131.5		0.65		7.7		24.6		1 mg/L resid, 1 hr, 25 °C		
MWDOP5		X	2.44	2.16	0.039	0.028	131.5		0.65		7.7		24.6		1 mg/L resid, 1 hr, 25 °C		
MWDOP5		X	2.44	1.97	0.039	0.024	131.5		0.65		7.7		24.6		1 mg/L resid, 1 hr, 25 °C		
MWDOP5		X	2.44	1.85	0.039	0.021	131.5		0.65		7.7		24.6		1 mg/L resid, 1 hr, 25 °C		
MWDOP5		X	2.44	1.80	0.039	0.023	131.5		0.65		7.7		24.6		1 mg/L resid, 1 hr, 25 °C		
MWDOP5		X	2.44	1.81	0.039	0.020	131.5		0.65		7.7		24.6		1 mg/L resid, 1 hr, 25 °C		
MWDOP5		X	2.44	1.99	0.039	0.024	131.5		0.65		7.7		24.6		1 mg/L resid, 1 hr, 25 °C		
MWDOP5		X	2.44	1.73	0.039	0.020	131.5		0.65		7.7		24.6		1 mg/L resid, 1 hr, 25 °C		

Utility ID:													
1. Study ID:													
2. Source wat													
3. Source wat													
								Indicate coagulants studied:					
5. Describe le								ID	oagula	Chemical formula		Units	
(indicate with								1	Alum	$Al_2(SO_4)_3 \cdot 14\,H_2O$		mg/L	
								2	Ferric	$FeCl_3 \cdot 6\,H_2O$		mg/L	
								3					
6. Indicate wit								4					
									Polymer added: 2, 3, 0.5 mg/L				
WATER QU								**TREATMENT CONDITIONS**					
Study ID				Disinfection By-products				Coagulation Conditions					
	ered			TTHM		HAA5		Coagulant	Dose	Acid	Base	Coag.	Coag.
	mmoni	bubation t	Residual	(µg/L)		(µg/L)		ID		adjusted?	adjusted?	pH	temp.
	dose	(h)		Raw	Filt.	Raw	Filt.	(see above)		(Y/N)	(Y/N)	()	(deg. C)
	g NH3-N	chlorine	(mg Cl2/L)										
MWDODP1	Cl2 thru filters				40.6			1	40			7.00	
MWDODP1	Cl2 thru filters							1	40			7.00	
MWDODP1	Cl2 thru filters				35.1		30.1	1	40			7.00	
MWDODP1	Cl2 thru filters							1	40			7.00	
MWDODP1	Cl2 thru filters				37.2		31.7	1	40			6.90	
MWDODP2					30.7		12.4	1	30	Y		6.40	
MWDODP2					32.9		12.0	1	35	Y		6.46	
MWDODP2					35.8		14.4	1	40	Y		7.03	
MWDODP2					29.9		12.2	1	40	Y		6.56	
MWDODP3					29.0		12.4	2	5			7.91	
MWDODP3					24.8		11.0	2	10			7.97	
MWDODP3					20.5		10.6	2	25			7.14	
MWDODP4					14.0		7.7	2	25	Y		5.59	
MWDODP5					45.5		19.3	2	5			7.90	
MWDODP5					40.9		15.4	2	10			7.54	
MWDODP5					35.4		16.1	2	15			7.13	
MWDODP5					33.9		14.0	2	20			7.23	
MWDODP5					31.7		19.3	2	20			7.20	
MWDODP5					29.4		20.2	2	25			6.97	
MWDODP5					28.4		15.6	2	25			6.95	
MWDODP5					33.8		14.6	2	30			7.18	
MWDODP5					26.1		15.3	2	30			6.86	
MWDODP6					33.2		17.8	2	10	Y		6.98	
MWDODP6					28.4		12.2	2	10	Y		6.24	
MWDODP6					27.7		12.7	2	15	Y		6.25	
MWDODP6					21.2		8.9	2	20	Y		6.25	
MWDODP6					24.1		15.6	2	20	Y		6.15	
MWDODP6					22.3		11.8	2	25	Y		6.15	
MWDODP6					20.3		9.0	2	30	Y		6.22	
MWDOP1					50.8		25.9	2	3			7.60	
MWDOP1					49.8		29.2	2	3			7.53	
MWDOP1								2	5			7.56	
MWDOP1					48.6		22.8	2	5			7.53	
MWDOP1					28.3		16.2	2	30			6.86	
MWDOP1					28.2		14.5	2	30			6.80	
MWDOP1					32.0		16.1	2	30			6.77	
MWDOP1					37.8		16.9	2	30			7.09	
MWDOP1					36.1		17.1	2	30			6.94	
MWDOP1					36.0		17.8	2	30			6.92	
MWDOP1					31.4		14.3	2	30			6.88	
MWDOP2					68.2		30.3	1	12			7.71	
MWDOP2					66.5		29.5	1	12			7.65	
MWDOP3					43.0		16.9	1	40	Y		6.41	
MWDOP3					38.3		17.9	1	40	Y		6.41	
MWDOP3					41.4		17.0	1	40	Y		6.37	
MWDOP3					38.0		17.1	1	40	Y		6.33	
MWDOP3					41.6		16.5	1	40	Y		6.43	
MWDOP3					39.4		16.4	1	40	Y		6.34	
MWDOP3					39.9		18.2	1	40	Y		6.33	
MWDOP3					36.7		16.4	1	40	Y		6.31	
MWDOP4					77.9		34.0	1	10	Y		7.82	
MWDOP4					75.7		33.7	1	10	Y		7.71	
MWDOP4					71.1		31.6	1	10	Y		7.00	
MWDOP4					59.6		25.1	1	10	Y		6.23	
MWDOP4					67.7		26.7	1	10	Y		5.41	
MWDOP4					70.8		< 32.5	1	20	Y		7.65	

Study ID				Disinfection By-products				Coagulation Conditions					
	ered			TTHM		HAA5		Coagulant	Dose	Acid	Base	Coag.	Coag.
	mmoni	bubation t	Residual	(µg/L)		(µg/L)		ID		adjusted?	adjusted?	pH	temp.
	dose	(h)		Raw	Filt.	Raw	Filt.	(see above)		(Y/N)	(Y/N)	()	(deg. C)
	g NH3-N	chlorine	(mg Cl2/L)										
MWDOP4					67.4		29.4	1	20	Y		7.17	
MWDOP4					62.7		< 28.9	1	20	Y		7.11	
MWDOP4					54.9		< 22.3	1	20	Y		6.34	
MWDOP4					49.9		21.0	1	20	Y		6.40	
MWDOP4					53.1		20.9	1	20	Y		5.52	
MWDOP4					52.2		22.4	1	20	Y		5.71	
MWDOP4					62.1		23.8	1	30	Y		7.26	
MWDOP4					63.5		<24.7	1	30	Y		7.05	
MWDOP4					53.0		< 21.1	1	30	Y		6.26	
MWDOP4					53.8		<20.3	1	30	Y		6.50	
MWDOP4					48.1		<17.8	1	30	Y		6.23	
MWDOP4					46.7		<21.5	1	30	Y		5.43	
MWDOP4					56.4		24.9	1	40	Y		6.97	
MWDOP4					57.1		25.3	1	40	Y		7.24	
MWDOP4					52.4		< 21.5	1	40	Y		6.30	
MWDOP4					43.9		<18.7	1	40	Y		6.19	
MWDOP4					45.9		< 18.0	1	40	Y		5.65	
MWDOP4					46.1		< 18.6	1	40	Y		5.74	
MWDOP4					43.6		<15.8	1	40	Y		5.42	
MWDOP5					22.2		11.7	1	10	Y		5.88	
MWDOP5					22.0		14.7	1	20	Y		7.58	
MWDOP5					18.7		11.1	1	20	Y		6.89	
MWDOP5					16.6		9.5	1	20	Y		6.50	
MWDOP5					17.4		9.2	1	20	Y		5.75	
MWDOP5					17.5		< 10.6	1	20	Y		5.31	
MWDOP5					18.7		9.8	1	40	Y		6.90	
MWDOP5					16.3		9.2	1	40	Y		5.53	

Utility ID: MWDSC (ACWD, CCWD, EBMUD, MWD, SCVWD)

1. Study ID: Oxidation Demonstration Project (Optimization Study 9/93, etc.)

2. Source water: River (River, lake, groundwater, etc.)

3. Source water ID: California State Project Water (State Project water, blend of ..., etc.)

4. If blended source water indicate sources and proportions: Source %

5. Describe level of study: (indicate with an 'X')
- Bench-scale
- Pilot-scale
- X Full-scale

In this data sheet, "Filt." refers to data collected after coagulation, flocculation, sedimentation, and filtration.

6. Indicate with an 'X' if data reported as "Filt." are from samples collected after sedimentation only:
or after sedimentation and filtration: X

WATER QUALITY DATA: PRE-OZONE

Date	TOC (mg/L) Raw	TOC Ozon.	TOC Filt.	UV-254 (/cm) Raw	UV-254 Ozon.	UV-254 Filt.	Alkalinity (mg/L as CaCO3) Raw	Alkalinity Ozon.	Alkalinity Filt.	Bromide ([illegible]) Raw	Bromide Ozon.	Bromide Filt.	Turbidity (NTU) Raw	Turbidity Ozon.	Turbidity Filt.	pH Raw	pH Ozon.	pH Filt.	Temperature (deg. C) Raw	Temperature Ozon.	Temperature Filt.	Bromate (µg/L) Raw	Bromate Ozon.	Bromate Filt.
09/08/92	3.86			0.116	0.089		87				0.31		1.8			8.07	8.07		26.7				9.0	
09/08/92	3.86	3.82		0.116	0.081		87				0.31		1.5			7.96	7.90		25.6				12.0	
09/09/92				0.114	0.084						0.31		2.3			7.89	7.89		25.0				10.0	
09/09/92				0.113	0.088						0.31		2.4			7.89	7.89		25.0				11.8	
09/10/92				0.113	0.095						0.30		1.6			7.91	7.91		24.4				7.0	
09/10/92				0.114	0.081						0.30		1.5			8.00	8.00		24.4				11.9	
09/10/92				0.118	0.078						0.30		1.5			8.01	8.01		25.6				13.0	
09/18/92				0.109	0.078								1.6				6.67		22.3				4.0	
09/21/92				0.110												7.98	7.33		23.2				8.0	
09/21/92				0.110	0.084								1.6			7.98	7.98		23.3				7.0	
09/22/92																	7.34		23.2				6.0	
09/22/92																	7.18		23.2				7.0	
09/23/92	3.32			0.109	0.079		87				0.31		1.6			8.02	8.02		23.1				8.0	
09/24/92					0.072								1.8			8.02	8.20		23.3				3.0	
09/24/92					0.079								1.6			8.02	8.18		23.3				4.5	
09/24/92					0.087								1.6			8.02	8.08		23.3				6.5	
10/06/92	3.27			0.106			85				0.34		1.8			7.81	8.17		21.7				1.5	
10/06/92	3.27			0.109			85				0.34		1.5			7.81	8.20		21.7				8.0	
10/12/92																	8.06		21.0				1.5	
10/12/92																	8.02		21.0				1.5	
10/12/92																	8.03		21.8				1.5	
10/13/92																	7.32		20.9				1.5	
10/13/92																	7.09		20.8				5.0	
10/14/92																	7.18		20.8				8.0	
10/14/92																	7.08		20.8				7.0	
10/14/92																	7.86		20.8				7.5	
10/20/92																7.87	7.87		19.9				13.0	
10/20/92																7.87	7.87		19.9				15.5	
10/20/92																7.87	7.87		18.9				23.5	
10/26/92																7.92	7.92		18.5				13.0	
10/26/92																7.92	7.92		19.5				18.5	
10/26/92																7.92	7.92		19.5				18.0	
01/21/93	3.50						73				0.34		3.1			7.81	7.81		10.0				9.5	
01/21/93	3.50						73				0.34		3.1			7.81	7.81		10.0				15.5	
01/21/93	3.50						73				0.34		3.1			7.81	7.81		10.0				23.0	
03/16/93	2.84			0.089							0.19					7.72	7.72		12.0				3.0	
03/16/93	2.84			0.089							0.19					7.72	7.72		12.0				6.8	
03/16/93	2.84			0.089							0.19					7.72	7.72		12.0				9.5	
04/01/93													2.2			7.58	8.01		12.0				1.5	
04/01/93													2.2			7.58	8.11		12.0				1.8	
04/01/93													2.2			7.58	8.09		12.0				1.5	
04/01/93													2.2			7.58	8.00		12.0				1.5	
04/01/93													2.2			7.58	8.07		12.0				5.0	
04/02/93													2.3			7.66	7.66		12.0				1.5	
04/02/93													2.3			7.66	7.60		12.0				3.6	
04/02/93													2.3			7.66	7.66		12.0				4.5	
04/02/93													2.3			7.66	7.66		12.0				1.5	
04/02/93													2.3			7.66	7.06		12.0				13.0	
04/05/93	2.76			0.098			72				0.19					7.50	7.50		12.2				8.0	
04/05/93	2.76			0.098			72				0.19					7.50	7.50		12.2				43.5	
04/06/93																	6.93		12.3				3.0	
04/06/93																	8.06		12.3				6.0	
04/07/93											0.18		1.3			7.58	8.13		12.1				3.5	
04/07/93											0.18		1.3			7.58	8.18		12.1				1.5	
04/07/93											0.18		1.3			7.58	8.08		12.1				3.5	
04/07/93											0.34		1.3			7.58	8.02		12.1				3.8	
04/07/93											0.28		1.3			7.58	8.03		12.1				1.5	
04/08/93											0.33		1.3			7.60	7.60		12.1				8.0	
04/08/93											0.19		1.3			7.60	7.60		12.1				8.0	
04/08/93											0.21		1.3			7.60	7.60		12.1				8.0	
04/08/93											0.27		1.3			7.60	7.60		12.1				7.5	
04/08/93											0.17		1.3			7.60	7.60		12.1				6.0	
04/12/93	2.76			0.095			73				0.47					7.57	7.57		12.1				3.5	
04/21/93																	8.15		13.0				1.5	

TREATMENT CONDITIONS

Date	Ozone dose (mg/L)	Ozone residual (mg/L)	Contact time (min) (full contactor)	Ozone pH ()	Ozone temp. (deg. C)	Ozone residual (mg/L) Ch. 1A	Ozone residual (mg/L) Ch. 1B	Ozone residual (mg/L) Ch. 2A	Ozone residual (mg/L) Ch. 2B	Ozone residual (mg/L) Ch. 3A	Ozone residual (mg/L) Ch. 3B
09/08/92	1.9		12.1			0.32	<.01	<.01	<.01	<.01	<.01
09/08/92	2.0		12.1			0.42	0.02	0.01	<.01	<.01	0.01
09/09/92	1.9		12.2			0.31	0.04	0.04	0.04	0.05	0.04
09/09/92	1.9		12.0			0.32	0.02	0.01	0.01	0.01	0.01
09/10/92	1.6		12.3			0.19	<.01	<.01	<.01	<.01	<.01
09/10/92	1.9		12.3			0.32	0.01	0.01	<.01	<.01	<.01
09/10/92	2.2		12.2			0.44	0.03	0.03	0.03	0.02	0.02
09/18/92	1.7		12.1			0.40	0.11	0.08	0.03	0.02	0.02
09/21/92	1.5		12.2			0.34	0.06	0.05	0.04	0.03	0.04
09/21/92	1.6		12.2			0.25	0.04	0.03	0.04	0.03	0.03
09/22/92	1.3		12.1			0.20	0.03	0.03	0.03	0.02	0.02
09/22/92	1.4		12.2			0.27	0.04	0.03	0.03	0.03	0.03
09/23/92	1.7		12.3			0.36	0.03	0.03	0.03	0.03	0.03
09/24/92	1.2		12.2			0.30	0.04	0.04	0.04	0.03	0.04
09/24/92	1.5		12.3			0.51	0.06	0.04	0.04	0.03	0.03
09/24/92	1.7		12.2			0.75	0.18	0.10	0.04	0.04	0.04
10/06/92	1.0		12.1			0.20	0.02	0.02	0.02	0.02	0.01
10/06/92	1.2		12.3			0.34	0.04	0.02	0.02	0.02	0.02
10/12/92	1.0		12.2			0.20	0.02	0.01	0.01	<0.010	0.01
10/12/92	1.1		12.1			0.24	0.02	0.02	0.02	0.02	0.02
10/12/92	1.1		12.1			0.33	0.03	0.02	0.02	0.02	0.01
10/13/92	1.1		12.2			0.23	0.03	0.07	0.07	0.02	0.02
10/13/92	1.1		12.2			0.32	0.01	0.02	0.02	0.01	0.01
10/14/92	1.0		12.3			0.22	0.02	0.01	0.01	<0.010	<0.010
10/14/92	1.2		12.3			0.34	0.01	<0.010	<0.010	<0.010	<0.010
10/14/92	1.4		12.3			0.42	0.05	0.02	0.01	0.01	<0.010
10/20/92	1.6		6.1			0.58	0.11	0.04	<0.010	<0.010	<0.010
10/20/92	1.8		6.1			0.66	0.11	0.14	0.02	<0.010	<0.010
10/20/92	2.1		6.1			0.72	0.28	0.28	0.11	0.06	0.03
10/26/92	1.4		12.2			0.42	0.08	0.04	0.04	0.04	0.04
10/26/92	1.7		12.2			0.43	0.04	0.03	0.03	0.03	0.03
10/26/92	2.0		12.2			0.67	0.10	0.08	0.03	0.03	0.03
01/21/93	1.8		11.9			0.58	0.19	0.05	<0.010	<0.010	<0.010
01/21/93	1.9		12.2			0.76	0.23	0.11	0.03	<0.010	<0.010
01/21/93	2.2		12.1			0.86	0.47	0.22	0.08	0.06	0.01
03/16/93	1.0		12.3			0.21	<0.010	<0.010	<0.010	<0.010	<0.010
03/16/93	1.5		12.3			0.58	0.27	0.08	0.04	0.03	0.03
03/16/93	2.0		12.2			0.78	0.31	0.21	0.09	0.06	0.03
04/01/93	0.8		12.2			0.11	<0.010	0.01	0.01	0.02	<0.010
04/01/93	1.0		12.2			0.39	0.02	0.01	<0.010	0.01	0.01
04/01/93	1.3		12.2			0.45	0.10	0.08	0.03	0.03	0.03
04/01/93	1.6		12.2			0.70	0.36	0.24	0.13	0.08	0.05
04/01/93	1.8		12.2			0.88	0.44	0.38	0.31	0.23	0.18
04/02/93	1.0		12.2			0.23	0.02	0.02	0.01	0.02	0.02
04/02/93	1.3		12.2			0.44	0.07	0.02	0.02	0.02	0.02
04/02/93	1.5		12.2			0.46	0.09	0.05	0.02	0.02	0.02
04/02/93	1.7		12.1			0.83	0.33	0.19	0.08	0.03	0.02
04/02/93	2.0		12.1			1.07	0.44	0.31	0.17	0.10	0.04
04/05/93	1.6		12.2			0.74	0.18	0.11	0.02	0.02	0.02
04/05/93	4.0		12.2			2.01	1.71	1.56	1.30	1.00	0.97
04/06/93	1.2		12.2			0.54	0.15	0.09	0.04	0.04	0.06
04/06/93	1.6		12.2			0.75	0.30	0.25	0.18	0.12	0.08
04/07/93	1.2		12.2			0.41	0.06	0.01	0.01	0.02	0.02
04/07/93	1.2		12.2			0.39	0.05	0.05	0.04	0.03	0.04
04/07/93	1.2		12.2			0.38	0.07	0.04	0.01	0.02	0.01
04/07/93	1.2		12.1			0.47	0.10	0.08	0.02	0.02	0.02
04/07/93	1.2		12.1			0.40	0.11	0.05	0.02	0.02	0.02
04/08/93	1.5		12.1			0.52	0.18	0.06	0.03	0.04	0.04
04/08/93	1.6		12.2			0.48	0.10	0.08	0.03	0.03	0.03
04/08/93	1.6		12.2			0.57	0.16	0.08	0.03	0.03	0.02
04/08/93	1.6		12.1			0.61	0.14	0.03	0.02	0.02	0.02
04/08/93	1.5		12.2			0.63	0.08	0.03	0.01	0.02	0.01
04/12/93	1.0		12.2			0.23	0.01	<0.010	<0.010	<0.010	<0.010
04/21/93	0.7		12.1			0.13	0.03	0.03	0.03	0.02	0.02

Date	TOC (mg/L)			UV-254 (1/cm)			Alkalinity (mg/L as CaCO3)			Bromide (mg/L)			Turbidity (NTU)			pH @			Temperature (deg. C)			Bromate (µg/L)			Ozonation Conditions: Ozone dose (mg/L)	Ozone residual (mg/L)	Contact time (min) (full contactor)	Ozone pH @	Ozone temp. (deg. C)	Ozone residual (mg/L) Ch. 1A	Ozone residual (mg/L) Ch. 1B	Ozone residual (mg/L) Ch. 2A	Ozone residual (mg/L) Ch. 2B	Ozone residual (mg/L) Ch. 3A	Ozone residual (mg/L) Ch. 3B
	Raw	Ozon.	Fil.	Raw	Ozon.	Fil.	Raw	Ozon.	Fil.	Raw	Ozon.	Fil.	Raw	Ozon.	Fil.	Raw	Ozon.	Fil.	Raw	Ozon.	Fil.	Raw	Ozon.	Fil.											
04/21/93																	8.11		13.0				1.5		1.8		12.1			0.19	0.02	0.01	0.02	0.03	0.02
04/21/93																	5.98		13.0				1.5		1.3		12.2			0.36	0.09	0.03	0.02	0.02	0.03
04/21/93																	6.06		13.0				3.0		1.5		12.3			0.50	0.15	0.09	0.02	0.02	0.02
04/21/93																	5.98		13.8				3.5		1.7		12.2			0.77	0.29	0.17	0.12	0.07	0.04
04/22/93																	7.30		13.2				1.6		1.0		12.3			0.19	<0.010	<0.010	<0.010	<0.010	<0.010
04/22/93																	7.30		13.2				1.5		1.2		12.3			0.25	0.04	0.01	0.01	0.01	<0.010
04/22/93																	7.30		13.2				1.5		1.5		12.3			0.40	0.01	0.01	<0.010	<0.010	<0.010
04/22/93																	7.30		13.2				1.5		1.7		12.2			0.60	0.19	0.09	0.03	0.01	0.02
04/22/93																	7.30		13.2				8.8		2.0		12.2			0.97	0.29	0.14	0.07	0.04	0.02
04/26/93	3.87			0.100			70				0.18						7.29		13.5				3.5		1.8		12.3			0.40	0.06	0.01	<0.010	0.02	<0.010
04/26/93	3.87			0.100			78				0.18						7.29		13.5				32.0		4.0		12.2			1.80	1.62	1.32	1.03	0.06	0.72
04/27/93																	8.09		13.8				1.5		1.2		12.2			0.33	0.01	0.01	0.01	0.01	0.01
04/27/93																	8.10		13.8				1.8		1.8		12.3			0.51	0.12	0.03	<0.010	0.02	0.01
04/28/93											0.63						8.09		14.2				1.5		1.2		12.2			0.18	<0.010	<0.010	<0.010	<0.010	<0.010
04/28/93											0.18						8.09		14.2				1.6		1.2		12.2			0.17	<0.010	<0.010	<0.010	<0.010	<0.010
04/28/93											0.30						8.13		14.2				1.5		1.2		12.1			0.10	<0.010	<0.010	<0.010	<0.010	<0.010
04/28/93											0.46						5.90		14.2				1.5		1.2		12.1			0.15	<0.010	<0.010	<0.010	<0.010	<0.010
04/28/93											0.25						8.11		14.2				1.5		1.2		12.2			0.06	<0.010	<0.010	0.01	<0.010	<0.010
04/29/93											0.56					8.41	8.41		17.2				1.5		1.5		12.2			0.03	<0.010	<0.010	<0.010	<0.010	<0.010
04/29/93											0.22					8.37	8.37		17.2				1.5		1.5		12.2			0.08	<0.010	<0.010	<0.010	<0.010	<0.010
04/29/93											0.59					8.27	8.27		17.2				27.5		4.1		12.2			0.35	0.03	0.03	0.01	<0.010	0.01
05/03/93	3.18			0.106			77				0.56					8.30	8.30		16.3				8.0		1.5		12.2			0.33	0.04	0.03	0.03	0.03	0.03
05/03/93	3.18			0.106			77				0.56					8.30	8.30		16.3				12.0		1.7		12.3			0.48	0.03	0.02	0.02	0.02	0.02
05/03/93	3.18			0.106			77				0.44					8.30	8.30		16.3				14.5		2.8		12.2			0.50	0.02	0.02	0.02	0.02	0.03
05/03/93	3.18			0.106			77				0.57					8.30	8.30		16.3				22.5		2.3		12.2			0.72	0.13	0.02	0.01	0.02	0.01
05/04/93											0.47						8.08		16.0				6.0		3.0		12.2			1.07	0.40	0.21	0.13	0.00	0.05
05/12/93											0.33						8.07		18.0				1.5		1.0		12.1			0.15	<0.010	<0.010	<0.010	0.04	0.02
05/12/93											0.32						8.03		18.0				1.5		1.2		12.1			0.30	0.01	<0.010	0.01	0.01	<0.010
05/12/93											0.32						8.02		18.0				1.6		1.5		12.1			0.40	0.10	0.03	0.02	0.02	0.02
05/12/93											0.32						8.10		18.0				3.0		1.7		12.1			0.06	0.18	0.12	0.02	0.02	0.01
05/12/93											0.32						8.84		18.0				1.5		2.0		12.1			0.71	0.41	0.20	0.00	0.04	0.01
05/13/93											0.33					8.08	8.08		18.0				3.5		1.2		12.2			0.14	0.01	0.01	0.01	0.01	0.02
05/13/93											0.32					8.09	8.06		18.0				5.5		1.5		12.1			0.27	0.02	0.02	0.01	0.02	0.02
05/13/93											0.33					8.08	8.06		18.0				7.0		1.7		12.2			0.44	0.02	0.02	0.02	0.02	0.02
05/13/93											0.32					8.08	8.08		18.0				10.0		2.0		12.1			0.65	0.06	0.02	0.03	0.02	0.03
05/13/93											0.33					8.06	8.06		18.0				13.0		2.2		12.2			0.73	0.11	0.00	0.02	0.02	0.02
06/14/93							82				0.51					7.78	7.78		19.2				14.5		2.0		12.2			0.47	0.05	0.00	0.00	0.00	0.00
06/14/93	3.34	3.83					82				0.50					7.78	7.78		19.2				20.5		2.4		12.1			0.87	0.20	0.00	0.00	0.00	0.00
06/14/93							82				0.52					7.78	7.78		19.2				31.0		2.7		12.2			0.87	0.20	0.16	0.02	0.00	0.00
06/21/93	3.53						85				0.49					7.89	7.89		20.5				4.5		1.5		12.3			0.17	<0.010	<0.010	0.00	0.00	0.00
06/21/93	3.63						85				0.49					7.89	7.89		20.5				8.5		2.0		12.3			0.44	0.01	<0.010	0.00	0.00	0.00
06/21/93	3.53	2.73					85				0.48					7.89	7.89		20.5				18.0		2.5		12.2			0.63	0.13	0.04	0.00	0.00	0.00
06/28/93	3.58						84				0.54					7.87	7.87		20.8				12.8		1.5		12.2			0.17	0.02	0.01	0.00	0.00	0.00
06/28/93	3.58						84				0.50					7.87	7.87		20.8				6.0		2.0		12.2			0.44	0.02	0.01	0.00	0.00	0.00
06/28/93	3.58	3.78					84				0.53					7.87	7.87		20.8				23.5		2.5		12.2			0.55	0.14	0.00	0.02	0.00	0.00
07/06/93				0.116			88				0.61					7.93	7.93		21.7				4.6		1.5		12.2			0.16	0.01	0.00	0.00	0.00	0.00
07/06/93				0.116			88				0.46					7.93	7.93		21.7				9.0		2.0		12.2			0.38	0.02	0.02	0.00	0.00	0.00
07/06/93				0.116	0.068		88				0.49					7.93	7.93		21.7				18.8		2.4		12.3			0.39	0.06	0.02	0.00	0.00	0.00
07/28/93											0.53					8.07	8.07		21.2				13.0		2.0		12.3			0.42	0.03	0.04	0.00	0.00	0.00
07/28/93											0.50					8.07	8.07		21.2				12.6		7.0		6.1			0.45	0.11	0.05	0.00	0.00	0.00
07/28/93											0.52					8.07	8.07		21.2				12.0		2.1		17.0			0.24	0.03	0.03	0.00	0.00	0.00
07/19/94	3.38 (d)	3.18 (d)	3.02 (d)	0.097	0.092	0.047	80				0.21		1.56			8.13	8.13	7.80	23.2				1.6		1.0		6.5			0.43	0.04	0.03	0.00	0.00	0.00
07/25/94	3.19 (d)	3.11 (d)	2.75 (d)	0.081	0.085	0.041	80				0.22		1.1			8.26	8.26	7.87	23.4				9.9		1.7		6.5			0.52	0.09	0.06	0.00	0.00	0.00
08/01/94	3.43 (d)	3.30 (d)	2.85 (d)	0.081							0.22		1.3			8.14	8.14	7.71	23.7				8.0		2.0		6.6			0.78	0.13	0.19	0.00	0.00	0.00
08/16/94													0.8			8.10	8.28	7.65	24.8				3.0		1.4		6.5			0.35	0.11	0.11	0.03	0.00	0.00
08/17/94													1.4			8.70	8.15	8.29	24.9				1.5		1.4		6.5			0.46	0.23	0.17	0.00	0.00	0.00
08/17/94																8.70	7.15		24.9				5.0		1.5		6.4			0.30	0.10	0.10	0.03	0.00	0.00
08/18/94	3.52 (d)	3.52 (d)	2.87 (d)	0.084	0.058	0.041							1.8			8.58	7.16	7.14	24.8				4.0		1.5		6.5			0.46	0.14	0.13	0.04	0.00	0.00
08/29/94	3.50 (d)	3.60 (d)	2.89 (d)	0.083	0.058	0.042	82				0.22		0.9			8.85	7.58	7.30	24.2				1.5		1.4		6.5			0.39	0.00	0.05	0.00	0.00	0.00
10/24/94	3.19 (d)	3.17 (d)	2.74 (d)	0.080	0.050	0.030	77				0.38		0.74			7.93	7.92	7.70	18.8				15.0		1.7		6.6			0.55	0.23	0.22	0.10	0.00	0.00
10/25/94																7.94	7.08		18.8				3.0		1.0		6.4			0.20	0.05	0.06	0.02	0.00	0.00
10/26/94																7.94	7.08		18.6				7.5		1.5		6.6			0.53	0.25	0.28	0.23	0.10	0.06
10/26/94																7.90	7.90		18.6				7.0		1.5		6.5			0.43	0.20	0.11	0.01	0.00	0.00
10/26/94																7.94	7.08		18.6				13.0		2.0		6.4			0.95	0.58	0.51	0.36	0.32	0.24
10/26/94																7.91	7.91		18.6				15.5		2.0		6.5			0.48	0.31	0.28	0.14	0.09	0.04
10/26/94																7.94	7.94		18.6				26.0		2.5		6.5			1.06	0.03	0.57	0.33	0.27	0.18
10/27/94																	6.39		18.4				1.5		1.0		6.4			0.33	0.11	0.11	0.05	0.02	0.02
10/27/94																	6.38		18.4				1.6		1.3		6.4			0.60	0.30	0.29	0.17	0.13	0.09
10/27/94																	6.40		18.4				3.0		1.5		6.4			0.88	0.38	0.42	0.29	0.26	0.20
10/28/94																	5.90		18.3				1.5		1.0		6.4			0.42	0.14	0.14	0.07	0.05	0.04
10/28/94																	5.97		18.3				1.6		1.2		6.4			0.64	0.28	0.30	0.20	0.16	0.12
10/28/94																	5.90		18.3				1.8		1.5		6.4			0.60	0.44	0.47	0.35	0.28	0.23
10/31/94	3.02 (d)	2.76 (d)	2.17 (d)	0.083	0.048	0.038	76				0.28		0.75			8.01	7.83	7.82	18.2				10.0		1.5		6.5			0.52	0.23	0.19	0.07	0.00	0.00
11/01/94											0.40					7.90	6.96		18.2				4.0		1.0		6.4			0.42	0.17	0.15	0.07	0.08	0.04
11/01/94											0.35					7.96	6.62		18.2				4.5		1.5		6.4			0.90	0.62	0.46	0.26	0.23	0.16
11/01/94											0.40					7.96	7.86		18.2				14.0		1.8		6.4			0.68	0.33	0.25	0.10	0.08	0.02
11/01/94											0.41					7.98	6.82		18.2				11.0		2.0		6.4			1.11	1.21	0.78	0.63	0.63	0.42
11/01/94											0.40					7.98	7.86		18.2				28.0		2.0		6.4			0.87	0.48	0.46	0.29	0.21	0.13
11/01/94											0.40					7.99	7.96		18.2				30.0		2.5		6.4			1.38	0.80	0.74	0.52	0.40	0.33
11/02/94											0.43						6.43		17.8				1.5		1.0		6.4			0.31	0.10	0.08	0.04	0.02	0.01
11/02/94											0.36						6.05		17.8				1.5		1.0		6.4			0.34	0.12	0.12	0.05	0.04	<0.010

Date	TOC (mg/L) Raw	TOC Ozon.	TOC Filt.	UV-254 (1/cm) Raw	UV-254 Ozon.	UV-254 Filt.	Alkalinity (mg/L as CaCO3) Raw	Alkalinity Ozon.	Alkalinity Filt.	Bromide (mg/L) Raw	Bromide Ozon.	Bromide Filt.	Turbidity (NTU) Raw	Turbidity Ozon.	Turbidity Filt.	pH Raw	pH Ozon.	pH Filt.
11/02/94											0.42						8.41	
11/02/94											0.41						8.05	
11/02/94											0.41						8.41	
11/02/94											0.42						8.05	
11/07/94	2.78 (d)	2.81 (d)	2.78 (d)	0.080	0.046	0.033	78				0.26		0.7			7.87	7.87	7.63
11/08/94											0.53					7.80	8.92	
11/08/94											0.55					7.80	7.80	
11/08/94											0.54					7.90	8.87	
11/08/94											0.55					7.90	7.90	
11/08/94											0.55					7.90	8.87	
11/08/94											0.54					7.90	7.90	
11/10/94											0.54						8.44	
11/10/94											0.54						8.08	
11/10/94											0.54						8.10	
11/10/94											0.53						8.44	
11/10/94											0.53						8.05	
11/10/94											0.58						8.44	
11/14/94	2.76 (d)	2.89 (d)	2.30 (d)	0.080	0.049	0.033	75				0.29		0.64			8.31	8.29	7.85
11/28/94	2.74 (d)	2.82 (d)	2.39 (d)				80				0.30		1.05			8.33	8.37	7.70
12/06/94	2.61 (d)	2.64 (d)	2.22 (d)								0.33		1.5			8.02	8.03	7.63
12/14/94													1.9			8.08	8.08	7.70
12/20/94	2.67 (d)	2.73 (d)	2.38 (d)	0.076	0.045	0.038	82						1.2			8.08	8.08	7.78
12/28/94	2.65 (d)	2.65 (d)	2.41 (d)	0.078	0.053	0.038	82				0.34		1.1			8.11	8.11	7.97
01/05/95	2.48 (d)	2.56 (d)	2.08 (d)	0.077	0.047	0.031							0.85			8.16	8.16	7.78
01/10/95	2.42 (d)	2.48 (d)	2.15 (d)	0.078	0.050	0.032	78				0.31		1.4			8.22	8.22	7.63
01/18/95	2.48 (d)	2.40 (d)	2.10 (d)	0.073	0.047	0.038	78				0.31		2.2			8.07	8.07	7.71
01/24/95	2.73 (d)	2.70 (d)	2.32 (d)	0.076	0.045	0.033	76				0.31		1.3			8.17	8.12	7.70
01/31/95	2.68 (d)	2.59 (d)	2.22 (d)	0.072	0.041	0.032	78				0.29		0.77			8.51	8.51	8.00
02/01/95	2.23						78				0.50					8.56	7.66	
02/02/95	2.50										0.50					8.36	7.80	
02/07/95	2.78 (d)	2.83 (d)	2.36 (d)	0.082	0.047	0.035	78				0.26		0.85			8.36	8.38	7.76
02/14/95	2.82 (d)	2.90 (d)	2.61 (d)	0.085	0.046	0.036	80				0.28		0.9			8.37	8.37	8.00
02/28/95	3.12 (d)	3.31 (d)	2.68 (d)	0.089	0.056	0.038					0.27		1.8			8.80	7.76	7.58
08/13/95	3.37			0.110			66			0.14			4.2			8.50	8.50	
08/14/95	3.27			0.104			68			0.14	0.34		3.5			8.52	8.52	
08/15/95	3.40			0.108			66				0.40		5.6			8.52	7.43	

Date	Temperature (deg. C) Raw	Temperature Ozon.	Temperature Filt.	Bromate (µg/L) Raw	Bromate Ozon.	Bromate Filt.	Ozonation Conditions: Ozone dose (mg/L)	Ozone residual (mg/L)	Contact time (min) (full contactor)	Ozone pH ()	Ozone temp. (deg. C)	Ozone residual (mg/L) Ch. 1A	Ozone residual (mg/L) Ch. 1B	Ozone residual (mg/L) Ch. 2A	Ozone residual (mg/L) Ch. 2B	Ozone residual (mg/L) Ch. 3A	Ozone residual (mg/L) Ch. 3B
11/02/94	17.6				4.0		1.2		6.4			0.53	0.34	0.29	0.18	0.13	0.09
11/02/94	17.6				4.0		1.3		6.4			0.51	0.29	0.28	0.18	0.14	0.09
11/02/94	17.6				5.0		1.5		6.4			0.80	0.31	0.38	0.27	0.23	0.18
11/02/94	17.6				3.5		1.8		6.4			0.82	0.46	0.50	0.33	0.30	0.23
11/07/94	16.4				15.0		1.7		6.5			0.76	0.49	0.36	0.20	0.00	0.00
11/08/94	16.2				6.0		1.0		6.4			0.43	0.18	0.18	0.08	0.07	0.03
11/08/94	16.2				12.5		1.2		6.4			0.52	0.17	0.18	0.08	0.06	0.04
11/08/94	16.2				9.5		1.5		6.4			0.89	0.58	0.55	0.40	0.35	0.31
11/08/94	16.2				21.0		1.5		6.4			0.70	0.37	0.33	0.17	0.11	0.07
11/08/94	16.2				12.0		2.0		6.4			1.23	0.84	0.88	0.74	0.65	0.58
11/08/94	16.2				34.6		2.0		6.4			0.98	0.55	0.57	0.45	0.37	0.29
11/10/94	16.0				3.0		1.0		6.4			0.39	0.14	0.15	0.08	0.06	0.02
11/10/94	15.9				1.5		1.0		6.4			0.40	0.18	0.21	0.11	0.10	0.08
11/10/94	15.8				3.0		1.2		6.4			0.48	0.33	0.32	0.24	0.21	0.17
11/10/94	15.9				5.0		1.3		6.4			0.60	0.37	0.33	0.22	0.17	0.12
11/10/94	15.9				4.0		1.5		6.4			0.89	0.48	0.52	0.41	0.38	0.31
11/10/94	15.8				5.0		1.5		6.4			0.77	0.49	0.62	0.38	0.33	0.26
11/14/94	16.1				8.0		1.5		6.5			0.84	0.13	0.18	0.08	0.00	0.08
11/28/94	12.7				7.0		1.5		6.4			0.51	0.23	0.21	0.08	0.05	0.00
12/06/94	11.3				10.0		1.3		6.5			0.63	0.31	0.38	0.16	0.12	0.07
12/14/94	11.9				8.0		1.2		6.6			0.56	0.32	0.26	0.15	0.10	0.07
12/20/94	10.1				9.0		1.2		6.4			0.62	0.35	0.27	0.15	0.12	0.08
12/28/94	9.8				7.8		1.2		6.5			0.46	0.30	0.27	0.15	0.12	0.07
01/05/95	10.0				6.0		1.2		6.4			0.44	0.26	0.29	0.14	0.10	0.05
01/10/95	10.4				8.0		1.2		6.4			0.54	0.23	0.23	0.13	0.08	0.05
01/18/95	10.2				6.0		1.3		6.6			0.40	0.21	0.24	0.10	0.08	0.04
01/24/95	10.3				6.0		1.3		6.5			0.56	0.28	0.25	0.11	0.08	0.05
01/31/95	11.1				6.0		1.5		6.5			0.54	0.22	0.22	0.09	0.05	0.01
02/01/95	11.7				14.8		1.6		6.6			0.78	0.43	0.48	0.36	0.30	0.23
02/02/95	11.3				21.5		2.0		6.5			1.25	0.70	0.74	0.58	0.52	0.43
02/07/95	11.6				12.0		1.6		6.5			0.58	0.25	0.27	0.13	0.09	0.03
02/14/95	11.4				12.0		1.6		6.4			0.86	0.29	0.28	0.14	0.08	0.03
02/28/95	12.9				6.0		1.8		6.6			0.47	0.19	0.19	0.07	0.03	<.01
08/13/95	19.4				4.0		3.0		6.5			0.70	0.15	0.07	0.03	0.02	0.02
08/14/95	19.4				21.0		3.3		6.6			0.65	0.10	0.10	0.01	0.01	0.01
08/15/95	19.4				18.0		3.0		6.5			0.72	0.47	0.49	0.20	0.18	0.09

Utility ID:	SCWWD	(ACWD, CCWD, EBMUD, MWD, SCWWD)		
1. Study ID:	Pilot Study 93-94	(Optimization Study 8/95, etc.)	4. If blended source water indicate sources and proportions:	
2. Source water:	South Bay Aqueduct	(River, lake, groundwater, etc.)	Source	%
3. Source water ID:	State Project Water	(State Project water, blend of...., etc.)		
5. Describe level of study: (indicate with an 'X')		Bench-scale	In this data sheet, "Filt." refers to data collected after coagulation, flocculation, sedimentation, and filtration.	
	X	Pilot-scale		
		Full-scale		
6. Indicate with an 'X' if data reported as "Filt." are from samples collected after sedimentation only:				
or after sedimentation and filtration:	X			

WATER QUALITY DATA: CONVENTIONAL

Date	TOC (mg/L) Raw	TOC Filt.	UV-254 (1/cm) Raw	UV-254 Filt.	Alkalinity (mg/L as CaCO3) Raw	Alkalinity Filt.	Hardness (mg/L as CaCO3) Total Raw	Total Filt.	Calcium Raw	Calcium Filt.	Bromide (µg/L) Raw	Bromide Filt.	Chloride (mg Cl-/L) Raw	Chloride Filt.	TDS (mg/L) Raw	TDS Filt.	Turbidity (NTU) Raw	Turbidity Filt.	pH () Raw	pH Filt.	Temperature (deg. C) Raw	Temperature Filt.
11/3/93	3.46	2.46	0.127	0.0532	83	81	117	117			170		61		232	237	2.9	0.071	8.1	7.98	18.7	21
11/4/93	3.32	2.14	0.113	0.0346	86	70	122	122			150		57		230	234	2.09	0.054	7.58	6.96	18.7	20.8
11/16/93	2.81	1.52	0.112	0.0238	60	8	103	103			230		75		235	253	7.19	0.096	7.40	5.52	18.8	17.5
11/17/93	3.05	0.78	0.116	0.011	62	21	105	105			220		71		238	255	10.13	3.17	7.42	5.53	18.4	18.1
11/18/93	2.94	0.92	0.114	0.013	70	26	105	105			220		74		241	251	4.68	0.048	7.24	6.24	17.5	18.2
11/3/93	3.46	2.46	0.127	0.049	83	67	117	117			170		61		232	240	2.9	0.066	7.6	6.8	18.7	21
11/3/93	3.46	1.22	0.127	0.023	83	66	117	117			170		61		232	242	2.9	0.06	7.6	6.49	18.7	21.3
11/4/93	3.32	2.16	0.113	0.039	85	68	122	122			150		57		230	240	2.09	0.063	7.58	7	18.7	20
11/4/93	3.32	0.7	0.113	0.010	85	39	122	122			150		57		230	250	2.09	0.041	7.58	6.44	18.7	21.3
11/15/93	2.96	1.05	0.123	0.016	71	12	108	108			170		72		237	260	4.76	0.046	7.75	5.49	17.7	18.7
11/15/93	2.96	1.03	0.123	0.026	71	13	106	108			170		72		237	253	4.76	0.098	7.75	5.52	17.7	17.5
11/16/93	2.81	0.94	0.112	0.016	60	7	103	103			230		75		235	257	7.19	0.051	7.48	5.58	18.8	17.8
2/15/94	4.82	2.74	0.215	0.057	83	55	115	115			160				219	234	7.37	0.101	7.59	6.4	12.8	13.3
4/25/94	4.6	2.57	0.181	0.046	81	56	124	124			550	290	70		272	283	5.94	0.07	7.87	6.71	16.9	17.2
4/27/94	4.67	2.49	0.168	0.041	82	57	127	127			530		73		274	291	7.07	0.067	7.64	6.78	17.1	17.8
4/28/94	4.58	2.4	0.193	0.040	81	59	126	126			658		74		280	293	6.69	0.09	7.5	6.77	18	18.3
5/2/94	4.58	2.53	0.161	0.041	81	60	127	127			660		72		281	292	6.34	0.085	8.13	6.71	17.6	17.9
5/16/94	3.97	2.57	0.142	0.053	95	80	129	129			450		50		241	246	5.57	0.104	8.04	7.06	18.2	18.1
5/16/94	3.97	2.57	0.142	0.053	95	80	129	129			460		50		241	246	5.57	0.104	8.04	7.06	18.2	18.1
5/16/94	3.97	2.57	0.142	0.053	95	80	129	129			450		50		241	246	5.57	0.104	8.04	7.06	18.2	18.1
5/16/94	3.97	2.57	0.142	0.053	95	80	129	129			460		50		241	246	5.57	0.104	8.04	7.06	18.2	18.1
5/17/94	3.79	2.68	0.155	0.056	81	69	120	120			630		89		266	259	4.92	0.087	8.71	7.28	18.5	18.5
5/19/94	3.88	2.57	0.141	0.050	85	71	120	120			600		89		261	273	5.4	0.063	8.56	7.06	18.5	18.9
5/24/94	3.89	2.73	0.136	0.050	89	82	128	128			670		54		236	242	6.84	0.083	8.12	6.99	16.8	20
3/1/94	5.57	2.31	0.262	0.045	70	53	113	113			170	120			235	250	9.66	0.099	7.6	6.23	14.5	15.8
3/1/94	5.57	2.31	0.262	0.045	70	53	113	113			170	120			235	250	9.66	0.099	7.6	6.23	14.5	15.8
3/1/94	5.57	2.31	0.262	0.045	70	53	113	113			170	120			235	250	9.66	0.099	7.6	6.23	14.5	15.8
3/1/94	5.57	2.31	0.262	0.045	70	53	113	113			170	120			235	250	9.66	0.099	7.6	6.23	14.5	15.8
6/13/94	3.2	2.08	0.121	0.046	77	68	115	115			660		71		263	266	4.5	0.072	8.1	7.16	19	20.2
6/14/94	3.22	2.48	0.114	0.054	78	65	117	117			600				283	276	4.53	0.117	8.29	7.32	19.9	21.2
6/15/94	3.25	2.8	0.118	0.059	78	75	113	113			608	290	73		267	275	4.80	0.098	8.2	7.45	18.2	20.1
6/16/94	3.15	1.87	0.118	0.027	79	43	114	114			1000	560	73		266	282	4.25	0.073	7.98	6.55	17.3	19.7

Utility ID:				
1. Study ID:				
2. Source wa				
3. Source wa				
5. Describe I				
(indicate wi				
6. Indicate w				

Indicate coagulants studied:

ID	oagulan	Chemical formula	Units
1	Alum	Al2(SO4)3	mg/L
2	erric Chl	FeCl3	mg/L
3			
4			

WATER Q

TREATMENT CONDITIONS

Date	Chlorination conditions: Filtered: indicate disinfectant(s) used with an 'X': chlorine	chloramine	Chlorine dose (mg Cl2/L)	Ammonia dose (mg NH3-N/L)	Incubation time (h): chlorine	chloramine	Incub. temp. (deg. C)	pH ()	Residual FREE (mg Cl2/L)	Disinfection By-products: TTHM (µg/L) Raw	TTHM Filt.	HAA5 (µg/L) Raw	HAA5 Filt.	HAA6 (µg/L) Raw	HAA6 Filt.	Coagulation Conditions: Coagulant ID (see above)	Dose	Acid adjusted? (Y/N)	Base adjusted? (Y/N)	Coag. pH ()	Coag. temp. (deg. C)
11/3/93	X	X	2.4	0.58	0.25	72	20 to 25	7.98	1.60		38		25.7		29.6	1	20	N	N	7.98	20
11/4/93	X	X	2.4	0.60	0.25	72	20 to 25	8.05	1.6		31		25.4		28.3	1	28	N	N	6.96	19.4
11/16/93	X	X	2.4	0.33	0.25	72	20 to 25	8.02	1		23		22.5		25.9	1	40	Y	N	5.52	17.1
11/17/93	X	X	2.4	0.39	0.25	72	20 to 25	8.05	1.17		14		18.5		20	1	40	Y	N	5.53	18.8
11/18/93	X	X	2.4	0.35	0.25	72	20 to 25	8.05	1.06		14		18.5		20	1	40	Y	N	6.24	18.6
11/3/93	X	X	2.3	0.69	0.17	72	20 to 25	6.8	2.07		34		24.7		29.3	2	15	N	N	6.73	19.6
11/3/93	X	X	2.3	0.57	0.17	72	20 to 25	6.8	1.72		21		13.5		15	2	15	N	N	6.59	20.3
11/4/93	X	X		0.55	0.17	72	20 to 25	7	1.65		35		19.7		23.8	2	15	N	N	7.08	19.5
11/4/93	X	X		0.89	0.17	72	20 to 25	6.48	2.07		11		13.5		15	2	45	N	N	6.3	19.3
11/15/93	X	X		0.36	0.25	72	20 to 25	5.81	1.07		18		15.4		16.9	2	30	Y	N	5.48	16.9
11/15/93	X	X		0.35	0.25	72	20 to 25	5.88	1.05		23		16.5		20.3	2	40	Y	N	5.49	18.6
11/16/93	X	X		0.35	0.25	72	20 to 25	5.87	1.05		20		13.5		15	2	30	Y	N	5.6	17.2
2/15/94	X	X	2	0.87	0.08	72	20 to 25	6.4	2		45		33.2		39.2	2	37	N	N	6.3	12.9
4/25/94	X	X	2	0.39	0.25	72	20 to 25	6.71	1.16		66		18.6		20.3	2	22	N	N	6.68	17.5
4/27/94	X	X	2	0.32	0.50	72	20 to 25	6.78	0.97		74		20.4		23.7	2	23	N	N	6.77	17.1
4/28/94	X	X	2	0.33	0.50	72	20 to 25	6.77	1		78		18.8		22.1	2	23	N	N	6.84	16.5
5/2/94	X	X	2	0.33	0.50	72	20 to 25	6.71	0.99		79		23		24.5	2	23	N	N	6.76	17.4
5/16/94	X	X	2	0.33	0.25	72	20 to 25	7.06	1		82		23		28.8	2	23	N	N	7.08	17.3
5/16/94	X	X	2	0.31	0.50	72	20 to 25	7.06	0.93		70		23		28.8	2	23	N	N	7.08	17.3
5/16/94	X	X	2	0.18	1.00	72	20 to 25	7.06	0.54		75		23		28.8	2	23	N	N	7.08	17.3
5/16/94	X	X	2	0.10	2.00	72	20 to 25	7.06	0.3		80		25		28.7	2	23	N	N	7.08	17.3
5/17/94	X	X	2	0.27	0.50	72	20 to 25	7.28	0.82		88		21.3		25.1	2	23	N	N	7.39	18.9
5/19/94	X	X	2	0.28	0.50	72	20 to 25	7.00	0.85		85		24		25.5	2	23	N	N	7.14	18.7
5/24/94	X	X	2	0.24	0.50	72	20 to 25	6.99	0.72		73		20.4		24.5	2	28	N	N	6.99	19.9
3/1/94	X	X	2	0.38	0.25	72	20 to 25	6.23	1.15		43		13.5		15	2	43	N	N	6.54	15.1
3/1/94	X	X	2	0.33	0.50	72	20 to 25	6.23	1		38		15.2		19.1	2	43	N	N	6.54	15.1
3/1/94	X	X	2	0.27	1.00	72	20 to 25	6.23	0.8		38		15.2		16.7	2	43	N	N	6.54	15.1
3/1/94	X	X	2	0.22	2.00	72	20 to 25	6.23	0.65		39		18		22.3	2	43	N	N	6.54	15.1
6/13/94	X	X	2	0.30	0.25	72	20 to 25	7.18	0.89		55		25		30	2	30	N	N	7.07	19.7
6/14/94	X	X	2	0.29	0.50	72	20 to 25	7.32	0.87				31.3		40.7	2	30	N	N	7.37	20.5
6/15/94	X	X	2	0.25	0.50	72	20 to 25	7.45	0.74				28		35.3	2	30	N	N	7.16	19.6
6/18/94	X	X	2	0.17	0.50	72	20 to 25	6.55	0.51				63.9		93.7	2	32	N	N	6.62	19.8

Utility ID:		SCVWD		(ACWD, CCWD, EBMUD, MWD, SCVWD)		
1. Study ID:		Pilot Study 93-94		(Optimization Study 9/95, etc.)		
2. Source water:		South Bay Aqueduct - San luis Reservoir		(River, lake, groundwater, etc.)		
3. Source water ID:		State and Federal Water Projects		(State Project water, blend of...., etc.)		
		5. Describe level of study:		Bench-scale		
		(Indicate with an 'X')	X	Pilot-scale		
				Full-scale		

WATER QUALITY DATA: CONVENTIONAL+OZONE

Date	Time	TOC (mg/L) Raw	TOC Settl.	TOC Ozon.	TOC Filt.	UV-254 (1/cm) Raw	UV-254 Settl.	UV-254 Ozon.	UV-254 Filt.	Alkalinity (mg/L as CaCO3) Raw	Alkalinity Settl.	Alkalinity Ozon.	Alkalinity Filt.	Hardness (mg/L as CaCO3) Total Raw	Hardness Settl.	Hardness Ozon.	Hardness Filt.	Bromide (μg/L) Raw	Bromide Settl.	Bromide Ozon.	Bromide Filt.	Ammonia (mg NH3-N/L) Raw	Ammonia Settl.	Ammonia Ozon.	Ammonia Filt.	Chloride (mg Cl-/L) Raw	Chloride Settl.	Chloride Ozon.	Chloride Filt.	TDS (mg/L) Raw	TDS Settl.	TDS Ozon.	TDS Filt.	Raw
5/11/93		3.51	2.59		2					68	44			110	110			170			110									236	254			11
5/18/93		3.58	2.37		1.64	0.027	0.034			62	49		41	105	110		107	160			140									234	233		220	10
5/25/93		5.85	3.09		2.17	0.041				79	58		52	130	130		130	230			190									270	282		290	6
2/15/94		4.82	2.66		1.73	0.215	0.293		0.026	63	50		57	116	115		115	160			100									219	230		233	7.37
3/1/94		5.57	2.99		2.27	0.262	0.023		0.029	70	44		43	113	113		113	170			140									235	248		242	9.66
3/14/94		3.09	2.18		1.67	0.114			0.023	70	53		56	107	107		107	200			130									243	245		249	1.429
4/25/94		4.6	3.06		2.32	0.181	0.209		0.033	81	59		59	124	124		124	650		550	370					70				272	283		284	5.94
4/25/94		4.6	3.06		1.55	0.181	0.209		0.023	81	59		56	124	124		124	650		550	320					70				272	283		284	5.94
5/16/94		3.97	3		2.24	0.142	0.218		0.031	95	79		79	129	129		129	450		480	320					50				241	245		248	5.57
5/16/94		3.97	3		1.85	0.142	0.218		0.025	95			74	129			129	490		480	330					50				241			248	5.57
6/13/94		3.2	2.17		1.69	0.121	0.123		0.026	77	59		58	115	115		116	560		360	390					71				263	267		269	4.5
6/13/94		3.2	2.17		1.32	0.121	0.123		0.021	77	59		56	115	115		115	560		360	370					71				263	267		269	4.5
	Bromate Data																																	
5/11/93		3.51	2.59		2					68	44			110	110			170			110									236				11
5/18/93		3.58	2.37		1.64	0.027	0.034			62	49		41	105	110		107	160			140									234			220	10
5/25/93		5.85	3.09		2.17	0.041				79	58		62	130	130		130	230			190									270			290	6
5/26/93		8.56	3.19			0.043				79	68		6.5	131				220												285			290	6
8/18/93		2.78	1.33			0.138	0.146			45	15			45												16				88.6			51	21
8/25/93		4.13								38	17			38	38			170								32				46.8				15
8/26/93		2.34	1.06			0.128	0.115			40	18		17	41	41											16				52.7			69	13
9/1/93		2.52	1.2			0.128	0.151			43	12		15	48	48			80	740							16				58.2			78	22.8
10/4/93		3.62	2.23			0.107	0.146			87	59		67	105	105		105	80	200				0.5			30				166			179	7.16
10/5/93		3.56	2.69			0.109	0.180			95	56		70	110	110		110	80	580				0.5			31				173			182	7.2
10/6/93		3.6	1.97			0.098	0.147			92	61		51	109	109		109	90					0.5			32				180			197	8.73
10/7/93		3.48	2.37			0.102	0.160			93	68		64	102	102		102	90	460				0.5			33				177			191	9.79
10/7/93		3.48				0.102				93	68		64	102	102		102	90	460				0.6			33				177			191	8.79
10/12/93		3.67				0.106				98	79		62	116	116		116	90	250				0.5			32				178			200	5.42
10/12/93		3.67	3.03			0.106	0.182			96	79		62	116	116		116	90	250				0.5			32				178			200	5.42
10/13/93		3.42	3.89			0.098	0.256			96	82		33	112	112		112	90	730				0.5			32				179			220	5.88
10/13/93		3.42	3.89			0.098	0.256			98	82		33	112	112		112	90	730				0.6			32				179			220	5.88
10/14/93		5.02	4.02			0.150	0.273			65	65		56	107	107		107	120	720							62				226			217	3.4
10/14/93		5.02	2.84			0.150	0.174			65	51		29	107	107		107	120	720							62				226			233	3.4
10/14/93		6.02				0.150				65	51		29	107	107		107	120	720							62				228			233	3.4
1/27/94										71	46		50	112	112		112	200												241			251	11.07
2/15/94		4.82	2.86		1.73	0.215	0.293			63	60		57	115	115		115	160			180									219			233	7.37
3/1/94		5.57	2.99		2.27	0.262	0.023			70	44		43	113	113		113	170			140									235			242	9.66
3/14/94		3.09	2.18		1.67	0.114				70	53		56	107	107		107	200			130									243			249	1.429
4/25/94		4.6	3.06		2.32	0.181	0.209			81	59		59	124	124		124	210	550		370					70				272			284	5.94
4/27/94		4.67	3.08			0.168	0.226			82	61		60	127	127		127	190	530		520					73				274			288	7.87
4/28/94		4.58	3.09			0.183	0.217			61	63		61	126	126		126	190	550		490					74				280			285	8.69
5/2/94		4.56	3.06			0.161	0.224			61	58		62	127	126		127	200	550		550					72				281			290	5.34
5/16/94		3.97	3		2.24	0.142	0.218			85	79		79	129	129		129	180	450		3					50				241			248	5.57
5/17/94		3.79	2.96			0.155	0.210			81	68		68	120	120		120	180	530		320					69				266			277	4.92
5/19/94		3.86	2.79			0.141	0.190			85	71		70	120	120		120	180	500							69				261			274	5.4
5/24/94		3.69	2.73			0.136	0.232			89	71		78	128	128		128	180	670		510					54				236			247	6.84
6/13/94		3.2	2.17		1.69	0.121	0.123			77	59		58	115	115		115	200	560		390					71				263			269	4.5
6/14/94		3.22	2.06			0.114	0.101			78	58		58	117	117		117	180	600		570									263			277	4.53
6/15/94		3.25	2.24			0.118	0.116			78	62		58	113	113		113	220	600		600					73				267			273	4.88
6/16/94		3.15	2.19			0.118	0.137			79	60		61	114	114		114	200	1000		1000					73				266			273	4.25

Utility ID:

1. Study

2. Source

3. Source

WATER

Date	Turbidity (NTU) Settl.	Turbidity Ozon.	Turbidity Filt.	pH () Raw	pH Settl.	pH Ozon.	pH Filt.	Temperature (deg. C) Raw	Temp. Settl.	Temp. Ozon.	Temp. Filt.	Bromide Bromate (µg/L) Raw	Bromide Settl.	Bromide Ozon.	Bromide Filt.	HPC (CFU/mL) Raw	HPC Settl.	HPC Ozon.	HPC Filt.
5/11/93	2		0.08	7.8	6.43	6.43		20	19.2			2			1				3933
5/18/93	1.7		0.1	7.8	6.56	6.56	6.56	21	21.5		21.8	11.6							108
5/25/93	3			6.8	6.33	6.33		16.7	17.8			16.5			13.5				3100
2/15/94	2.32		0.164	7.59	6.24	6.24	6.34	12.5	12.8		14.8	1			2	820			1900
3/1/94	3.05		0.077	7.6	6.4	6.4	6.52	14.5	14.1		16.6	1			2	2100			1300
3/14/94	1.499		0.087	7.28	6.76	6.76	6.56	12.9	14.2		18	2.2			2.6				2800
4/25/94	2.02		0.05	7.87	6.69	6.69	6.92	16.9	17.2		17.9	2			2	81			570
4/25/94	2.02		0.053	7.87	6.69	6.69	6.79	16.9	17.2		18.2	2			2	81			2100
5/16/94	2.14		0.066	8.04	7.04	7.04	6.98	16.2	17.7		18.6	2.4			2.8	1600			1300
5/16/94	2.14		0.067	8.04	7.04	7.04	6.9	16.2	17.7		18.4	2.4			2	1500			3100
6/13/94	1.14		0.041	8.1	6.8	6.8	6.87	19	19.5		20.8	3.5			3.2	690			860
6/13/94	1.14		0.029	8.1	6.8	6.8	6.97	19	19.5		21	3.5			2.4	690			3100
5/11/93	2		0.08	7.8	6.43	6.43		20	19.2		.			2	1				
5/18/93	1.7		0.1	7.8	6.56	6.56	6.56	21	21.5		21.8			11.5					
5/25/93	3			6.8	6.33	6.33		16.7	17.8					16.5	13.5				
5/26/93	4.2		0.28	6.8	6.8	6.8	6.49	17.3	16.7		18			23					
8/18/93	2		0.097	7.4	6.103	6.103	6.21	22.9	23.9		25.8				1				
8/25/93	1.7		0.05	7.3	6.11	6.11		23	26.3						2.2				
8/26/93	1.5		0.1	7.6	6.21	6.21	6.35	22.6	26.3		27.4				4.1				
9/1/93	2		0.02	7.47	5.93	5.93	6.06	23.7	25		26.5				1				
10/4/93	1.27		0.04	7.74	6.52	6.52	6.44	19	19.8		20.5				1				
10/5/93	1.14		0.058	7.81	6.62	6.62	7	18.2	18.6		18.9				4.2				
10/6/93	1.28		0.083	7.81	6.77	6.77	6.64	17.7	17.8		19.7				4.7				
10/7/93	1.81		0.058	7.94	6.89	6.89	6.9	18.4	19.3		22				4.7				
10/7/93	1.81		0.058	7.94	6.89	6.89	6.9	18.4	19.3		22				4.3				
10/12/93	2.9		0.085	7.6	6.98	6.98	6.75	18.5	19		20.9				12.4				
10/12/93	2.9		0.085	7.6	6.98	6.98	6.75	18.5	19		20.9				1				
10/13/93	2.18		0.128	7.93	7.16	7.16	6.1	18.8	19.4		20				1				
10/13/93	2.18		0.128	7.93	7.16	7.16	6.1	18.8	19.4		20				1				
10/14/93	3.4		0.26	7	7	7	6.53	19	19		20.3				9.1				
10/14/93	1.34		0.09	7	6.67	6.67	6.15	19	19.2		20.2				6.4				
10/14/93	1.34		0.09	7	6.67	6.67	6.16	19	19.2		20.2				2.7				
1/27/94	3.36		0.415	7.15	6.28	6.28	6.33	11.9	13		15.4				2				
2/15/94	2.32		0.164	7.59	6.24	6.24	6.34	12.5	12.8		14.8			1	2				
3/1/94	3.05		0.077	7.6	6.4	6.4	6.52	14.5	14.1		16.6			1	2				
3/14/94	1.499		0.087	7.28	6.76	6.76	6.58	12.9	14.2		18			2.2	2.6				
4/25/94	2.02		0.05	7.87	6.69	6.69	6.92	16.9	17.2		17.9			2	2				
4/27/94	2.73		0.056	7.64	6.89	6.89	6.89	17.1	17.1		18.5			2	2				
4/28/94	2.72		0.071	7.6	6.91	6.91	6.84	16	16.8		18.3			2	2				
5/2/94	1.89		0.074	8.13	6.74	6.74	6.8	17.6	17.4		18.5			2	2				
5/16/94	2.14		0.066	8.04	7.04	7.04	6.98	16.2	17.7		18.6			2.4	2.9				
5/17/94	1.79		0.054	8.71	7.18	7.18	7.12	18.5	18.9		19.6			2.7	2.8				
5/19/94	2.16		0.058	8.56	7.12	7.12	6.99	18.5	18.4		19.7			2.1	2.1				
5/24/94	2.04		0.056	8.12	6.83	6.83	6.87	16.8	19.3		20.9			2	2				
6/13/94	1.14		0.041	8.1	6.8	6.8	6.87	19	19.5		20.8			3.5	3.2				
6/14/94	1.94		0.044	8.29	7	7	6.92	19.9	20.1		21.9			4	3.2				
6/15/94	0.97		0.037	8.2	6.79	6.79	7.04	18.2	18.8		20.5			2.2	2.1				
6/16/94	1.58		0.032	7.98	6.93	6.93	6.97	17.3	18.6		20.4			2.9	2.6				

Chlorination conditions — Filtered

Date	Indicate disinfectant(s) used with an 'X': chlorine	chloramine	Chlorine dose (mg Cl2/L)	Ammonia dose (mg NH3-N/L)	Incubation time (h): chlorine	chloramine	Incub. temp. (deg. C)	pH ()	Residual (mg Cl2/L)	Raw	Settl.
5/11/93	X	X	2.5	0.73	0.083	168	20-25	6.6	2.18		
5/18/93	X	X	2.5	0.66	0.083	168	20-26	6.60	1.97		
5/25/93	X	X	2.5	0.73	0.083	168	20-27	6.41	2.2		
2/15/94	X	X	2	0.49	0.083	168	20-28	6.34	1.46		
3/1/94	X	X	2	0.45	0.083	168	20-29	6.52	1.35		
3/14/94	X	X	2	0.56	0.083	168	20-30	6.58	1.67		
4/25/94	X	X	2	0.50	0.083	168	20-31	6.92	1.49		
4/25/94	X	X	2	0.47	0.083	168	20-32	6.79	1.42		
5/16/94	X	X	2	0.53	0.083	168	20-33	6.98	1.59		
5/16/94	X	X	2	0.51	0.083	168	20-34	6.9	1.52		
6/13/94	X	X	2	0.47	0.083	168	20-35	6.87	1.41		
6/13/94	X	X	2	0.47	0.083	168	20-36	6.97	1.42		

Utility ID:	
1. Study	
2. Source	
3. Source	

Indicate coagulants studied:

ID	Coagulant	Chemical formula	Units
1	Alum	Al2(SO4)3	mg/L
2	Ferric Chlo.	FeCl3	mg/L
3			
4			

WATER TREATMENT CONDITIONS

Date	Disinfection By-products																Coagulation Conditions						Ozonation Conditions				
	M (/L)		HAA5 (µg/L)				HAA6 (µg/L)				TOX (µg Cl-/L)				Coagulant ID (see above)	Dose	Acid adjusted? (Y/N)	Base adjusted? (Y/N)	Coag. pH ()	Coag. temp. (deg. C)	Ozone dose (mg/L)	Ozone residual (mg/L)	Contact time (min)	Ozone pH ()	Ozone temp. (deg. C)
	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.	Raw	Settl.	Ozon.	Filt.											
5/11/93		12				60.3				61.8					2	20	N		6.43	19.2	1.6	0.7	12	6.4	19.2
5/18/93		7				18				17.6					2	20	N		6.56	21.5	2.1	1.3	12	6.56	21.5
5/25/93		11				25				37					2	30	N		6.33	17.8	3.4	1.33	12	6.22	19.7
2/15/94		23				15.2				16.7					2	30	N		6.24	12.8	1.2	0.28	12	6.24	13.3
3/1/94		20				13.5				15					2	30	N		6.4	14.1	0.9	0.12	12	6.36	15.7
3/14/94		14				13.5				15					2	22	N		6.76	14.2	0.9	0.15	12	6.51	18.5
4/25/94		48				17.4				18.9					2	20	N		6.69	17.2	0.7	0.15	12	6.7	17.3
4/25/94		30				15.2				16.7					2	20	N		6.69	17.2	0.7	0.15	12	6.7	17.3
5/16/94		30				17.9				19.4					2	20	N		7.04	17.7	0.9	0.16	12	7.04	17.7
5/16/94		29				15.9				17.4					2	20	N		7.04	17.7	0.9	0.16	12	7.04	17.7
6/13/94		28				17.4				18.9					2	20	N		6.8	19.5	0.9	0.18	12	6.91	19.6
6/13/94		42				15.7				17.2					2	20			6.8	19.5	0.9	0.18	12	6.91	19.6
5/11/93																					1.6	0.7	12	6.4	19.2
5/18/93																					2.1	1.3	12	6.56	21.5
5/25/93																					3.4	1.33	12	6.22	19.7
5/26/93																					4	1.06	12	6.8	16.7
8/18/93																					0.7	0.16	12	6.21	25.8
8/25/93																					1.6	0.27	12	6.3	23
8/26/93																					2.7	1.13	12	6.1	26.8
9/1/93																					0.8	0.26	12	5.96	25.1
10/4/93																					0.8	0.22	12	6.46	19.6
10/5/93																					1.7	0.74	12		
10/6/93																					2.7	1.65	12		
10/7/93																					0.8	0.16	12	6.9	20
10/7/93																					1.7	0.83	12		
10/12/93																					2.7	1.35	12	6.99	19.8
10/12/93																					0.7	0.2	12		
10/13/93																					1.6	0.78	12	6.05	19.7
10/13/93																					2.6	1.31	12	5.98	19.3
10/14/93																					2.2	0.63	12		
10/14/93																					2.8	1.28	12		
10/14/93																					2.2	0.63	12		
1/27/94																					1	0.23	12	6.28	13
2/15/94																					1.2	0.28	12	6.24	13.3
3/1/94																					0.9	0.12	12	6.36	15.7
3/14/94																					0.9	0.15	12	6.51	18.5
4/25/94																					0.7	0.15	12	6.7	17.3
4/27/94																					1	0.2	12	6.84	18
4/28/94																					1	0.25	12	6.94	16.9
5/2/94																					1	0.18	12	6.8	18.5
5/16/94																					0.9	0.16	12	7.04	17.7
5/17/94																					1.05	0.26	12	7.12	16.7
5/19/94																					1.05	0.27	12	7.05	19
5/24/94																					0.9	0.18	12	6.8	19.8
6/13/94																					0.9	0.18	12	6.91	19.6
6/14/94																					0.9	0.24	12	7.06	19.1
6/15/94																					0.9	0.24	12	7	19
6/16/94																					0.9	0.19	12	7	18.4

Utility ID:	SCVWD	(ACWD, CCWD, EBMUD, MWD, SCVWD)			
1. Study ID:	Pilot Study	(Optimization Study 9/95, etc.)			
2. Source water:	South Bay Aqueduct - San Luis Reservoir	(River, lake, groundwater, etc.)			
3. Source water ID:	State and Federal Water Projects	(State Project water, blend of...., etc.)			
5. Describe level of study:		Bench-scale	In this data sheet, "Filt." refers to data collected		
(indicate with an 'X')	X	Pilot-scale	after coagulation, flocculation, sedimentation, and		
		Full-scale	filtration.		

6. Indicate with an 'X' if data reported as "Filt." are from samples collected after sedimentation only:
or after sedimentation and filtration: X

WATER QUALITY DATA: PRE-OZONE

Date	Time	TOC (mg/L) Raw	TOC Ozon.	TOC Filt.	UV-254 (1/cm) Raw	UV-254 Ozon.	UV-254 Filt.	Alkalinity (mg/L as CaCO3) Raw	Alkalinity Ozon.	Alkalinity Filt.	Hardness (mg/L as CaCO3) Total Raw	Hardness Total Ozon	Hardness Total Filt.	Bromide ~~(ppm)~~ (mg/L) Raw	Bromide Ozon.	Bromide Filt.	Ammonia (mg NH3-N/L) Raw	Ammonia Ozon.	Ammonia Filt.	Chloride (mg Cl-/L) Raw	Chloride Ozon.	Chloride Filt.	TDS (mg/L) Raw	TDS Ozon.	TDS Filt.	Turbidity (NTU) Raw	Turbidity Ozon.	Turbidity Filt.	pH () Raw	pH Ozon.	pH Filt.	Tempera (deg. Raw	Tempera Ozon.
5/11/93		3.51		2.13				68			110			0.17		0.18							238			11		0.05	7.8	7.8	6.64	20	20
5/18/93		3.58		1.85				62		48	105		108	0.16		0.16							234		220	10		0.05	7.8	7.8	6.66	21	21
5/25/93		5.86		2.97				79		52	130		131	0.23		0.22							270		292	6			6.8	6.8		18.7	18.1
11/17/93		3.05		2.06	0.118		0.029	62		69	105		105	0.22		0.23				71			238		282	10.13		0.074	7.42		7.86	16.4	
1/4/94		3.44		1.91	0.120		0.028	64		53	103		103	0.23		0.14							235		223	2.9		0.17	7.7		6.7	13.5	
1/5/94		3.27		1.83	0.119		0.030	69		47	102		102	0.89									236		243	2.46		0.092	7.48		6.75	12.8	
1/5/94		3.27		1.09	0.119		0.018	69		56	102			0.89		0.68							236		243	2.46		0.085	7.48		6.81	12.8	
2/15/94		4.82		2.05	0.215		0.033	83			115		115	0.16		0.12							219			7.37			7.59	7.02		12.5	12.5
3/1/94		5.57		2.46	0.262		0.032	70		42	113		113	0.17		0.14							235		248	0.66		0.134	7.6	7.15	6.48	14.5	14.1
3/14/94		3.09		1.49	0.114		0.018	70		53	107		107	0.2		0.14							243		250	1.429		0.083	7.28	7.23	6.43	12.9	14.3
4/25/94		4.6		2.19	0.181		0.027	61		59	124		124	0.65	0.55	0.37				70			272		283	5.94		0.047	7.87	7.16	6.59	16.9	17
4/25/94		4.6		1.39	0.181		0.022	61		51	124		124	0.66	0.66	0.31				70			272		286	5.94		0.071	7.87	7.16	6.53	16.9	17
5/16/94		3.87		2.1	0.142		0.028	95		75	129		129	0.45	0.46	0.32				60			241		247	5.57		0.071	8.04	7.85	6.85	16.2	17.2
5/16/94		3.97		1.79	0.142		0.023	95		7	129		129	0.45	0.46	0.24				60			241		248	5.57		0.069	8.04	7.85	6.8	16.2	17.2
	Bromate Data																																
5/11/93		3.51		2.13				68			110			170		180							236			11		0.05	7.8	20	7.87	20	
5/13/93		4.17			0.028			70			113			170									241			11		0.06	7.8	20	6.3	20	
5/18/93		3.58		1.85				62		48	105		108	160		160							234		220	10		0.05	7.8	21	6.66	21	
5/19/93		3.55						63		37	111			180									233			9		0.09	7.3		6.03	22	
5/25/93		5.86		2.97				79		52	130		131	230		220							270		292	6			6.8	16.1		16.7	
5/26/93		6.56			0.043			70		5.3	131			220									285		298	6		0.1	6.8	16.2	6.7	17.3	
8/18/93		2.78			0.136			45			45									16			88.8		53	21		0.178	7.4	23.8	5.3	22.9	
8/25/93		4.13						38			38			170		140				32			46.8			15		0.05	7.3	21.5		23	
8/26/93		2.34			0.128			40		5	41			100		110				16			52.7		68.2	13		0.041	7.6	24.6	5.44	22.5	
9/1/93		2.52			0.126			43		18	48			740		530				18			58.2		66	22.6		0.02	7.47	23.7	6.07	23.7	
10/4/93		3.62			0.107			87			105			200		180		0.6		30			166		184	7.16		0.069	7.74	20	6.34	19	
10/5/93		3.56			0.109			95		54	110		110	880		540		0.5		31			173		186	7.2		0.075	7.61	18.8	6.6	18.2	
10/7/93		3.48			0.102			93		50	102		102	460		0.46		0.5		33			177		197	9.79		0.052	7.94	19.6	6.5	18.4	
10/12/93		3.67			0.106			96		22	116		116	260		250		0.5		32			178		204	5.42		0.063	7.8	18.6	5.7	18.5	
11/17/93		3.05		2.06	0.118			62		69	105		105	220		230				71			238		282	10.13		0.074	7.42		7.86	16.4	
12/6/93		3.27		1.95	0.115			66		85	103		103			180				69			244		252	1.6		0.06	7.5	16.8	6.68	16	
1/4/94		3.44		1.91	0.120			64		53	103		103	230		140							235		223	2.9		0.17	7.7		6.7	13.5	
1/5/94		3.27		1.83	0.119			69		47	102		102	690									236		243	2.46		0.092	7.48		6.75	12.8	
1/5/94		3.27		1.09	0.119			69		58	102			890		680							236		243	2.48		0.085	7.48		6.81	12.8	
1/27/94								71		45	112		112	200									241		248	11.07		0.202	7.15	12.3	6.25	11.9	
2/15/94		4.62		2.05	0.215			83			115		115	180		120							219			7.37			7.59	12.5		12.5	
3/1/94		5.57		2.46	0.262			70		42	113		113	170		140							235		248	0.66		0.134	7.6	14.1	6.46	14.5	
3/14/94		3.09		1.49	0.114			70		53	107		107	200		140							243		250	1.429		0.083	7.28	14.3	6.43	12.9	
4/25/94		4.6		2.19	0.181			61		59	124		124	550	550	370				70			272		283	5.94		0.047	7.87	17	6.59	16.9	
4/25/94		4.6		1.39	0.181			61		51	124		124	550	550	310				70			272		286	5.94		0.071	7.87	17	6.53	16.9	
4/27/94		4.67			0.168			62		58	127		127	530	540	430				73			274		287	7.97		0.056	7.64	16.9	6.77	17.1	
4/27/94		4.67			0.168			62		59	127		127	530	540	470				73			274		290	7.97		0.06	7.64	16.9	6.8	17.1	
4/28/94		4.58			0.193			61		57	126		126	550	550	533				74			280		281	6.69		0.076	7.5	16.4	6.78	16	
4/28/94		4.58			0.193			61		61	126		126	550	550	420				74			280		286	6.69		0.08	7.5	16.4	6.77	16	
5/2/94		4.56			0.161			61		63	127		127	560	570	570				72			281		289	5.34		0.081	8.13		6.67	17.6	
5/2/94		4.56			0.161			61		60	127		127	560	570	480				72			281		288	5.34		0.080	8.13		6.6	17.6	
5/16/94		3.97		2.1	0.142			95		75	129		129	450	460	0.32				60			241		247	5.57		0.071	8.04	17.2	6.85	16.2	
5/16/94		3.97		1.79	0.142			95		7	129		129	450	460	0.24				60			241		248	5.57		0.069	8.04	17.2	6.6	16.2	
5/17/94		3.79			0.155			61		61	120		120	530	560	0.52				69			266		277	4.92		0.042	8.71	18.3	6.97	18.5	
5/17/94		3.79			0.155			61		62	120		120	530	560	0.47				69			266		277	4.92		0.053	8.71	18.3	7.03	18.5	
5/19/94		3.88			0.141			65		71	120		120	500						69			281		271	5.4		0.092	8.56	18.7	7.05	18.5	
5/19/94		3.88			0.141			65		70	120		120	500						69			281		271	5.4		0.089	8.56	18.7	6.98	18.5	
5/24/94		3.89			0.136			69		75	128		128	670	550	0.5				54			236		246	6.84		0.051	8.12	19	6.62	16.8	
5/24/94		3.89			0.136			69		75	128		128	670	550	0.43				54			236		247	6.84		0.054	8.12	19	6.69	16.8	

Utility ID:

1. Study ID:

2. Source wa

3. Source wa

5. Describe I
(indicate wi

6. Indicate w

Indicate coagulants stu	
ID	Coagulant
1	Alum
2	Ferric Chlo.
3	
4	

WATER Q

TREATMENT CONDI

Date	re	Bromate (µg/L)			HPC (CFU/mL)			Chlorination conditions Filtered									Disinfection By-products									Coagu	
	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Indicate disinfectant(s) used with an "X"		Chlorine dose	Ammonia dose	Incubation time (h)		Incub. temp.	pH	Residual	TTHM (µg/L)			HAA5 (µg/L)			HAA6 (µg/L)			Coagulant ID	Dose
								chlorine	chloramine	(mg Cl2/L)	(mg NH3-N/L)	chlorine	chloramine	(deg. C)	()	(mg Cl2/L)	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	Raw	Ozon.	Filt.	(see above)	
5/11/93	21.5		4.1	5.3			13851	X	X	2.5	0.67	0.083	168	20-25	8.94	2.01			19			21.01			40.01	2	20
5/18/93	22 2		16.3	13.5			192	X	X	2.5	0.69	0.083	168	20-25	8.84	2.07			9			11.07			20.07	2	20
5/25/93			18.7	13.3			5700	X	X	2.5	0.70	0.083	168	20-25	8.4	2.1			16			16.1			34.1	2	30
11/17/93	17.8			13.7				X	X		0.00	0.000	168	20-25	8	0			1			1			2	2	25
1/4/94	16.1			5.8			1400	X	X		0.33	0.083	168	20-25	8.7	1						1			1	2	15
1/5/94	15.5			14.5			15390	X	X		0.33	0.083	168	20-25	8.8	1			56.5			57.6			114	2	
1/5/94	15.5			14.4			14250	X	X		0.33	0.083	168	20-25	8.7	1			38.5			39.5			78	2	
2/15/94			2.4	5.3	820		5700	X	X	2	0.50	0.083	168	20-25	8.3	1.6			23			24.5			47.5	2	30
3/1/94	16.7		2	2.4	2100		1800	X	X	2	0.78	0.083	168	20-25	8.46	2.35			23			25.35			48.35	2	40
3/14/94	20.2		7.5	6.8			4200	X	X	2	0.53	0.083	168	20-25	8.43	1.8			21			22.8			43.6	2	26
4/25/94	17.6		10.5	9.64	61		860	X	X	2	0.52	0.083	168	20-25	8.59	1.55			46			47.55			93.55	2	21.5
4/25/94	17.5		10.5	8	81		3100	X	X	2	0.43	0.083	168	20-25	8.53	1.3			30			31.3			61.3	2	21.5
5/16/94	18.7		16.5	13.6	1500		1900	X	X	2	0.51	0.083	168	20-25	8.85	1.52			37			38.52			75.52	2	21
5/16/94	18.2		16.5	7.1	1500		2400	X	X	2	0.62	0.083	168	20-25	8.8	1.55			32			33.55			65.55	2	21
5/11/93	21.5		4.1	5.3																						2	20
5/13/93	20		12.1																							2	20
5/18/93	22 2		16.3	13.5																						2	20
5/19/93	22.8		20																							2	20
5/25/93			18.7	13.3																						2	30
5/26/93	17.3		18																							2	5.3
8/16/93	24.9			1																						2	20
8/25/93				4.2																						2	10
8/20/93	27.5			3.8																						2	10
9/1/93	28.5			13.8																						2	20
10/4/93	19.7			2.4																						2	20
10/5/93	19 5			11.1																						2	20
10/7/93	20.9			12																						2	20
10/12/93	20.7			1																						2	20
11/17/93	17.8			13.7																						2	25
12/6/93	17.4			69.7																						2	15
1/4/94	16.1			5.8																						2	15
1/5/94	15.5			14.5																						2	
1/5/94	15.5			14.4																						2	
1/27/94	15			3.3																						2	25
2/15/94			2.4	5.3																						2	30
3/1/94	16.7		2	2.4																						2	40
3/14/94	20.2		7.5	6.8																						2	26
4/25/94	17.6		10.5	9.64																						2	21.5
4/25/94	17.5		10.5	8																						2	21.5
4/27/94	18.3		6.8	8.9																						2	21
4/27/94	18.4		8.6	6.2																						2	21
4/28/94	18.1		7.8	6.5																						2	22
4/28/94	18.2		7.8	3.3																						2	22
5/2/94	18.8		5.4	5																						2	22
5/2/94	18.7		5.4	2																						2	22
5/16/94	18.7		16.5	13.6																						2	21
5/16/94	18.2		16.5	7.1																						2	21
5/17/94	19.5		8.3	4.3																						2	21
5/17/94	19.5		8.3	3.3																						2	21
5/19/94	19.7		20.4	16.8																						2	21
5/19/94	19.6		20.4	17.5																						2	21
5/24/94	20.9		7.3	6.1																						2	25
5/24/94	20.6		7.3	3.1																						2	25

Utility ID:									
1. Study ID:									
2. Source wa									
3. Source wa									
	ed:								
5. Describe t	Chemical formula		Units						
(Indicate wit	Al2(SO4)3		mg/L						
	FeCl3		mg/L						
6. Indicate w									
WATER Q	IONS								

Date	tion Conditions				Ozonation Conditions				
	Acid adjusted? (Y/N)	Base adjusted? (Y/N)	Coag. pH ()	Coag. temp. (deg. C)	Ozone dose (mg/L)	Ozone residual (mg/L)	Contact time (min)	Ozone pH ()	Ozone temp. (deg. C)
5/11/93			6.64	19.7	3	0.43		7.8	20
5/18/93			6.73	22.2	4	0.52		7.8	21
5/25/93					5.3	0.71	18.36	6.8	16.1
11/17/93			7.68	17.7	3	0.43	12.24		
1/4/94			7.15	14.5	1.5	0.18	12.24		
1/5/94			6.76	14.2			12.24		
1/5/94			6.72	14.4	1.8	0.36	12.24		
2/15/94			6.3	12.7	3.1	0.32	12.24	7.02	12.6
3/1/94			6.36	15.2	3.4	0.48	12.24	7.15	14.1
3/14/94			6.51	15.7	2.3	0.45	12.24	7.23	14.3
4/25/94			6.63	17.3	3.6	0.57	12.24	7.18	17
4/25/94			6.63	17.3	3.5	0.57	12.24	7.18	17
5/16/94			7	17.5	2.5	0.4	12.24	7.85	17.2
5/16/94			7	17.5	2.5	0.4	12.24	7.85	17.2
5/11/93			6.64	19.7	3	0.43	18.36	7.8	20
5/13/93			6.29	20	3.1	0.65	18.36	6.5	20
5/18/93			6.73	22.2	4	0.52	18.36	7.8	21
5/19/93			6.04	23	4.7	1.3	12.24		
5/25/93					5.3	0.71	18.36	6.8	16.1
5/26/93			6.65	17.2	6.5	0.45	18.36	7	16.2
8/18/93			5.43	24.5	1.9	0.3	12.24	5.94	23.8
8/25/93			5.4	25.9	2.8	0.45	12.24	6.3	21.5
8/26/93			4.21	28.1	3.8	1.31	12.24	5.85	24.6
9/1/93			6.32	25.4	2.4	0.48	12.24	7.47	23.7
10/4/93			6.45	19.8	1.8	0.24	12.24	6.45	20
10/5/93			6.58	19.2	1.5	0.23	18.36	7.04	18.8
10/7/93			5.67	19.8	3.1	1.07	12.24	6.99	19.6
10/12/93			5.52	18.9	1.2	0.12	12.24	6.01	18.6
11/17/93			7.68	17.7	3	0.43	12.24		
12/6/93			6.6	17	5	1.29	12.24	7.56	16.8
1/4/94			7.15	14.5	1.5	0.18	12.24		
1/5/94			6.76	14.2			12.24		
1/5/94			6.72	14.4	1.8	0.36			
1/27/94			6.16	13.4	3.2	0.47	12.24	7.18	12.3
2/15/94			6.3	12.7	3.1	0.32		7.02	12.8
3/1/94			6.36	15.2	3.4	0.48	12.24	7.15	14.1
3/14/94			6.51	15.7	2.3	0.45	12.24	7.23	14.3
4/25/94			6.63	17.3	3.6	0.67	12.24	7.18	17
4/25/94			6.63	17.3	3.5	0.57	12.24	7.18	17
4/27/94			6.82	17.1	4.85	0.5	12.24	7.32	16.9
4/27/94			6.82	17.1	4.85	0.5	12.24	7.32	16.9
4/28/94			6.85	17	3	0.62	12.24	7.63	18.4
4/28/94			6.85	17	3	0.62	12.24	7.63	18.4
5/2/94			6.65	18.1	2.9	0.27	12.24		
5/2/94			6.65	18.1	2.9	0.27	12.24		
5/16/94			7	17.5	2.5	0.4		7.85	17.2
5/16/94			7	17.5	2.5	0.4	12.24	7.85	17.2
5/17/94			18.6	6.97	2.5	0.38	12.24	8.4	18.3
5/17/94			18.6	6.97	2.5	0.38	12.24	8.4	18.3
5/19/94			7.19	19.1	2.6	0.27	12.24	8.35	18.7
5/19/94			7.19	19.1	2.6	0.27	12.24	8.35	18.7
5/24/94			6.88	19.8	2.2	0.27	12.24	7.5	19
5/24/94			6.88	19.8	2.2	0.27	12.24	7.5	19
							12.24		

Los Angeles Department of Water & Power

URBAN WATER
MANAGEMENT PLAN

2010

RESOLUTION NO. 011 268

WHEREAS, the California Urban Water Management Planning Act requires California water suppliers to prepare and adopt an Urban Water Management Plan every five years that describes their historical and future efforts in the area of water resources; and

WHEREAS, the Los Angeles Department of Water and Power (LADWP) has prepared a five-year update to the City of Los Angeles ' Urban Water Management Plan (UWMP) pursuant to applicable provisions of Sections 10610 through 10656 of the California Water Code; and

WHEREAS, the UWMP is required as a condition of application for various water system grant and loan funding opportunities administered by the State of California; and

WHEREAS, LADWP has selected Method 3 of the four methods developed by the California Department of Water Resources for calculating the 2020 water use target and 2015 interim target in the UWMP as required in the California Water Conservation Act of 2009, SBX7-7; and

WHEREAS, LADWP's current water rate structure includes funding for water conservation, water recycling, and stormwater capture programs; and

WHEREAS, the development of the UWMP involved public meeting notices, public involvement, and incorporated oral and written public comments prior to final adoption; and

WHEREAS, the final UWMP must be adopted by LADWP's Board of Water and Power Commissioners and submitted to the California Department of Water Resources by July 1, 2011.

NOW, THEREFORE, BE IT RESOLVED, that the City of Los Angeles Department of Water and Power 2010 Urban Water Management Plan is hereby adopted; and

BE IT FURTHER RESOLVED that the President or Vice President of the Board, or the General Manager or such person as he shall designate in writing as his designee, and the Secretary, Assistant Secretary, or the Acting Secretary of the Board be and they are hereby authorized, empowered, and directed to approve said UWMP for and on behalf of LADWP.

I HEREBY CERTIFY that the foregoing is a full, true, and correct copy of a Resolution adopted by the Board of Water and Power Commissioners of the City of Los Angeles at its meeting held MAY 03 2011

APPROVED AS TO FORM AND LEGALITY
CARMEN A. TRUTANICH, CITY ATTORNEY

APR 11 2011

BY Janna
JANNA SIDLEY
DEPUTY CITY ATTORNEY

Barbara E. Moschos
Secretary

Urban Water Management Plan

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Note: The 2010 Urban Water Management Plan for the Los Angeles Department of Water and Power is available to the public at Los Angeles City Public Library, County of Los Angeles Public Library, West Hollywood Library, Culver City Julian Dixon Library, California State Library, and LADWP website at www.ladwp.com.

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Urban Water Management Plan

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Urban Water Management Plan

Glossary of Abbreviations and Terms

Agencies

AVEK	Antelope Valley-East Kern Water Agency
BOE	City of Los Angeles Department of Public Works, Bureau of Engineering
BOS	City of Los Angeles Department of Public Works, Bureau of Sanitation
Caltrans	California Department of Transportation
CDPH	California Department of Public Health
CDTSC	California Department of Toxic Substance Control
CITY	City of Los Angeles
CUWCC	California Urban Water Conservation Council
CVWD	Coachella Valley Water District
DWR	California Department of Water Resources
IAPMO	International Association of Plumbing and Mechanical Officials
IID	Imperial Irrigation District
KERN-DELTA	Kern Delta Water District
LACDPH	Los Angeles County Department of Public Health
LACDPW	Los Angeles County Department of Public Works
LACFCD	Los Angeles County Flood Control District
LADBS	Los Angeles Department of Building and Safety
LADWP	Los Angeles Department of Water and Power
LARWQCB	Los Angeles Regional Water Quality Control Board
LASGRWC	Los Angeles and San Gabriel Rivers Watershed Council
LBWD	Long Beach Water Department
MWD	Metropolitan Water District of Southern California
NWRI	National Water Research Institute
PVID	Palo Verde Irrigation District
RWAG	Recycled Water Advisory Group
RWQCB	Regional Water Quality Control Board
SBMWD	San Bernardino Municipal Water District
SCAG	Southern California Association of Governments
SWRCB	State Water Resources Control Board
USBR	United States Bureau of Reclamation
USEPA	United States Environmental Protection Agency
WBMWD	West Basin Municipal Water District
WRD	Water Replenishment District

Facilities and Locations

AWTF	Advanced Water Treatment Facility
BAY-DELTA	San Francisco Bay and Sacramento-San Joaquin River Delta
CRA	Colorado River Aqueduct
DCT	Donald C. Tillman Water Reclamation Plant
ECLWRF	Edward C. Little Water Recycling Facility
EOC	Emergency Operations Center
HTP	Hyperion Treatment Plant
JWPCP	Joint Water Pollution Control Plant
LAA	Los Angeles Aqueducts (First and Second)
LAAFP	Los Angeles Aqueduct Filtration Plant
LAG	Los Angeles/Glendale Water Reclamation Plant
LVMWD	Las Virgenes Municipal Water District
NTPS	Neenach Temporary Pumping Station
RWMP	Recycled Water Master Plan
SFB	San Fernando Basin
SWP	State Water Project
TIWRP	Terminal Island Water Reclamation Plant
ULARA	Upper Los Angeles River Area

Measurements and Miscellaneous

ACT	Urban Water Management Planning Act
AF	Acre-Feet
AFY	Acre-Feet Per Year
BACM	Best Available Control Measures
BDCP	Bay Delta Conservation Plan
BMP	Best Management Practices
CBO	Community-Based Organizations
CEQA	California Environmental Quality Act
CFS	Cubic Feet Per Second
CII	Commercial/Industrial/Institutional
CIP	Capital Improvement Program
CVP	Central Valley Project
EIR	Environmental Impact Report
ERP	Emergency Response Plan
FY	Fiscal Year
FYE	Fiscal Year Ending
GAC	Granular Activated Carbon
GCM	Global Climate Models
GHG	Greenhouse Gases
GPCD	Gallons Per Capita Per Day
GPD	Gallons Per Day
GPF	Gallons Per Flush
GPM	Gallons Per Minute
GSIS	Groundwater System Improvement Study
GWR	Groundwater Replenishment
HET	High Efficiency Toilets
IAP	Independent Advisory Panel
IRP	Integrated Resources Plan
IAWP	Interim Agricultural Water Program

IRWMP	Integrated Regional Water Management Plan
KWh/AF	Kilowatt-Hour per Acre-Foot
LID	Low Impact Development
LRP	Long-Range Finance Plan
M&I	Municipal and Industrial
MAF	Million Acre-Feet
MCL	Maximum Contaminant Level
MF/RO	Microfiltration/Reverse Osmosis
MGD	Million Gallons Per Day
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
NDMA	N-nitrosodimethlamine
NdN	Nitrification/Denitrification
NPR	Non-Potable Water Reuse
PCE	Perchloroethylene
PPB	Parts Per Billion
PPCPs	Pharmaceuticals and Personal Care Products
PPM	Parts Per Million
QSA	Quantification Settlement Agreement
RI	Remedial Investigation
ROD	Record of Decision
RTP	Southern California Association of Governments Regional Transportation Plan
RWMP	Recycled Water Master Plan
RUWMP	Regional Urban Water Management Plan (Prepared by MWD)
SB	Senate Bills
SOC	Synthetic Organic Compounds
SUSMP	Standard Urban Stormwater Mitigation Plan
STORMWATER PLAN	Stormwater Capture Master Plan
SWAT	Irrigation Association Smart Water Application Technologies
SWE	Snow Water Equivalent
TAF	Thousand Acre-Feet
TAP	Technical Assistance Program
TCE	Trichloroethylene
TDMLs	Total Maximum Daily Loads
TOC	Total Organic Carbon
ULF	Ultra-Low Flush
UWMP	Urban Water Management Plan
VOCs	Volatile Organic Compounds
WAS	Los Angeles Basin Water Augmentation Study
WBICs	Weather-Based Irrigation Controllers
WQCMPUR	Water Quality Compliance Master Plan for Urban Runoff
WRR	Water Recycling Requirements
WSA	Water Supply Assessment
WSAP	Metropolitan Water District's Water Supply Allocation Plan
WSDM Plan	Water Surplus and Drought Management Plan
20x2020	Reduce Per Capita Water Use by 20 Percent by 2020; Senate Bill x7-7

Executive Summary

ES-1 Overview and Purpose of Plan

In 1902, the City created a municipal water system by acquiring title to all properties of a private water company. In 1925, the Los Angeles Department of Water and Power (LADWP) was established by a new city charter. The availability of water has significantly contributed towards the economic development of the City of Los Angeles (City). It has supported the City's need for water resources as it has developed from a town with a population of approximately 146,000 residents in 1902, into the nation's second largest city with over 4 million residents, encompassing a 473 square mile area. As the largest municipal utility in the nation, LADWP delivers safe and reliable water and electricity supplies at an affordable price to the residents and businesses of Los Angeles.

Overview of Water Issues

LADWP, along with all other water agencies in Southern California, is faced with the challenge of providing a reliable and high quality water supply to meet current and future needs. In the past five years, water supplies in California and locally have become scarcer due to multi-year dry weather and regulatory restrictions affecting water supplies originating in the Sacramento-San Joaquin Delta (Bay Delta) and Colorado River Basin. It is projected that imported and local water supplies will be adversely affected by global climate change. Finally, contamination of local groundwater has resulted in reduced groundwater supplies for the City.

To address these issues, LADWP will take the following water management actions in order to meet the City's water needs while maximizing local resources and minimizing the need to import water:

- Significantly enhance water conservation, stormwater capture and recycling projects to increase supply reliability.
- Implement treatment for San Fernando Basin groundwater supplies.
- Ensure continued reliability of the water supplies from the Metropolitan Water District of Southern California (MWD) through active representation of City interests on the MWD Board.
- Maintain the operational integrity of the Los Angeles Aqueduct (LAA) and in-City water distribution systems.
- Meet or exceed all Federal and State standards for drinking water quality.

Purpose of Plan

The California Urban Water Management Planning Act (first effective on January 1, 1984) requires that every urban water supplier prepare and adopt an Urban Water Management Plan (UWMP) every five years. Since its original enactment, there have been several amendments added to the Act. The main goal of the UWMP is to forecast future water demands and water supplies under average and dry year conditions, identify future water supply projects such as recycled water, provide a summary of water conservation best management practices (BMPs), and provide a single and multi-dry year management strategy.

LADWP's 2010 UWMP serves two purposes: (1) achieve full compliance with requirements of California's Urban Water Management Planning Act; and (2) serve as a master plan for water supply and resources management consistent with the City's goals and policy objectives.

Changes Since 2005 UWMP

A number of important changes have occurred since LADWP prepared its 2005 UWMP. First, LADWP released its Water Supply Action Plan (Action Plan) in 2008 to address the water reliability issues associated with the lowest snowpack on record in the Sierra Nevada (in 2007), the driest year on record for the Los Angeles Basin (in 2007), increased water for environmental mitigation and enhancement in the Owens Valley, San Fernando Groundwater Basin contamination, and reduced imported water from the Bay-Delta due to a prolonged water shortage and environmental restrictions on Delta exports. Second, a number of new requirements were added to the Urban Water Management Planning Act, such as addressing California's new mandate of reducing per capita water use by 20 percent by the year 2020. And third, LADWP developed a new water demand forecast based on a more rigorous analysis of water use trends and measurement of achieved water conservation.

As a result of these changes, the implementation plan and schedule in the 2005 UWMP have been revised as follows:

- The Water Supply Action Plan provided more focused strategies as described in Section 1.1.2 with more conservation and recycled water than the amounts planned in the 2005 UWMP.
- Owens Lake Dust Mitigation water use exceeded the 55,000 AFY estimated in 2005 UWMP and resulted in reduced LAA deliveries.
- Groundwater production decreased due to expanded San Fernando Groundwater Basin contamination impacts.

- Seawater desalination was removed from planned water supplies due to concerns over high cost and environmental impacts.

- The schedule for water transfers was postponed because the California Aqueduct interconnection with the Los Angeles Aqueduct has not yet been constructed.

ES-2 Existing Water Supplies

Primary sources of water for the LADWP service area are the Los Angeles Aqueducts (LAA), local groundwater, and purchased imported water from MWD (see Exhibit ES-A). An additional fourth source, recycled water, is increasingly becoming a larger source in the overall supply portfolio. Two of the supply sources, LAA and water purchased from MWD, are classified as imported as they are obtained from outside LADWP's service area. MWD is the regional wholesale water agency, importing water from the Bay-Delta via the State Water Project (SWP) and from the Colorado River via the Colorado River Aqueduct (CRA). Groundwater is local and is obtained within the service area. Historical supply sources are increasingly under multiple constraints including potential impacts of climate change, groundwater contamination, and reallocation of water for environmental concerns. To mitigate these impacts on supply sources, LADWP is modifying its water supply portfolio through increased water use efficiency programs, water recycling, and stormwater capture.

The challenge of water management in California is the year-to-year variability in availability of surface water due to hydrologic conditions from wet and dry years. Also, environmental regulations can result in temporary or permanent restrictions in certain water supplies. For example, recent pumping restrictions in the Bay-Delta resulted in MWD restricting the availability of imported water to LADWP. The LAA supply has also seen reductions in availability due to dry years and environmental mitigation and enhancement needs. Exhibit ES-B shows LADWP's historical water supplies from fiscal year (FY) 1980/81 to 2009/10. The supplies in FY 2009/10 are much lower due to the mandatory water use restrictions LADWP imposed on its customers in response to the prolonged statewide supply shortage and environmental regulations reducing pumping from the Bay-Delta.

ES-A L.A. Water Supplies

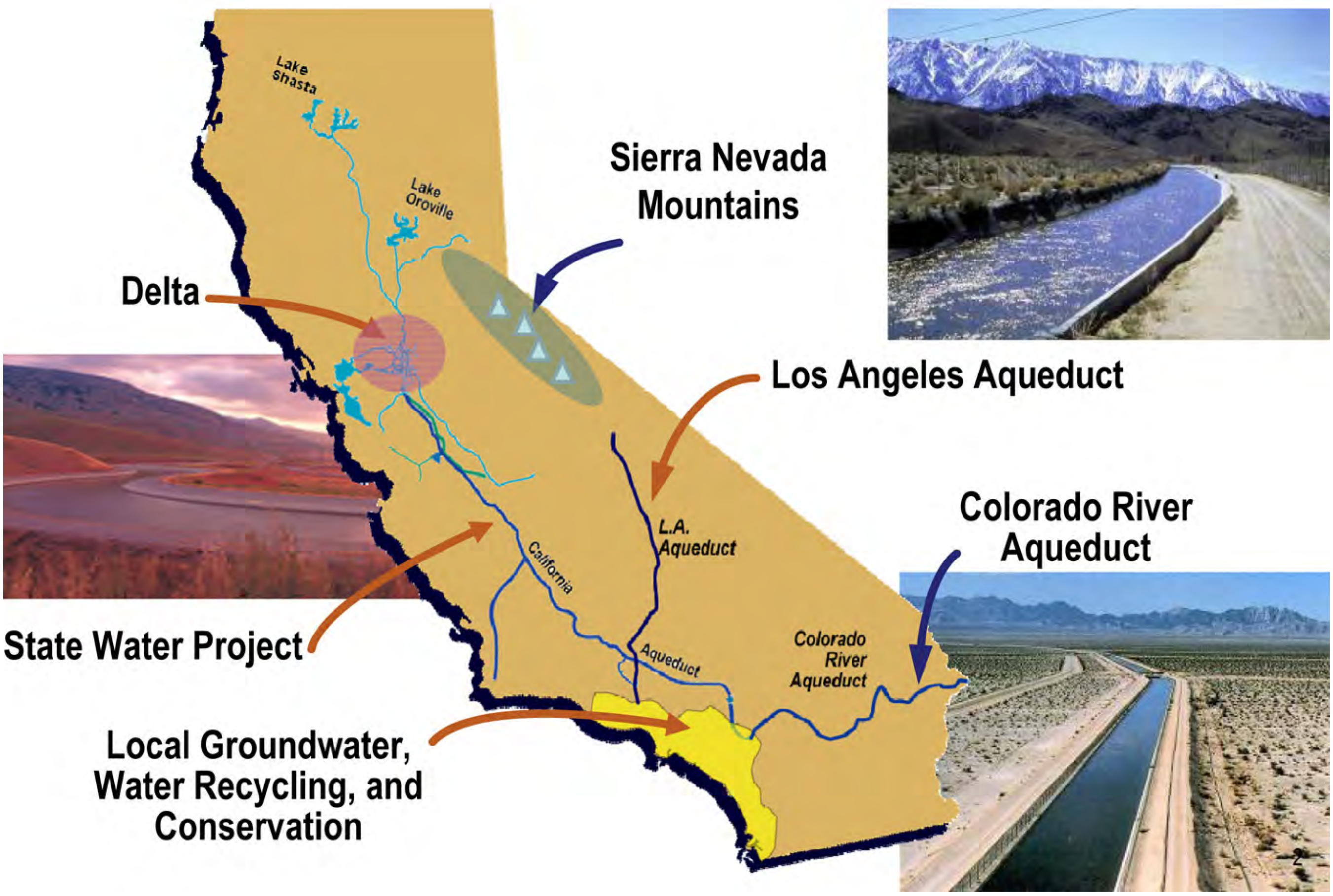
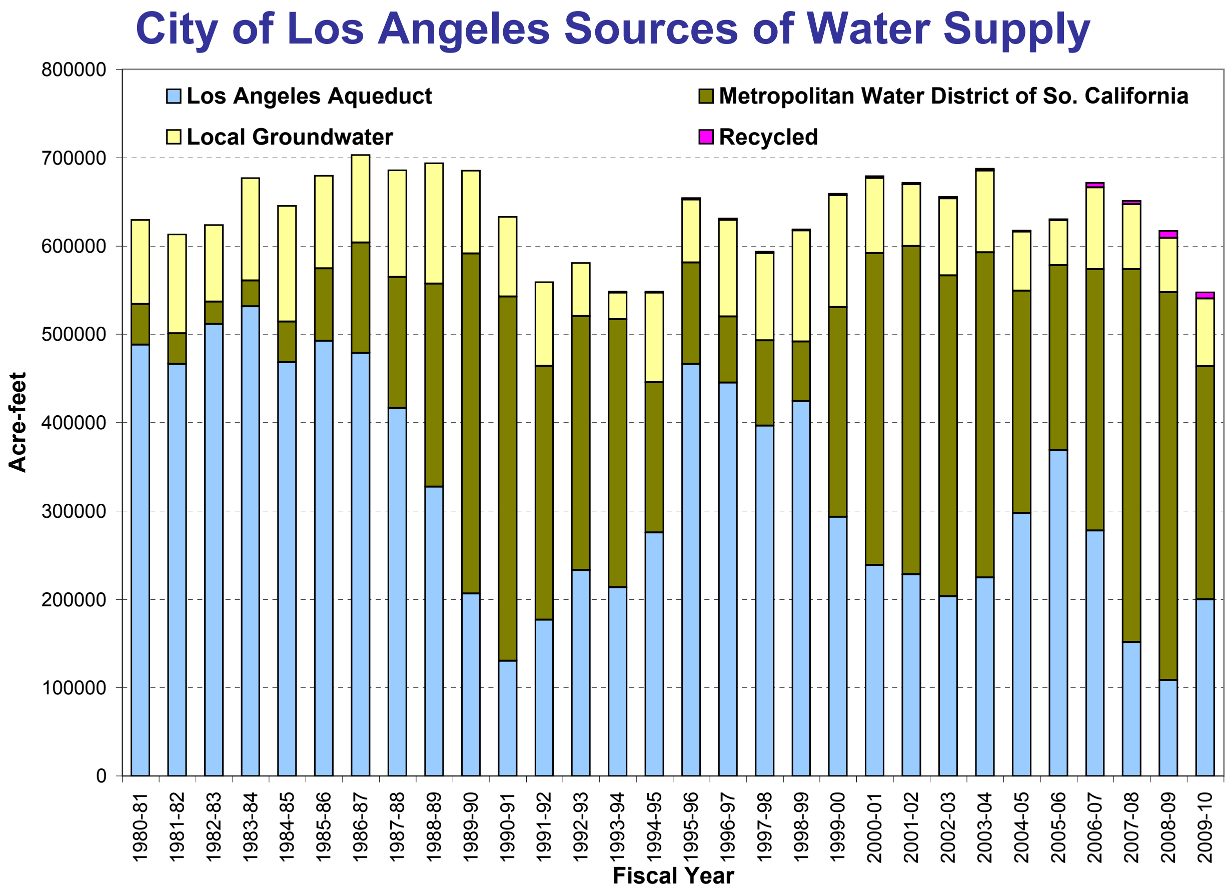


Exhibit ES-B
LADWP Historical Water Supply Sources 1980-2010



Recycled Water

In 1979, LADWP began delivering recycled water to the Department of Recreation and Parks for irrigation of areas in Griffith Park. This service was later expanded to include Griffith Park's golf courses. In 1984, freeway landscaping adjacent to the park was also irrigated with recycled water. In addition, the Japanese Garden, Balboa Lake and Wildlife Lake in the Sepulveda Basin now utilize recycled water for environmentally beneficial reuse purposes. The Greenbelt Project, which carries recycled water from the Los Angeles-Glendale Water Reclamation Plant to Forest Lawn Memorial Park, Mount Sinai Memorial Park, Lakeside Golf Club of Hollywood and Universal Studios, began operating in 1992, and represents LADWP's first project to supply recycled water to non-governmental customers. In 2009 phase 1 of the Playa Vista development began receiving recycled water. Playa Vista is the first planned development in the City that uses recycled water to meet all landscape needs. Future recycled water projects will continue to build on the success of these prior projects making recycled water a more prominent component of the City's water supply portfolio. LADWP expects to increase the use of recycled water to 59,000 AFY by 2035.

Los Angeles Aqueduct

Since its construction in the early 1900's, the Los Angeles Aqueduct historically provided the vast majority of water for the City. It remains as a significant water supply source, providing an average of 36 percent of total water supplies from FY 2005/06 to 2009/10. In the last decade environmental considerations have required that the City reallocate approximately one-half of the Los Angeles Aqueduct (LAA) water supply to environmental mitigation and enhancement projects. As a result, approximately 205,800 AF of water supplies for environmental mitigation and enhancement in the Owens Valley and Mono Basin regions were used in 2010, which is in addition to the almost 107,300 acre-ft per year (AFY) supplied for agricultural, stockwater, and Native American Reservations. Reducing water deliveries to the City from the LAA has led to increased dependence on imported water supply from MWD. This need for purchased water has reinforced LADWP's plans to focus on developing local supplies.

Local Groundwater

A key resource that the City has relied upon as the major component of its local supply portfolio is local groundwater. Over the last ten years local groundwater has provided approximately 12 percent of the total water supply for Los Angeles, and historically has provided nearly 30 percent of the City's total supply during droughts when imported supplies become unreliable. In recent years, contamination issues have impacted LADWP's ability to fully utilize its local groundwater entitlements. Additionally, reduction of natural infiltration due to expanding urban hardscape and channelization of stormwater runoff has resulted in declining groundwater elevations. In response to contamination issues and declining groundwater levels, LADWP is working to clean up the San Fernando Basin's groundwater, and is making investments to recharge local groundwater basins through stormwater recharge projects, while at the same time collaborating on rehabilitation of aging stormwater capture and spreading facilities. The San Fernando Basin is a fully adjudicated basin with an active Watermaster and Administrative Committee.

MWD Supply

As a wholesaler, MWD sells water to all of its 26 member agencies. LADWP is exclusively a retailer and has historically purchased MWD water to make up the deficit between demand and other City supplies. As a percentage of the City's total water supply, purchases of MWD water have historically varied from 4 percent in FY 1983/84 to 71 percent in FY 2008/09, with a 5-year average of 52 percent between FY 2005/06 and FY 2009/10. The City relies on MWD water even more in dry years and has increased its dependence in recent years as LAA supply has been reduced. Although the City plans to reduce its reliance on MWD supply, it has made significant investments in MWD anticipating that the City will continue to rely on the wholesaler to meet its current and future supplemental water needs.

ES-3 Water Demands

Water demands are driven by a number of factors: demographics (population, housing and employment); implementation of water conservation programs; behavioral practices of water users; and weather. For the development of LADWP's 2010 UWMP, a new water demand forecast was prepared using: (1) the latest trends in water use; (2) econometric-derived elasticities for estimating the impacts of weather, price of water, income, and family size on per household and per employee water use; and (3) more accurate estimates of the effectiveness of water conservation in the City.

Demographics and Climate

Over 4 million people reside in the LADWP service area which is slightly larger than the legal boundary of the City of Los Angeles. LADWP provides water service outside the City's boundary to portions of West Hollywood, Culver City, Universal City, and small parts of the County of Los Angeles. The population within LADWP's service area increased from 2.97 million in 1980 to 4.1 million in 2009, representing an average annual growth rate of 1.3 percent. The total number of housing units increased from 1.10 million in 1980 to 1.38 million in 2009, representing an average annual growth rate of 0.9 percent.

During this time, average household size increased from 2.7 persons in 1980 to 2.9 persons in 2009. Employment grew by about 1.0 percent annually from 1980 to 1990, but declined from 1990 to 2000 as a result of an economic recession that started in 1991. Another decline in employment began in 2008 reflecting the recent economic recession. Overall, employment increased by about 0.3 percent annually from 1990 to 2009.

Demographic projections for LADWP's service area are based on the 2008 forecast generated by the Southern California Association of Governments (SCAG). Exhibit ES-C summarizes these demographic projections for the LADWP service area. Service area population is expected to increase at a rate of 0.4 annually over the next 25 years. While this growth is substantially less than the historical 1.3 percent annual growth rate from 1980 to 2009, it will still lead to approximately 367,300 new residents over the next 25 years.

Weather in Los Angeles is considered mild with blue skies, and sunshine throughout most of the year. Favorable weather is a popular attribute that attracts businesses, residents, and tourists to the City. Because of its relative dryness, Los Angeles' climate has been characterized as Mediterranean. Exhibit ES-D provides a summary of average monthly rainfall, maximum temperatures, and evapotranspiration readings.

Exhibit ES-C Demographic Projections for LADWP Service Area

Demographic	2010	2015	2020	2025	2030	2035
Population	4,100,260	4,172,760	4,250,861	4,326,012	4,398,408	4,467,560
Housing						
Single-Family	627,395	646,067	665,261	678,956	691,703	701,101
Multi-Family	764,402	804,013	846,257	880,580	914,125	942,846
Total Housing	1,391,797	1,450,080	1,511,518	1,559,536	1,605,828	1,643,947
Persons per Household	2.88	2.81	2.75	2.71	2.67	2.65
Employment						
Commercial	1,674,032	1,724,106	1,754,998	1,790,798	1,828,765	1,865,156
Industrial	163,382	157,652	155,012	152,426	150,009	147,508
Total Employment	1,837,415	1,881,758	1,910,010	1,943,224	1,978,773	2,012,664

Source: SCAG Regional Transportation Plan (2008), modified using MWD's land use planning to represent LADWP's service area.

Exhibit ES-D Average Climate Data for Los Angeles 1990-2010

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Maximum Temperature (°F)[1]	68	68	70	73	75	78	83	85	83	79	73	68	75
Average Precipitation (inches)[1]	3.62	4.46	2.28	0.75	0.34	0.12	0.01	0	0.07	0.68	0.72	2.53	15.58
Average Eto (inches)[2,3]	1.98	2.26	3.66	4.96	5.46	6.08	6.46	6.31	4.87	3.63	2.56	2.03	50.26

1. 1990-2010, Los Angeles Downtown USC Weather Station ID 5115

2. Average of Hollywood Hills (Station Id. 73), Glendale (Station Id. 133), and Long Beach (Station Id. 174)

3. www.cimis.water.ca.gov

Exhibit ES-E
Historical Total Water Demand in LADWP's Service Area

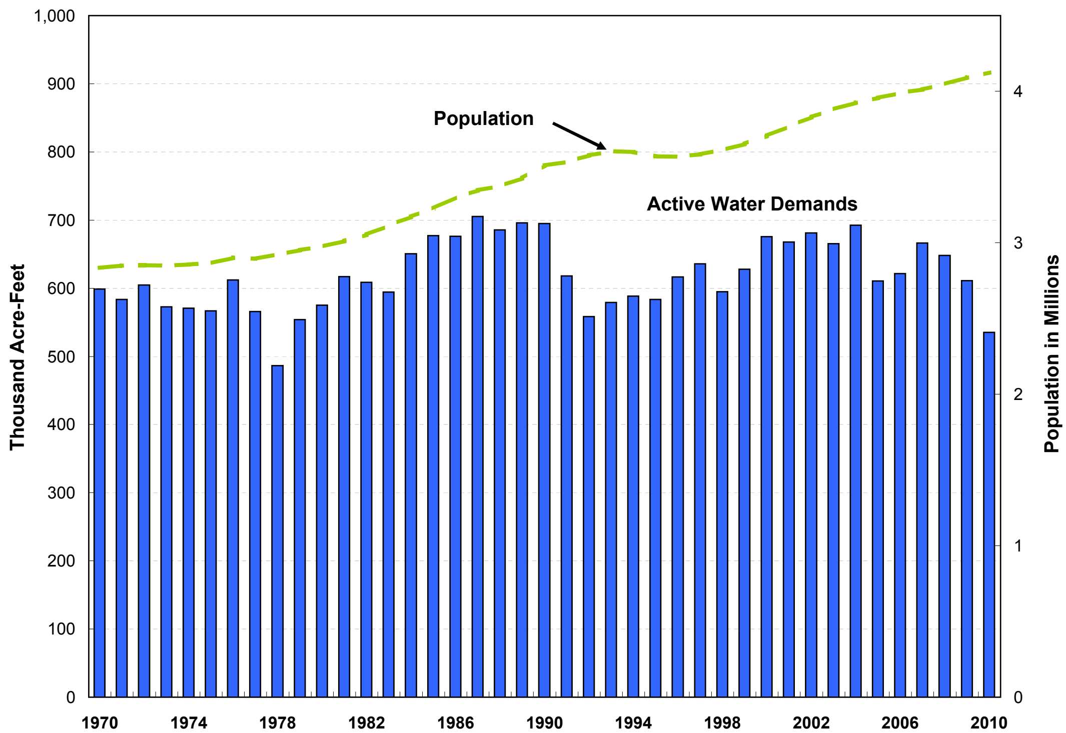


Exhibit ES-F
Breakdown in Historical Water Demand for LADWP's Service Area

Fiscal Year	Single-Family		Multifamily		Commercial		Industrial		Government		Non-Revenue		Total
Ending	AF	%	AF	%	AF	%	AF	%	AF	%	AF	%	AF
1986-90 Avg	238,248	35%	197,312	29%	123,324	18%	30,502	4%	43,378	6%	52,830	8%	685,594
1991-95 Avg	197,322	35%	177,104	31%	110,724	19%	21,313	4%	38,600	7%	24,100	4%	569,164
1996-00 Avg	222,748	35%	191,819	30%	111,051	18%	23,560	4%	39,830	6%	43,617	7%	632,626
2001-05 Avg	239,754	36%	190,646	29%	109,685	17%	21,931	3%	41,888	6%	58,299	9%	662,203
2005-10 Avg	236,154	38%	180,279	29%	106,955	17%	23,201	4%	42,940	7%	31,929	5%	621,458
25-yr Avg	226,845	36%	187,432	29%	112,348	18%	24,101	4%	41,327	6%	42,155	7%	634,209

Historical Water Use

Exhibit ES-E presents the historical water demand for LADWP. In 2009, an economic recession and a water supply shortage required LADWP to impose mandatory conservation. In 2010 mandatory conservation continued as the economic recession became more severe, resulting in a 19 percent decrease in water use.

Prior to 1990, population growth in Los Angeles was a good indicator of total demands. From 1980 to 1990, population in the City grew at 1.7 percent annually. Water demands during this same ten year period also grew at 1.7 percent annually. However, after 1991, LADWP began implementing water conservation measures and water use efficiency programs which prevented water demands from returning to pre-1990 levels. Average water demands in the last five years from FY 2004/05 to 2009/10 are about the same as they were in FY1980/81 despite the fact that over 1.1 million additional people now live in Los Angeles.

Exhibit ES-F shows the breakdown in average total water use between LADWP's major billing categories and non-revenue water in five-year intervals for the past

25 years. Non-revenue water, which is the difference between total water use and billed water use, includes water for fire fighting, reservoir evaporation, mainline flushing, leakage from pipelines, meter error, and theft. Single-family residential water use comprises the largest category of demand in LADWP's service area, representing about 36 percent of the total. Multifamily residential water use is the next largest category of demand, representing about 29 percent of the total. Industrial use is the smallest category, representing only 4 percent of the total demand. Although total water use has varied substantially from year to year, the breakdown between the major billing categories of use has not.

In order to assess the potential for water use efficiency and target conservation programs, LADWP conducted an analysis to determine indoor and outdoor water uses for its major billing categories. The analysis concluded that the City's total outdoor water use was approximately 39 percent of the total water use during the study period from 2004 to 2007. (see Exhibit ES-G).

Water Demand Forecast

Using an econometric water demand forecasting approach, LADWP projected water demands by major category and under different weather conditions. Exhibit ES-H presents the water demand forecast with and without future active water conservation programs.

Categorically, conservation can be grouped into two main types; active and passive conservation. Passive conservation accounts for the improved water use efficiency of retrofitted and new residential homes and commercial buildings due to plumbing code changes. The passive conservation due to the 1991 and 2010 plumbing code changes is hardwired into the 2010 water demand forecast model. Therefore, both cases of demand forecast on Exhibit ES-H are presented with the built-in passive conservation.

Examples of active conservation include installation of low-flush toilets and low flow plumbing fixtures, replacing turf with drought resistant landscaping, and programs which promote water use efficiency in industrial processes. The demand forecast model can present the

Exhibit ES-G
Indoor and Outdoor Water Use in LADWP's Service Area

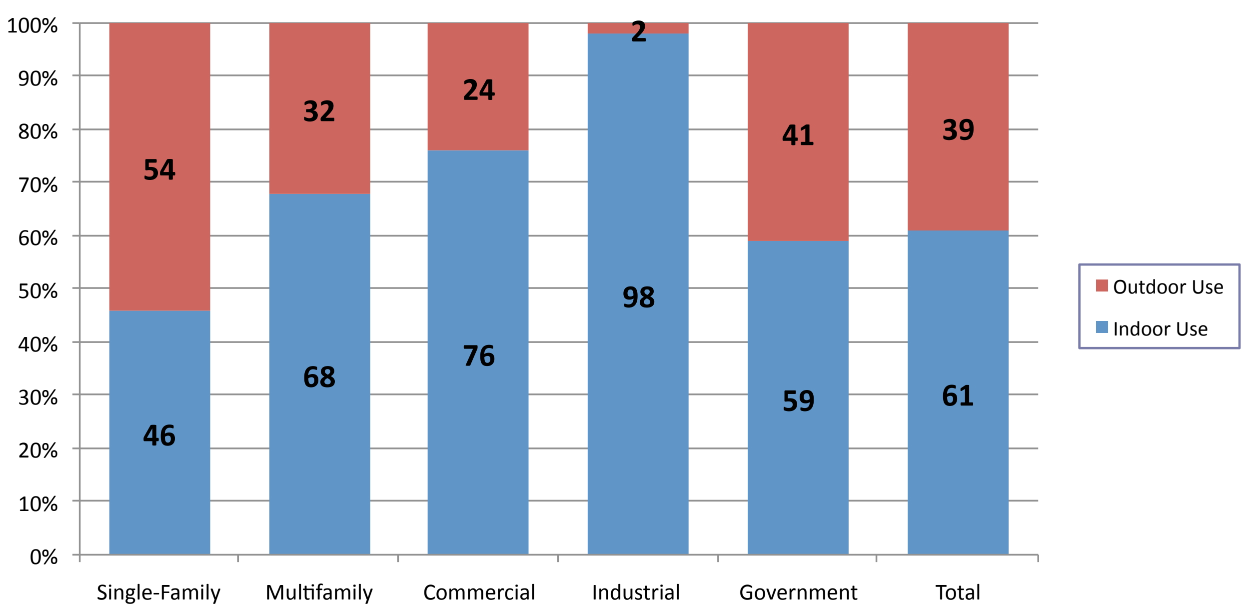


Exhibit ES-H Water Demand Forecast and Conservation Savings Under Average Weather Fiscal Year Ending June 30 (Acre-Feet)

Demand Forecast with Passive Water Conservation	2005	2010	2015	2020	2025	2030	2035
Single-Family		198,444	229,115	241,976	249,528	257,693	259,904
Multifamily		167,299	179,653	194,724	205,136	216,054	221,912
Commercial/Gov		135,000	143,081	149,597	153,791	158,628	160,049
Industrial		20,298	20,524	20,726	20,532	20,408	19,852
Non-Revenue		33,515	42,421	44,989	46,617	48,380	49,042
Total		554,556	614,794	652,012	675,604	701,164	710,760
Demand Forecast with Passive & Active Water Conservation	**2005 Actual**	**2010 Actual**	**2015**	**2020**	**2025**	**2030**	**2035**
Single-Family	233,192	196,500	225,699	236,094	241,180	246,879	247,655
Multifamily	185,536	166,810	178,782	193,220	202,999	213,284	218,762
Commercial/Gov	107,414	130,386	135,112	133,597	129,761	126,567	120,420
Industrial	62,418	19,166	18,600	16,852	14,708	12,634	10,513
Non-Revenue	26,786	32,909	41,370	42,969	43,627	44,421	44,272
Total	615,346	545,771	599,563	622,732	632,275	643,785	641,622
Aggregate Active Water Conservation Savings From	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Single-Family		1,944	3,416	5,882	8,349	10,815	12,249
Multifamily		489	871	1,504	2,137	2,770	3,150
Commercial/Gov		4,614	7,969	16,000	24,030	32,061	39,629
Industrial		1,132	1,924	3,874	5,824	7,774	9,339
Non-Revenue		606	1,051	2,020	2,990	3,959	4,771
Total		8,785	15,231	29,280	43,329	57,379	69,138

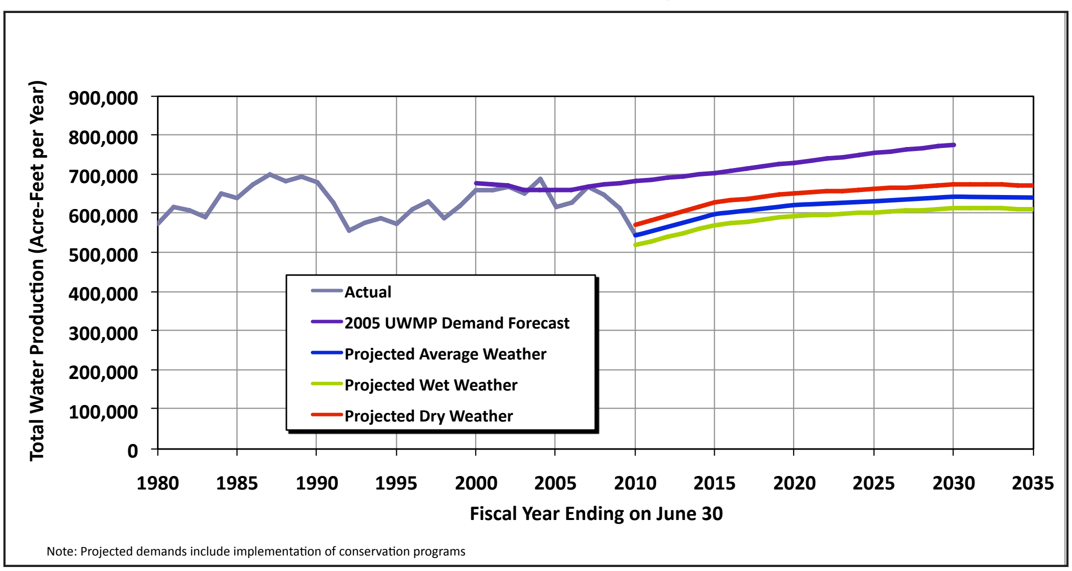
* Non-revenue is the combination of unaccounted water and accounted non-revenue water. Unaccounted water is defined as system losses. In recent years, the City experienced no accounted non-revenue water. Thus, non-revenue water is considered system loss.

results with or without the additional active conservation planned after 2008. The active conservation prior to 2008 is considered a permanent part of the newly established water demand factors for the 2010 water demand forecast model and is accounted for in the forecast.

The calculated active conservation savings include the planned active conservation savings and the additional savings as a result of the decrease in non-revenue water, which is proportional to the decrease of the total water demand.

Exhibit ES-I shows the projected water demands can vary by approximately ± 5 percent in any given year due to average historical weather variability. Historical water use from 1980 to 2010 is illustrated as actual water use. When comparing with the demands forecasted in the 2005 UWMP, the 2010 demand forecasts are about 15 percent lower.

Exhibit ES-I
LADWP Water Demand Forecast with Average Weather Variability



ES-4 Water Conservation

Los Angeles is a national leader in water use efficiency. This accomplishment has resulted from the City's sustained implementation of effective water conservation programs since the 1990s. One of LADWP's most effective conservation tools is its customer's water use efficiency ethic. During past water shortages, residents and businesses have aggressively implemented conservation to achieve demand reductions. During FY 2009/10, water use was below 1979 water use levels thanks to extraordinary conservation efforts by LADWP customers.

To measure conservation effectiveness, LADWP developed a statistical regression model that correlates total water use against population, weather, economic recession, and conservation. The model can predict what water use would be based on actual population, weather and economy in a given year, but without the conservation. The predicted water use is then compared to actual water use and the difference between the two is the annual total water conservation/savings as shown in Exhibit ES-J. The exhibit summarizes LADWP's historical water conservation since FY 1990. The table shows water savings from hardware programs, such as ultra-low-flow and high-efficiency toilet retrofits, cooling tower recirculation, high efficiency clothes washer machines, and other plumbing and efficiency measures. The table also shows water savings that occur from non-hardware programs that result from changes in water customer behavior, such as reduced watering, and taking shorter showers. These behavioral conservation savings occur as a result of public education and information programs, and increases in the price of water. As shown in the exhibit, hardware water savings have been steadily increasing since 1990 while non-hardware water savings peaked in FY 1991/92 and again in FY 2009/10. The peaks in non-hardware savings were due to City of Los Angeles' mandatory water use restrictions implemented in response to multi-year water shortages.

Exhibit ES-J
Historical Water Conservation in LADWP's Service Area

Fiscal Year	Additional Annual Hardware Installed Savings (AF)	Cumulative Annual Hardware Savings (AF)	Annual Non-Hardware Savings (AF)	Annual Total Savings (AF)
Prior to 1990/1991	31,825	31,825		
1990/1991	4,091	35,916	76,350	112,267
1991/1992	8,670	44,586	105,593	150,179
1992/1993	3,286	47,872	58,546	106,417
1993/1994	4,961	52,832	60,928	113,761
1994/1995	4,041	56,873	62,084	118,958
1995/1996	4,642	61,516	52,648	114,164
1996/1997	2,376	63,892	33,720	97,612
1997/1998	2,637	66,529	30,434	96,964
1998/1999	2,781	69,310	38,305	107,614
1999/2000	3,532	72,842	-6,262	66,580
2000/2001	3,078	75,920	-3,407	72,513
2001/2002	2,452	78,371	15,131	93,502
2002/2003	2,630	81,002	8,725	89,726
2003/2004	3,257	84,259	13,107	97,366
2004/2005	3,299	87,558	46,865	134,423
2005/2006	2,404	89,963	62,223	152,186
2006/2007	2,095	92,058	76,643	168,701
2007/2008	782	92,840	64,472	157,312
2008/2009	3,127	95,967	106,151	202,118
2009/2010	4,269	100,236	126,466	226,702

1. Negative non-hardware savings are due to overestimation in hardware savings due to years with extreme wet weather conditions.

Exhibit ES-K
Active Water Conservation Projections

Sector	Acre-feet per Fiscal Year				
	2014/2015	2019/2020	2024/2025	2029/2030	2034/2035
Single-Family Residential	3,416	5,882	8,349	10,815	12,249
Multi-Family Residential	871	1,504	2,137	2,770	3,150
Commercial/Government	7,969	16,000	24,030	32,061	39,629
Industrial	1,924	3,847	5,824	7,774	9,339
Total Active Conservation Projections	14,180	27,260	40,340	53,420	64,368

Water Conservation Goals

LADWP has set a water conservation goal to further reduce potable water demands an additional 64,000 AFY by 2035. This aggressive approach includes multiple strategies: investments in state-of-the-art technology; rebates and incentives promoting installation of weather-based irrigation controllers (WBICs), efficient clothes washers and urinals; expansion and enforcement of prohibited water use; reductions in outdoor water uses; and extending education and outreach efforts. Exhibit ES-K shows the projected water conservation by sector of use. Note that these projected savings are in addition to what has already occurred in the City since the 1990s.

The California Water Conservation Act of 2009, Senate Bill x7-7, requires water agencies to reduce per capita water use by 20 percent by the year 2020 (20x2020). This includes increasing recycled water use to offset potable water use. Water suppliers are required to set a water use target for 2020 and an interim target for 2015 using one of four methods. The 2020 urban water use target may be updated in a supplier's 2015 UWMP. The California Department of Water Resources (DWR) has developed four methods for measuring compliance with 20x2020.

LADWP has selected Method 3 to set its 2015 interim and 2020 water use targets. Method 3 requires setting the 2020 water use target to 95 percent of the applicable State hydrologic region target as provided in the State's Draft 20x2020 Water Conservation Plan. LADWP is within State hydrologic region 4, the South Coast region. LADWP was required to further adjust the calculated 2020 target to achieve a minimum reduction in water use. The per capita water use at 95 percent of the hydrologic region was 142 gallons per capita per day (gpcd), and using 95 percent of the five-year average base daily per capita water use was equal to 138 gpcd. Therefore, LADWP was required to set its 2020 target at the smaller of the two resultant values. LADWP's interim 2015 target is 145 gpcd and the 2020 target is 138 gpcd. Exhibit ES-L presents the calculations for LADWP's 20x2020 target. Also shown in this exhibit for reference is LADWP's 10-year and 5-year historical average per capita water use.

Exhibit ES-L
20x2020 Base and Target

20x2020 Required Data	Gallons Per Capita Per Day (GPCD)
Base Per Capita Daily Water Use	
10-Year Average[1]	152
5-Year Average[2]	145
2020 Target Using Method 3[3]	
95% of Hydrologic Region Target (149 gpcd)	142
95% OF Base Daily Capita Water Use 5-Year Average (145 gpcd)	138
Actual 2020 Target	**138**
2015 Interim Target	145

1. Ten-year average based on fiscal year 1995/96 to 2004/05

2. Five-year average based on fiscal year 2003/04 to 2007/08

3. Methodology requires smaller of two results to be actual water use target to satisfy minimum water use target.

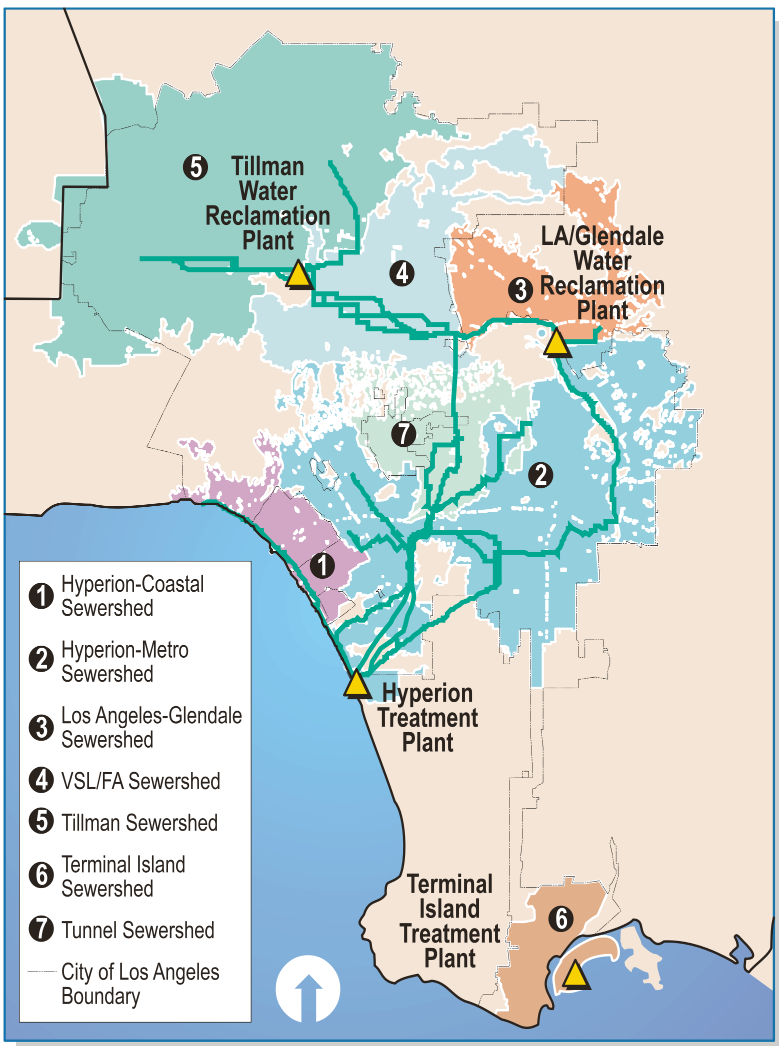
Exhibit ES-M
Water Conservation BMPs and Implementation Status

Category	Sub-category	Practices	Status
Foundational			
Utility Operations	Operations Practices	Maintain the position of a trained conservation coordinator	Implemented
		Prevent water waste – enact, enforce or support legislation, regulations, and ordinances	Implemented
		Wholesale agency assistance programs	Not applicable
	Water Loss Control	Conduct Standard Water Audit and Water Balance	Implemented
		Measure performance using AWWA software	Implemented
		Locate and Repair all leaks and breaks	Implemented
	Metering with Commodity Rates	100% of existing unmetered accounts to be metered and billed by volume of use	Implemented
	Conservation Pricing	Maintain a water conserving retail rate structure	Implemented
Education	Public Information Programs	Maintain active public information program to promote and educate customers about water conservation	Implemented
	School Education Programs	Maintain active program to educate students about water conservation and efficient water use	Implemented
Programmatic			
Residential		Residential Assistance – provide leak detection assistance	Implemented
		Landscape Water Surveys for residential accounts	Implemented
		High efficiency clothes washer incentive program	Implemented
		WaterSense Specification (WSS) for toilets	Implemented
Commercial/ Industrial/ Institutional (CII)		Implement unique conservation programs to meet annual water savings goals for CII customers	Implemented
Landscape		Implement Large Landscape custom programs	Implemented
		Offer technical assistance and surveys upon request	Implemented
		Implement and maintain incentive program(s) for irrigation equipment retrofits	Implemented

Water Conservation Best Management Practices (BMPs)

LADWP is one of the original signatories to the California Urban Water Conservation Council Memorandum of Understanding (MOU), and as such has to report its progress on achieving water conservation BMPs. Exhibit ES-M presents the checklist of BMPs that LADWP has implemented. LADWP is currently in compliance with all the BMP's contained in the MOU.

Exhibit ES-N
City Wastewater Plants and Sewersheds



ES-5 Future Water Supplies

As stated previously, the water management goal of LADWP is to implement cost-effective conservation, recycled water, and stormwater capture programs. In addition, LADWP is also pursuing water transfers in order to make up for its LAA water losses.

Water Recycling

LADWP is committed to significant expansion of recycled water in the City's water supply portfolio. Realizing multiple factors are decreasing the reliability of imported water supplies, LADWP released the City of Los Angeles Water Supply Action Plan (Plan), "Securing L.A.'s Water Supply" in May of 2008. The Plan established the goal of using 50,000 AFY of recycled water to offset demands on potable supplies. In order to meet this goal, LADWP, in conjunction with the Department of Public Works Bureau of Sanitation (BOS), are working together to develop a Recycled Water Master Plan (RWMP). Opportunities to expand the water recycling program are being studied through development of the RWMP. These include expanding the recycled water distribution system for Non-Potable Reuse (NPR) such as for irrigation and industrial use, along with replenishment of groundwater basins with highly purified recycled water. Beyond 50,000 AFY, LADWP expects to increase recycled water use by approximately 1,500 AFY annually, bringing the total to 59,000 AFY by 2035.

LADWP's water recycling program is dependent on the City's wastewater treatment infrastructure. Wastewater in the City of Los Angeles is collected and transported through some 6,500 miles of major interceptors and mainline sewers, more than 11,000 miles of house-sewer connections, 46 pumping plants, and four treatment plants. BOS is responsible for the planning and operation of the wastewater program. The City's wastewater system serves 515 square miles, of which 420 square miles are within the City. In addition to the City, service is provided to 29 non-City agencies through contract services. Exhibit ES-N shows the City's four wastewater treatment plants and seven sewersheds that feed those plants. A portion of the treated effluent from the wastewater plants is utilized by LADWP to meet recycled water demands.

In FY 2009/10, LADWP provided 31,872 AFY of recycled water for municipal & industrial purposes and environmental benefits.

The use of recycled water must meet California's regulatory requirements for safety. Non-potable water reuse (NPR) regulations in the City of Los Angeles are governed by the California Department of Public Health (CDPH), State Water Resources Control Board (SWRCB), Los Angeles Regional Water Quality Control Board (LARWQCB) and the Los Angeles County Department of Public Health (LACDPH). Criteria and guidelines for the production and use of recycled water were established by the CDPH in the California Code of Regulations, Title 22, Division 4, and Chapter 3 (Title 22). Title 22, also known as Water Recycling Criteria, establishes required wastewater treatment levels and recycled water quality levels dependent upon the end use of the recycled water. Title 22 additionally establishes recycled water reliability criteria to protect public health.

The regulations governing recharge of groundwater or groundwater replenishment (GWR) with recycled water are established by the CDPH and LARWQCB. For groundwater replenishment, LADWP will implement advanced treatment that includes reverse osmosis, microfiltration, and advanced oxidation. This level of treatment will address water quality concerns for the health of the basin along with emerging contaminants of concern.

Exhibit ES-O presents LADWP's projected recycled water use based on preliminary findings from the RWMP.

Stormwater Capture

The 2010 UWMP projects that the stormwater capture can potentially provide increased groundwater pumping rights in the San Fernando Basin of 15,000 AFY from groundwater recharge using captured stormwater, and 10,000 AFY of additional water conservation from

Exhibit ES-O
Recycled Water Use Projections

Category	Projected Use (AFY)[1]				
	2015	2020	2025	2030	2035
Municipal and Industrial Non-Potable Reuse	20,000	20,400	27,000	29,000	29,000
Indirect Potable Reuse (Groundwater Recharge)	0	0	15,000	22,500	30,000
Subtotal[2]	**20,000**	**20,400**	**42,000**	**51,500**	**59,000**
Environmental[3]	26,990	26,990	26,990	26,990	26,990
Seawater Intrusion Barrier (Dominguez Gap Barrier)	3,000	3,000	3,000	3,000	3,000
Total	**49,990**	**50,390**	**71,990**	**81,490**	**88,990**

1. Projected use by category is subject to change per completion of Recycled Water Master Plan, but overall total will not change. Does not include deliveries of 34,000 AFY of secondary treated water to WBMWD for further treatment to recycled water standards.

2. To offset potable use and included in supply reliability tables in Chapter 11.

3. Environmental use includes Wildlife Lake, Balboa Lake, and the Japanese Garden. Additional environmental benefits associated with recycled water discharges to the Los Angeles River are not included.

Exhibit ES-P Planned Centralized Stormwater Capture Programs

Project	Current Annual Recharge (AFY)	Increased Annual Capture/ Recharge (AFY)	Expected Annual Recharge (AFY)	Estimated Project Completion	Total Project Cost (millions)	LADWP Share (millions)
Sheldon-Arleta Gas Collection System	-	4,000 (1)	-	Completed Nov 2009	$8.2	$6.3
Big Tujunga Dam Rehabilitation (3)	-	4,500	-	July 2011	$105.7	$9.0
Hansen Spreading Grounds Upgrade	13,834	1,200	17,284 (2)	Dec 2011	$9.3	$4.8
Tujunga Spreading Grounds Upgrade	4,419	8,000	18,669 (4)	2015	$24.0	$24.0
Pacoima Spreading Grounds Upgrade	6,453	2,000	8,453	2015	$32.0	$16.0
Lopez Spreading Grounds Upgrade	527	750	1,277	2016	$8.0	$4.0
Strathern Wetlands Park	-	900	900 (5)	2016	$46.0	$4.0
Hansen Dam Water Conservation	-	3,400	3,400	2017	$5.0	$2.5
Valley Generating Station Stormwater Capture	-	700	700	2018	$9.7	$9.7
Branford Spreading Basin Upgrade	549	500	1,049	2018	$4.0	$2.0
Total Estimated Yield	**25,782**	**25,950**	**51,732**		**$251.9**	**$82.3**

1. This will allow increased collection of 4,000 AFY at Tujunga Spreading Grounds.
2. Includes 1/2 benefits from Big Tujunga Dam Rehabilitation Project.
3. No recharge occurs at the facility. All additional capture has been divided between Hansen & Tujunga Spreading Grounds.
4. Including benefits from Sheldon-Arleta Project and 1/2 benefits from Big Tujunga Dam Rehabilitation Project.
5. To be recharged at Sun Valley Park.

capture and reuse solutions such as rain barrels and cisterns, for a total of 25,000 AFY by FY 2034/35. A Stormwater Capture Master Plan is being prepared and will comprehensively evaluate stormwater capture potential within the City.

In January 2008, LADWP created the Watershed Management Group which is responsible for developing and managing the water system's involvement in emerging issues associated with local and regional stormwater capture. The Watershed Management Group coordinates activities with other agencies, departments, stakeholders and community groups for the purpose of planning and developing projects and initiatives to improve stormwater management within the City. The Group's primary goal is to increase stormwater capture by enhancing existing centralized stormwater capture facilities and promoting distributed stormwater infiltration systems to achieve the City's long-term strategy of enhancing local stormwater capture.

Watershed management provides additional important benefits to the City of Los Angeles, including surface water quality improvements, water conservation, open space enhancements, and flood control. Water quality improvements are necessary because stormwater runoff is a conveyance mechanism that transports pollutants from the watershed into waterways and ultimately the Pacific Ocean. Pollutants include, but are not limited to, bacteria, oils, grease, trash, and heavy metals. The City must comply with adopted Total Maximum Daily Loads (TMDLs) for pollutants. TMDLs set maximum limits for a specific pollutant that can be discharged to a water body without causing the water body to become impaired or limiting certain uses.

LADWP has already been implementing several watershed projects and has identified others for planned implementation. Exhibit ES-P summarizes the currently planned watershed projects.

The Stormwater Capture Master Plan (Stormwater Plan) is being prepared to investigate potential strategies for stormwater and watershed management in the City. The Stormwater Plan will be used to guide decision makers in the City when making decisions affecting how the City will develop both centralized and distributed stormwater capture goals. The Stormwater Plan will evaluate existing stormwater capture facilities and projects, quantify the maximum stormwater capture potential, develop feasible stormwater capture alternatives (i.e., projects, programs, potential policies, etc.), and provide strategies to increase stormwater capture. It will also evaluate the multi-beneficial aspects of increasing stormwater capture, including potential open space alternatives, improved downstream water quality, and peak flow attenuation in downstream channels, creeks, and streams such as the Los Angeles River.

Water Transfers

Water transfers involve the lease or sale of water or water rights between consenting parties. Water Code Section 470 (The Costa-Isenberg Water Transfer Act of 1986) states that voluntary water transfers between water users can result in a more efficient use of water, benefiting both the buyer and the seller. The State Legislature further declared that transfers of surplus water on an intermittent basis can help alleviate water shortages, save capital outlay development costs, and conserve water and energy. This section of the Water Code also obligates the California Department of Water Resources (DWR) to facilitate voluntary exchanges and transfers of water.

LADWP plans on acquiring water through transfers to replace a portion of LAA water used for environmental enhancements in the eastern Sierra Nevada. The City would purchase water when available and economically beneficial for storage or delivery to LADWP's transmission and distribution system. The City is seeking non-State Water Project water to replace the reallocation of LAA water supply for environmental enhancements. MWD holds an exclusive contractual right to deliver State Water Project entitlement water into its service territory, which includes the City of Los Angeles. Purchasing only non-State Water Project supplies will ensure the City's compliance with MWD's State Water Project contract.

To facilitate water transfers, LADWP is constructing an interconnection between the LAA and the State Water Project's California Aqueduct, located where the two aqueducts intersect in the Antelope Valley (Neenach, California). This interconnection, the Neenach Pumping Station will allow for water transfers from the East Branch of the State Water Project to the LAA System, as well as provide operational flexibility in the event of a disruption of flows along the LAA System. Construction of the Neenach Pumping Station required a four-way agreement between DWR, MWD, LADWP, and the Antelope Valley-East Kern Water Agency (AVEK). When completed, the Neenach Pumping Station facility will be owned by DWR but will be designated as an AVEK interconnection. The Neenach Pumping Station will be operated on behalf of the LADWP. MWD is involved in the agreement to provide consent for the transfer of water into its service territory.

LADWP's current goal is to transfer up to 40,000 AF per year once the Neenach Pumping Station facilities are in place. This will provide LADWP with the ability to replace some Los Angeles Aqueduct supplies reallocated to environmental enhancement projects. This will also provide increased operational flexibility and the ability to yield cost savings.

Other Water Supply Opportunities

Seawater Desalination
LADWP initiated efforts in 2002 to evaluate seawater desalination as a potential water supply source with the goals of improving reliability and increasing diversity in its water supply portfolio. These efforts led to the selection of the Scattergood Generating Station's unused tank farm as a potential site for a seawater desalination plant. For the City, seawater desalination is a potential resource that could also offset supplies that had been committed from the LAA for environmental restoration in the eastern Sierra Nevada. As an identified project in MWD's Seawater Desalination Program, the proposed full-scale project would have qualified for MWD's grant of $250 per acre-foot of water produced. However, in May 2008, LADWP decided to focus on water conservation and water recycling as primary strategies for creating a sustainable water supply due to concerns with cost and the environmental impacts associated with the implementation of desalination. While desalination may be explored further in the future, it currently represents only a supply alternative.

Graywater Systems
As defined by State regulations, graywater is untreated household wastewater which has not come into contact with toilet waste or unhealthy bodily wastes. It includes water sources from bathtubs, showers, bathroom wash basins, and water from clothes washing machines and laundry tubs. It specifically excludes water from kitchen sinks and dishwashers. Graywater is a drought-proof source of supply for subsurface landscape irrigation. Graywater regulations do not allow its application using spray irrigation. Graywater is also not allowed to pond or runoff, enter a storm drain system or surface water body, or irrigate root crops or edible food crops that are directly in contact with the surrounding soil.

The Graywater Systems for Single Family Residences Act of 1992 legally incorporated the use of graywater as part of the California Plumbing Code. In September 1994, the City approved an ordinance that permitted the installation of graywater systems in residential homes. However, installing graywater systems under the Act was costly in terms of both installation and maintenance. To address the current water shortage and reduce water demands, emergency graywater regulations added Chapter 16A (Part I) "Non-potable Water Reuse Systems" to the 2007 California Plumbing Code. These regulations were approved by California Building Standards Commission in 2009 and became effective on August 4, 2009. Further revisions were made to the regulations and the regulations became permanent on January 12, 2010 with an effective date of January 20, 2010. These new code changes allow the use of certain types of untreated graywater systems as long as specific health requirements are met as defined by the authority having jurisdiction.

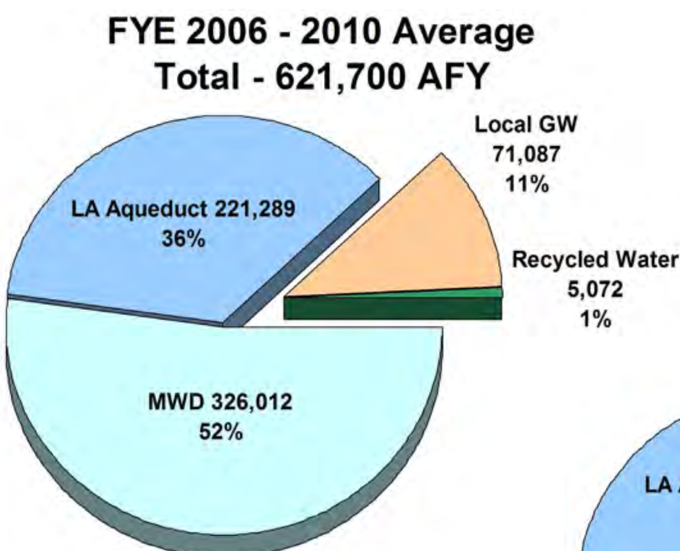
ES-6 Water Supply Reliability

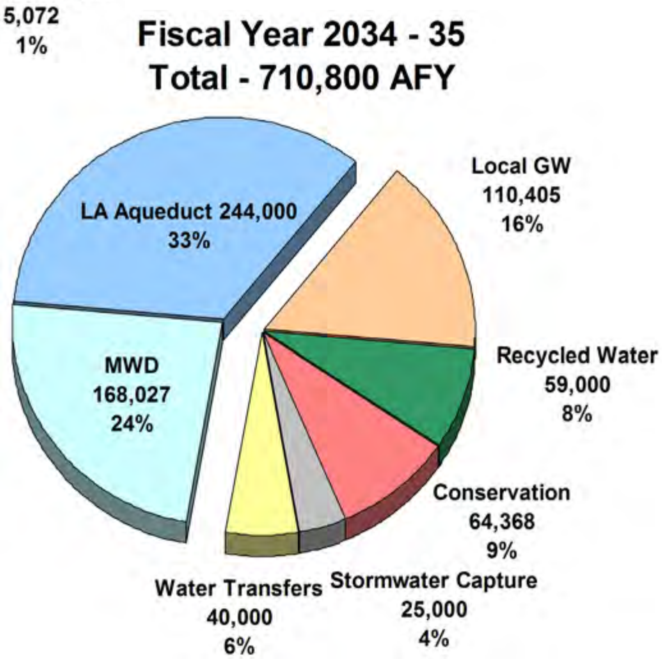
With its current water supplies, planned future water conservation, and planned future water supplies, LADWP will be able to reliably provide water to its customers through the 25-year planning period covered by this UWMP. While there may be times in which severe water shortages require MWD to allocate its imported water in the future, LADWP's customers have shown that they can adapt and reduce consumption in those years. However, MWD's 2010 Regional UWMP currently shows that with its investments in storage, water transfers and improving the reliability of the Delta, water shortages are not expected to occur within the next 25 years.

Exhibit ES-Q shows the current and future mix of LADWP's water supply. As shown in this exhibit, local water supplies and new water conservation are projected to increase from the current 12 percent to 43 percent by 2035. This increased local supply mix will allow LADWP to reduce by half its MWD water supply purchases, effectively making LADWP less subject to cost increases on purchased water. The focus on local supplies also increases flexibility and overall reliability, particularly during periods of water shortage.

Exhibit ES-Q
Current and Projected Mix of LADWP's Water Supplies

Note: Charts do not reflect approximately 100,000 AF of existing conservation





Supply Reliability Assessment

To demonstrate LADWP's water supply reliability, Exhibit ES-R summarizes the water demands and supplies for an average weather year through 2035.

Exhibit ES-S presents the supply reliability for the driest three-year sequence from 2010 to 2013, as required by the UWMP guidelines.

Water Quality Issues

Water quality is an important and necessary consideration in all impact water management strategies and supply reliability. For example as shown in Footnote 2 of the Exhibit ES-R, the sustainability of the groundwater production is contingent on completing two groundwater treatment facilities for the San Fernando Basin groundwater. Similarly, the effectiveness of expanding

Exhibit ES-R Service Area Reliability Assessment for Average Weather Year

Demand and Supply Projections (in acre-feet)	FY2009-10 Actual	**Average Weather Conditions (FY 1956/57 to 2005/06) Fiscal Year Ending on June 30**				
		2015	2020	2025	2030	2035
Total Demand	**555,477**	**614,800**	**652,000**	**675,600**	**701,200**	**710,800**
Existing / Planned Supplies						
Los Angeles Aqueduct[1]	199,739	252,000	250,000	248,000	246,000	244,000
Groundwater[2]	76,982	40,500	96,300	111,500	111,500	110,405
Conservation	8,178	14,180	27,260	40,340	53,419	64,368
Recycled Water						
- Irrigation and Industrial Use	6,703	20,000	20,400	27,000	29,000	29,000
- Groundwater Replenishment	0	0	0	15,000	22,500	30,000
Water Transfers	0	40,000	40,000	40,000	40,000	40,000
Subtotal	291,602	366,680	433,960	481,840	502,419	517,773
MWD Water Purchases With Existing/Planned Supplies	263,875	248,120	218,040	193,760	198,781	193,027
Total Supplies	**555,477**	**614,800**	**652,000**	**675,600**	**701,200**	**710,800**
Potential Supplies						
Stormwater Capture						
- Capture and Reuse (Harvesting)	0	2,000	4,000	6,000	8,000	10,000
- Increased Groundwater Production (Recharge)	0	0	2,000	4,000	8,000	15,000
Subtotal	0	2,000	6,000	10,000	16,000	25,000
MWD Water Purchases With Existing/Planned/Potential Supplies	263,875	246,120	212,040	183,760	182,781	168,027
Total Supplies	**555,477**	**614,800**	**652,000**	**675,600**	**701,200**	**710,800**

[1] Los Angeles Aqueduct supply is estimated to decrease 0.1652% per year due to climate change impact.

[2] North Hollywood/Rinaldi-Toluca Treatment Complex is expected in operation in 2019-20. Tujunga Groundwater Treatment Plant is expected in operation in 2020-21. Storage credit of 5,000 afy will be used to maximize the pumping in 2020-21 and thereafter. Sylmar Basin production was increased to 4,500 AFY from 2014-15 to 2029-30 to avoid the expiration of stored water credits, then go back to its entitlement of 3,405 AFY in 2030-31.

Exhibit ES-S
Driest Three-Year Water Supply Sequence

Demand and Supply Projections (in acre-feet)	FY2009-10 Actual	Followed by Repeat of Driest Three Consecutive Years FY 1958/59 to 1960/61 Hydrology Fiscal Year Ending on June 30		
		2011	2012	2013
Total Demand	**555,477**	**590,000**	**608,200**	**626,500**
Existing / Planned Supplies				
Los Angeles Aqueduct[1]	199,739	104,530	50,849	59,382
Groundwater[2]	76,982	61,090	53,660	46,260
Conservation	8,178	9,380	10,580	11,780
Recycled Water				
- Irrigation and Industrial Use	6,703	7,500	8,300	9,000
- Groundwater Replenishment	0	0	0	0
Water Transfers	0	0	0	0
Subtotal	291,602	182,500	123,389	126,422
MWD Water Purchases With Existing/Planned Supplies	263,875	407,500	484,811	500,078
Total Supplies	**555,477**	**590,000**	**608,200**	**626,500**

1. Driest three consecutive years on record in LAA watershed (FY1958-59 to FY1960-61) averaged 28 percent of normal runoff.
2. LAA deliveries reflect increased releases for environmental restoration in the Owens Valley and Mono Basin.
3. Dry year demands are 5 percent greater than normal year demands
4. MWD's Water Surplus and Drought Management Plan actions sufficient to meet LADWP demands.

the use of the San Fernando Basin groundwater from recycled water and captured stormwater also depends on implementation of treatment.

In the portions of the eastern San Fernando Basin, we have detected several industrial contaminants. These include trichloroethylene (TCE), perchloroethylene (PCE), hexavalent chromium, perchlorate and other volatile organic compounds (VOCs). These contaminants are a result of historical improper chemical disposal in the San Fernando Valley. Nitrates in the San Fernando Basin is an additional contaminant of concern which is the result of decades of agricultural activities. These contaminants threaten the overall reliability and sustainability of the City's groundwater supply. LADWP is determined to address the contamination in order to continue to provide high quality water. In this effort, LADWP is working with local, state and federal agencies such as the U.S. Environmental Protection Agency, the California Department of Public Health, the Los Angeles Regional Water Quality Control Board, and the California Department of Toxic Substances Control. LADWP has an ongoing extensive groundwater monitoring program to ensure that groundwater pumping occurs from the safer areas of the basin. LADWP has shutdown groundwater pumping from highly contaminated regions. This has resulted in a 40 percent reduction in pumping from the San Fernando Basin. LADWP has embarked on an ambitions and comprehensive undertaking to address this groundwater contamination. It has begun with a $19 million Groundwater System Improvement Study (GSIS) that will provide vital information to assist with developing both short and long-term projects to maximize the restore the City's historical groundwater usage from the San Fernando Basin. This includes installing additional monitoring wells to help identify contaminants and the best technologies to treat them. The pace of implementation of treatment will be subject to necessary approvals and availability of funding. Already some wellfield treatment projects are underway in partnership with the U.S. Environmental Protection Agency, Metropolitan Water District of Southern California and others.

LADWP closely monitors water quality issues regarding source water challenges and proposed regulations at the local, state and federal levels. LADWP also proactively researches and invests in advanced and emerging technologies to ensure continued safety and reliability of the City's water supplies. A recent example of LADWP's regulatory diligence is addressing the Stage 2 Disinfectants and Disinfection Byproduct Rule with the conversion from chlorine to chloramine as the City's secondary disinfectant. Studies have shown that chlorine tends to increase levels of disinfection byproducts such as trihalomethanes (THMs) and haloacetic acids (HAAs). While still protective, chloramine is significantly less reactive and forms lesser levels of THMs and HAAs. LADWP is planning to complete the conversion from chlorine to chloramine by April 2014.

Similarly, LADWP is closely monitoring level of naturally occurring arsenic in the LAA supply. Although the levels of arsenic in the water served is on average 3.3 parts per billion (ppb) and is well below the current federal and state drinking water standard of 50 ppb. LADWP is committed to continuing research to develop strategies to further reduce the levels of arsenic in its water supply.

LADWP continuously strives to surpass the water quality standards and requirements and do so in an effective and affordable way for our customers. By managing state-of-the-art water treatment process, maintaining and operating treatment facilities, and vigilantly monitoring and testing the water we serve, LADWP has been meeting or exceeding all health-based drinking water standards. The drinking water standards are set by the U.S. Environmental Protection Agency and the California Department of Public Health.

Global Climate Change

LADWP is considering impacts of climate change during development of its long-term water supply plan. Climate change is a global-scale concern, but is particularly important in the western United States where potential impacts on water resources can be significant to supplies for water agencies. Climate change can impact surface supplies from the LAA, imported supplies from MWD, and local demands. As a result, LADWP completed a study to analyze the operational and water supply impacts of potential shifts in the timing and quantity of runoff along the LAA system due to climate change in the 21st Century. Such potential shifts may require LADWP to develop, enhance, and modify management of local water resources. Projected changes in climate are expected to alter hydrologic patterns in the Eastern Sierra through changes in precipitation, snowmelt, relative ratios of rain and snow, and runoff.

To understand some of the key issues surrounding climate change impacts, it is important to put it into the context of LADWP's water supplies. California lies within multiple climate zones. Therefore, each region will experience unique impacts to climate change. Because LADWP relies on both local and imported water sources, it is necessary to consider the potential impacts climate change could have on the local watershed as well as the western and eastern Sierra Nevada watersheds where a portion of MWD's imported water originates and LADWP's imported LAA supplies originate, respectively, and the Colorado River Basin where the remainder of MWD's imported supplies originate. Generally speaking, any water supplies that are dependent on natural hydrology are vulnerable to climate change, especially if the water source originates from mountain snow pack. For LADWP, the most vulnerable water sources subject to climate change impacts are imported water supplies from MWD and the LAA. In addition to water supply impacts, changes in local temperature and precipitation are expected to alter water demand patterns.

The LAA is one of the major imported water sources delivering a reliable water supply to the City of Los Angeles. The LAA originates approximately 340 miles away from snowmelt runoff in the eastern Sierra Nevada; hence LAA is subject to hydrologic variability associated with climate change. Since the majority of precipitation occurs during winter in the eastern Sierra Nevada watershed, water is stored in natural reservoirs in the form of snowpacks, and is gradually released into streams that feed into the LAA during spring and summer. Higher concentrations of greenhouse gases in the atmosphere are often indications of pending climate change. These changes threaten the hydrologic stability of the eastern Sierra Nevada watershed through alterations in precipitation, snowmelt, relative ratios of rain and snow, winter storm patterns, and evapotranspiration, all of which have major potential impacts on the LAA water supply and deliveries.

LADWP's climate change study evaluated the potential impacts of climate change on the eastern Sierra Nevada watershed and the LAA water supply and deliveries. In this study, future climate conditions were predicted using a set of sixteen global climate models and two greenhouse gas emission scenarios. Results of the study show steady temperature increases throughout the 21st century and are consistent with other prior studies performed in the scientific community. Temperature is the main climate variable that is projected to rise significantly in the coming years and this rise in temperature directly affects several variables including:

- Whether precipitation falls as snow or rain.
- The ground-level temperature determines the timing and rate of snowmelt.
- The temperature profile that determines the rate of evapotranspiration.

Results have shown that future predictions for the early-21st century suggested a warming trend of 0.9 to 2.7 °F and almost no change in average precipitation. Mid-21st century projections suggested a warming trend of 3.6 to 5.4 °F and a small average decrease in precipitation, approximately 5 percent. This warming trend is expected to increase significantly by the end of 21st century, as the results suggest further warming of 4.5 to 8.1 °F and a decrease in precipitation of approximately 10 percent. Projected changes in temperature (warmer winters) will change precipitation patterns to rain with larger fractions than historically encountered. Consequently, peak Snow Water Equivalent (SWE) and runoff are projected to undergo a shift in timing to earlier dates.

Exhibit ES-T
Projected Runoff, Snow-Water Equivalent, and Rain-to-Snow Ratio for Eastern Sierra Nevada Watershed

	Runoff (MAF)	April 1 SWE (Inches)	Rain/Snow Ratio
Baseline (Second Half of 20th Century)	**0.6**	**15.0**	**0.2**
Early 21st-century (2010-2039)	0.5 - 0.85	10.6 - 19.0	0.24 - 0.33
Mid-century (2040-2069)	0.34 - 0.9	7.0 - 19.7	0.25 - 0.43
End-of-century (2070-2099)	0.35 – 1.1	5.0 - 16.0	0.28 - 0.54

Exhibit ES-T summarizes the projections for runoff, SWE, and rain-to-snow ratio for the 21st century. The projected temperature and precipitation dataset form the basis of the hydrologic model projections for runoff, snow-water equivalent (SWE), and rain-to-snow ratio. To compare the future projections of these variables, the trends that dominated the second half of the 20th century are considered baselines for future trends. The baseline values for runoff, SWE, and rain-to-snow ratio are 0.6 million acre-feet (MAF), 15 inches, and 0.2, respectively. By Early 21st century (2010 – 2039), results illustrate runoff is projected to undergo increases and decreases averaging between 0.5 to 0.85 MAF; SWE is projected to undergo decreases and increases ranging between 10.6 to 19.0 inches, and the rain-to-snow ratio is projected to increase between 0.24 to 0.33. By mid-century (2040 – 2069), the same trends are expected to dominate, with runoff ranging between 0.34 to 0.9 MAF, SWE ranging between 7.0 to 19.7 inches, and the rain-to-snow ratio increasing between 0.25 to 0.43. These trends are expected to govern until the end-of-century (2070 -2099) with runoff ranging between 0.35 to 1.1 MAF, SWE ranging between 5.0 to 16.0 inches, and rain-to-snow ratio increasing between 0.28 to 0.54.

It is important to acknowledge that the predictions of global climate models lack the desired precision due to the presence of uncertainties inherent in the analyses. The uncertainty to future emissions of greenhouse gases and the chaotic nature of the climate system leads to uncertain response of the global climate system to the increases in greenhouse gases. In addition, the science of climate change still lacks the complete understanding of regional manifestations that will result from global changes, thus restraining the projecting capacity of these models. However, these projections are consistent with the state of science today, and they help predict the manner of which hydrologic variables are likely to respond to a range of possible future climate conditions, and thus help to guide water managers in their planning and development efforts to ensure the reliability and sustainability of adequate water supply and delivery.

ES-7 Financing

The UWMP also addresses financing issues associated with providing a reliable water supply. To fund future water conservation, recycled water, and stormwater programs, LADWP will utilize the following funding sources:

- Water Rates – An existing component of water rates currently provide approximately $100 million annually for water conservation, water recycling, and stormwater capture programs. It is anticipated that the water conservation, water recycling, and stormwater capture goals of the UWMP can be met with current levels of expenditures. State and/or federal funding will offset LADWP revenues, or allow goals to be achieved sooner than projected. In order to accomplish the UWMP goals related to treatment of contaminated groundwater supplies it will be necessary to increase current levels of expenditure, which will require an increase in water rates.

- MWD – Currently provides funding up to $250 per AF for water recycling through their Local Resources Program. MWD also provides some water conservation incentive funding through rebates equal to $195 per AF of water saved or half the product cost whichever is less.

- State Funds – Funds for recycling, conservation, and stormwater capture have been available on a competitive basis though voter approved initiatives, such as Propositions 50 and 84. The proposed 2012 Water Bond also includes potential funding for groundwater cleanup. Occasionally low or zero-interest loans are also available though State Revolving Fund programs.

- Federal Funds – Federal funding for recycling is available through the U.S. Army Corps of Engineers, via periodic Water Resource Development Act legislation, and the U.S. Bureau of Reclamation's Title XVI program.

To fund its future water quality programs, including groundwater cleanup, LADWP will seek reimbursement from potential responsible parties to assist with cleanup program costs. However, it is anticipated that water rates will need to be increased to pay for these much needed capital projects in order to ensure our groundwater supply is maximized.

ES-8 Conclusion

LADWP's 2010 Urban Water Management Plan is not only designed to meet the current requirements of the UWMP Act, but also serves as the City's master plan for water supply and resource management. The UWMP provides the basic policy principles that guide LADWP's decision-making process to secure a sustainable water supply for Los Angeles in the next 25 years.

The 2010 UWMP projects a 15 percent lower water demand trend than what was projected in the 2005 UWMP. It lays out a detailed plan to develop a sustainable water supply portfolio that includes the increase of local water supplies and water conservation from the current 12 percent to 43 percent by 2035. This increased local supply mix will allow the City to reduce its reliance on the purchased MWD water supply by one-half. The focus on local supplies increases flexibility and overall water supply reliability.

Chapter One
Introduction

1.0 Overview

In 1902, the City of Los Angeles (City) had a population of approximately 146,000 residents and created a municipal water system by acquiring title to a private water company. In 1925, the Los Angeles Department of Water and Power (LADWP) was established by a new city charter. The availability of water has significantly contributed to the economic development of the City. LADWP met the City's need for water resources as Los Angeles developed into the nation's second largest city with over 4 million residents, encompassing a 473-square-mile area. As the largest municipal utility in the nation, LADWP delivers safe and reliable water and electricity services at an affordable price to the residents and businesses of Los Angeles.

With increasing demands for additional water supplies, LADWP and other water agencies in Southern California are faced with the challenge of providing a reliable water supply for a growing population.

LADWP plans to meet the City's water needs through the following actions:

- Significantly enhance water conservation, stormwater capture, and recycling projects to increase supply reliability.
- Implement treatment for San Fernando Basin groundwater supplies.
- Ensure continued reliability of the water supplies from the Metropolitan Water District of Southern California (MWD) through active representation of City interests on the MWD Board.
- Maintain the operational integrity of the Los Angeles Aqueduct and in-City water distribution systems.
- Meet or exceed all Federal and State standards for drinking water quality.

1.1 Purpose

The LADWP's 2010 Urban Water Management Plan (UWMP) serves two purposes: (1) compliance with the requirements of California's Urban Water Management Planning Act (Act), and (2) as a master plan for water supply and resources management consistent with the City's goals and policy objectives.

1.1.1 UWMP Requirements and Checklist

This 2010 UWMP complies with Sections 10610 and 10656 of the California Water Code, the Urban Water Management Planning Act (Act), and details how LADWP plans to meet all of the City's customer water needs. The Act became effective on January 1, 1984 and requires that every urban water supplier that provides municipal and industrial water to more than 3,000 customers (or supplies more than 3,000 acre-feet per year) prepare and adopt a UWMP every five years in accordance with prescribed requirements.

The Act was originally developed due to concerns about potential water supply shortages throughout California. Therefore, it required information that focused primarily on water supply reliability and water use efficiency measures. Since its original passage in 1983, there have been several amendments, the most recent adopted in 2009. Some of the recent amendments include: requirements to assess present and proposed future demands to achieve per capita water use reductions of 20 percent by 2020, project water use for low-income single family and multi-family residential housing, and add "indirect potable reuse" to the list of recycled water uses. A copy of the Act is provided in Appendix A. A checklist cross-referencing Act requirements to applicable pages in this UWMP is provided in Appendix B.

With the passage of Senate Bills (SB) 610 and 221 in 2001, UWMPs took on even more importance. SB 610 and 221 require counties and cities to consider the availability of adequate water supplies for certain new large developments and to have written verification of sufficient water supply to serve them. UWMPs are identified as key source documents for this verification. Based on these statutes the LADWP prepares individual Water Supply Assessments for these new large developments.

LADWP's 2010 UWMP not only meets the current requirements of the Act, but also serves as the City's master plan for water supply and resource management. The UWMP helps guide policy makers in the City and the Metropolitan Water District of Southern California (MWD) and provides information to the citizens of Los Angeles. The UWMP presents the basic policy principles that guide LADWP's decision-making process to secure a sustainable water supply for Los Angeles.

1.1.2 Water Supply Action Plan

LADWP has a long history of working to ensure that its customers have enough water. These efforts go back to the early 20th century with the building of the Los Angeles Aqueduct. Investments in water rights, aqueducts, reservoirs, conservation, and, more recently, recycled water and stormwater capture have allowed City residents to enjoy a reliable water supply. Sound planning and timely investments in water have played a critical role in meeting the water needs of the City despite the fact that Southern California is a semi-arid region.

In May of 2008, LADWP's Water Supply Action Plan (Plan), "Securing L.A.'s Water Supply", was released. It addressed a number of critical water supply reliability issues including: (1) the 2007 occurrence of the lowest snowpack on record in the

Eastern Sierras, which has historically provided Los Angeles with the greatest share of its water supply; (2) the 2007 occurrence of the driest year on record for the Los Angeles basin; (3) anticipated regional water allocations by MWD in response to dry year and regulatory reductions in imported water available from the San Francisco Bay Delta; (4) local groundwater contamination in the San Fernando Basin, restricting LADWP's ability to fully utilize this local resource; (5) Los Angeles Aqueduct delivery reductions due to environmental mitigation and enhancements in the Owens Valley and Mono Lake Basins, totaling nearly one-half of historic water supplies from the Eastern Sierra watershed; and (6) uncertain climate change impacts which threaten traditional water supply sources.

The convergence of these critical issues has far-reaching implications for the City of Los Angeles' water supply that require long-range planning to ensure a reliable supply of water to meet current and future demand. The Plan was a blueprint for creating sustainable water resources to serve the future needs of the City, and outlined responsible water management and long-term planning. By 2028, the Plan envisioned a six-fold increase in recycled water supplies to a total of 50,000 Acre-Feet per Year (AFY). Similarly, by 2030 an increase of 50,000 AFY was planned for conservation. As described in the Plan, this aggressive approach included investments in state-of-the-art technology; a combination of rebates and incentives; efficient clothes washers and urinals; and long-term measures such as expansion of water recycling and treatment of contaminated groundwater supplies. A multi-faceted approach to developing a locally sustainable water supply was developed incorporating the following key short-term and long-term strategies:

Short-Term Conservation Strategies

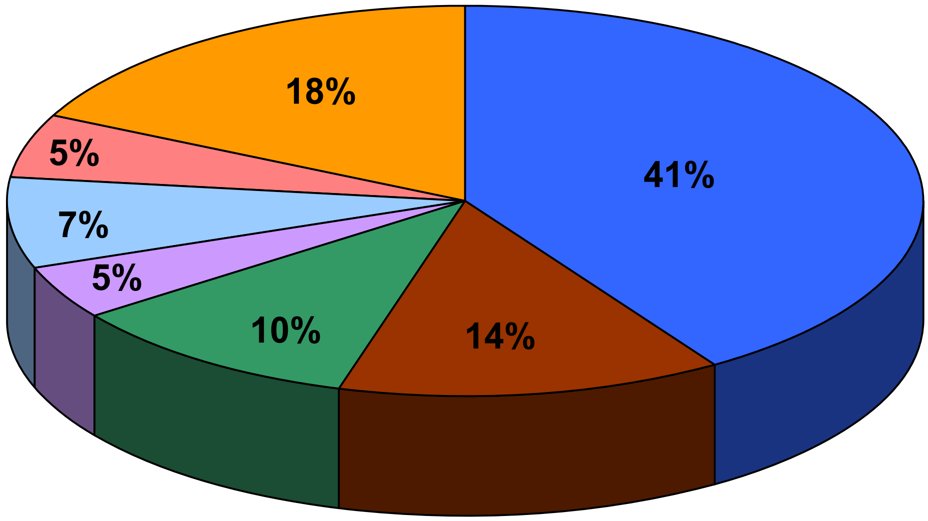
- Enforcing prohibited uses of water
- Expanding prohibited uses of water
- Extending outreach efforts
- Encouraging regional conservation measures

Long-Term Strategies

- Increasing water conservation through reduction of outdoor water use and new technology
- Maximizing water recycling
- Enhancing stormwater capture
- Accelerating groundwater basin treatment
- Expanding groundwater storage
- Green Building Initiatives (added subsequent to the release of the Plan)

The Water Supply Action Plan is an integral part of the UWMP, and is incorporated into the associated chapters. The UWMP outlines how the strategies contained in the Water Supply Action Plan will be implemented and how these strategies will increase the reliability of LADWP's water supplies through 2035.

Exhibit 1A
City of Los Angeles Land Uses



Land Use Type	Acres
Single-family Residential[1]	123,365
Open Space/Parks	41,317
Multi-family Residential	31,718
Commercial	13,632
Manufacturing	22,567
Public Facilities	16,314
Other[2]	53,731
Total	302,644

Source: Data aggregated from City of Los Angeles, Department of City Planning, November, 2009

Notes:

1. Includes agricultural use as defined by LA City Planning Department
2. Includes parking, hillside area, and other miscellaneous area

1.2 Service Area

In order to properly plan for water supply, it is important to understand the factors that influence water demands over time. These factors include land use, demographics, and climate.

1.2.1 Land Use

The City of Los Angeles is comprised of approximately 302,644 acres. Residential development constitutes over 51 percent of the total land use within the City. Within the residential land use category, single-family residential is the largest at approximately 123,000 acres or 41 percent of the total land use within the City. Multi-family residential is at approximately 32,000 acres or 10 percent of the total land use within the City. Open space/parks is the second largest land use within the City at approximately 14 percent. Commercial, public facilities and manufacturing land uses combined account for approximately 17 percent of the total. Public facilities include land uses such as libraries, public schools, and other government facilities. Exhibit 1A provides a breakdown of the land uses within the City of Los Angeles. The "Other" category includes specific plans, transportation, freeways, rights of way, hillsides, and other miscellaneous uses that are not zoned.

1.2.2 Demographics

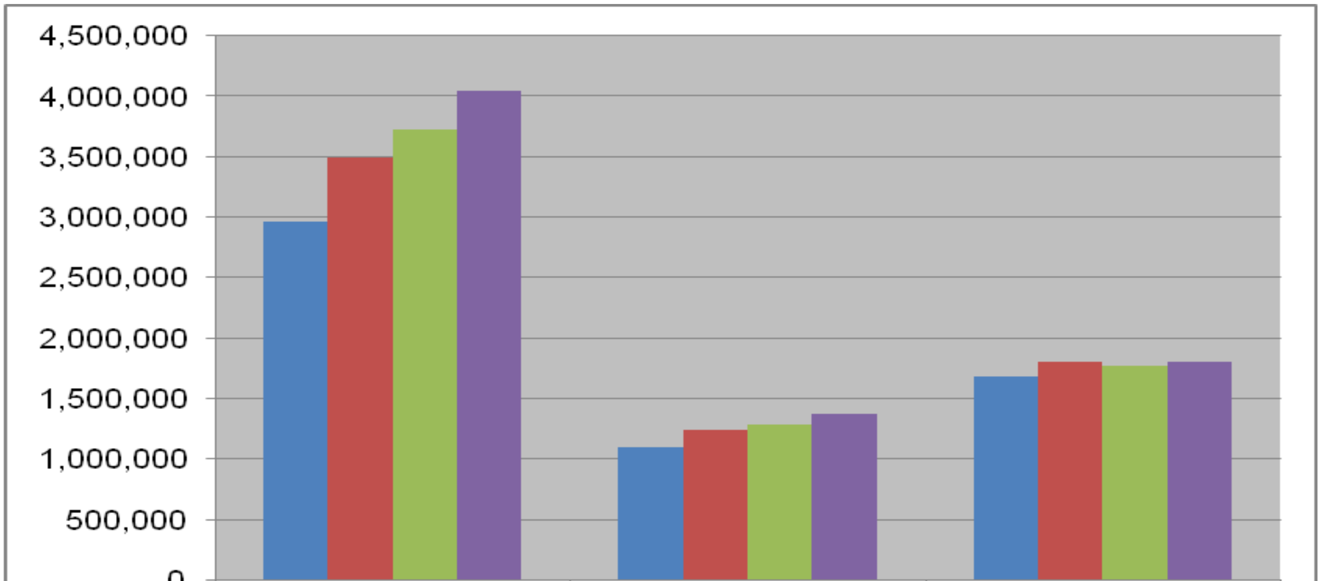
Over 4 million people reside in the LADWP service area, which is slightly larger than the legal boundary of the City of Los Angeles. In addition to the City, LADWP also provides water service to portions of West Hollywood, Culver City, Universal City, and small parts of the County of Los Angeles.

The population within LADWP's service area increased from 2.97 million in 1980 to 4.1 million in 2009, representing an average annual growth rate of 1.3 percent. The total number of housing units increased from 1.10 million in 1980 to 1.38 million in 2009, representing an average annual growth rate of 0.9 percent. During this time, average household size increased from 2.7 persons in 1980 to 2.9 persons in 2009. Employment grew by about 1.0 percent annually from 1980 to 1990, but declined from 1990 to 2000 as a result of an economic recession that started in 1991. Another decline began in 2008 reflecting the recent economic recession. Overall, employment increased by about 0.3 percent annually from 1990 to 2009. Exhibit 1B summarizes the historical demographics for the LADWP service area.

Demographic projections were obtained for the LADWP service area from the MWD. The MWD utilizes a land-use based planning tool that allocates projected demographic data from the Southern California Association of Governments (SCAG) into water service areas for each of MWD's member agencies. MWD's demographic projections use data reported in SCAG's 2008 Regional Transportation Plan (RTP). Exhibit 1C summarizes these demographic projections for the LADWP service area.

LADWP's service area population is expected to continue to grow over the next 25 years at a rate of 0.4 percent annually. While this is substantially less than the historical 1.3 percent annual growth rate from 1980 to 2009, it will still lead to approximately 367,300 new residents over the next 25 years. According to SCAG's 2008 RTP, housing is expected to grow faster than population over the next 25 years at 0.7 percent annual growth versus 0.4 percent annual growth for population,

Exhibit 1B Historical Demographics for LADWP Service Area



	Population	Housing	Employment
1980	2,970,000	1,100,000	1,692,000
1990	3,501,602	1,243,022	1,813,615
2000	3,732,579	1,290,440	1,773,895
2009	4,051,438	1,376,013	1,812,926

Exhibit 1C
Demographic Projections for LADWP Service Area

Demographic	2010	2015	2020	2025	2030	2035
Population	4,100,260	4,172,760	4,250,861	4,326,012	4,398,408	4,467,560
Housing						
Single-Family	627,395	646,067	665,261	678,956	691,703	701,101
Multi-Family	764,402	804,013	846,257	880,580	914,125	942,846
Total Housing	1,391,797	1,450,080	1,511,518	1,559,536	1,605,828	1,643,947
Persons per Household	2.88	2.81	2.75	2.71	2.67	2.65
Employment						
Commercial	1,674,032	1,724,106	1,754,998	1,790,798	1,828,765	1,865,156
Industrial	163,382	157,652	155,012	152,426	150,009	147,508
Total Employment	1,837,415	1,881,758	1,910,010	1,943,224	1,978,773	2,012,664

Source: SCAG Regional Transportation Plan (2008), modified using MWD's land use planning to represent LADWP's service area.

and it is anticipated that household size will continue to decline over the projection period.

The 2008 RTP projects that by 2035 the average household size will decrease to 2.65 persons per household. Throughout the projection period, multi-family housing units are expected to increase at slightly less than twice the rate of single-family housing units (0.93 percent annual growth vs. 0.47 percent annual growth).

Employment is expected to increase by 0.4 percent annually throughout the projection period. This growth is primarily driven by the current and long-term opportunities available from the economic base within the five-county metropolitan region of Southern California. The economic base is wide-ranging and includes services, wholesale and retail trade, manufacturing, government, financial service industries, transportation, utilities, construction, education, and tourism. Over the 25-year forecast period, industrial growth is expected to decline and experience a subtle annual negative growth of -0.4 percent, while commercial employment is expected to increase by about 0.5 percent annually.

The SCAG demographic projections for population, households, and employment included in their 2008 RTP and presented in LADWP's 2010 UWMP vary from what was presented in LADWP's 2005 UWMP. The demographic projections in the 2005 UWMP were based on SCAG's 2004 RTP. The current 2008 projections incorporate the latest population, households, and employment data from multiple local, state, and federal agencies. Projected 2008 RTP data reflect adjustments in future population growth related to declining fertility, mortality, labor force participation, and household headship rates; leveling in net migration; fluctuating net domestic migration in response to economic cycles; and an employment shift from the manufacturing

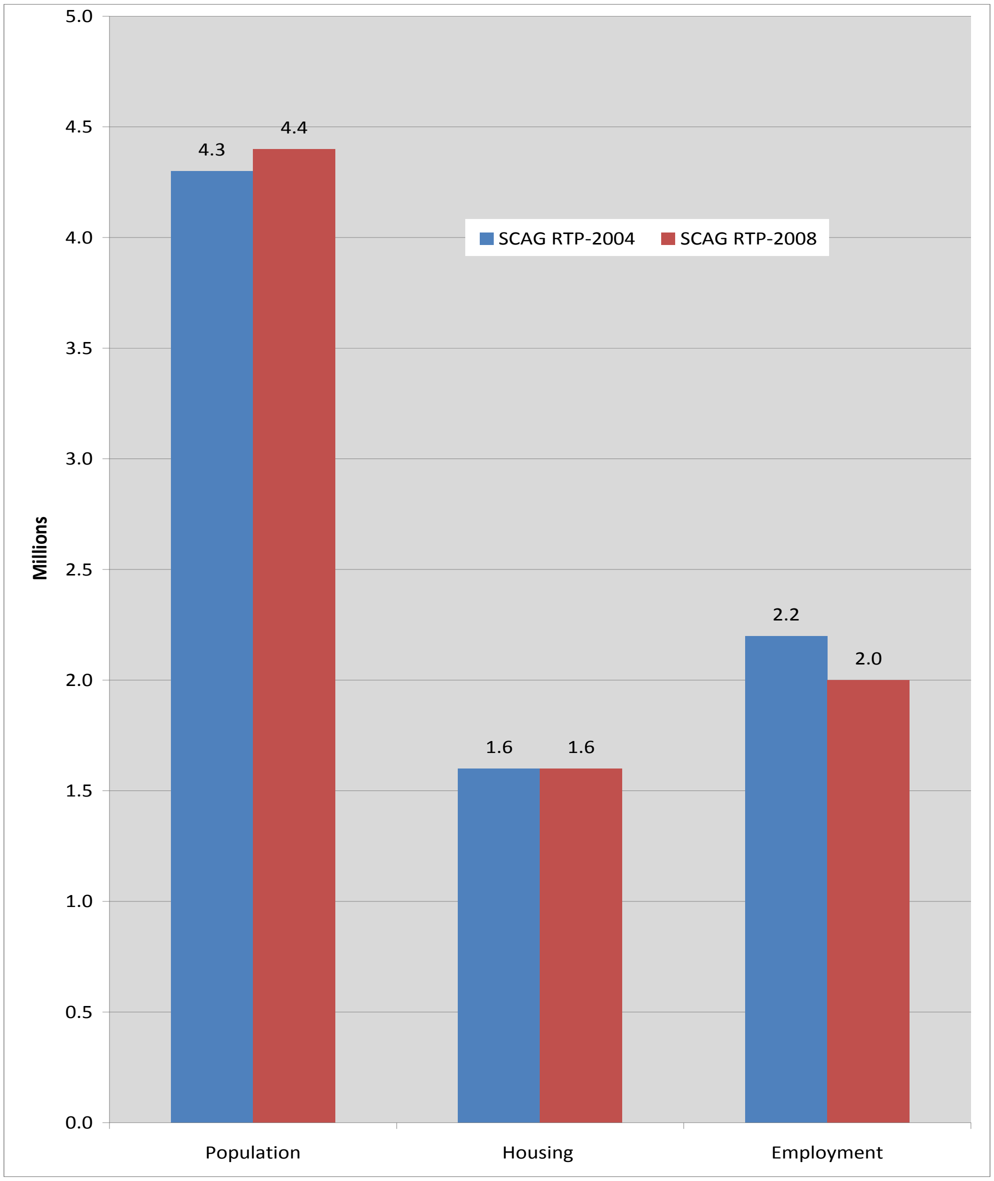


Exhibit 1D Comparison of SCAG Demographic Projections for LADWP Service Area Between 2004 and 2008 RTP Forecasts for Year 2030

sector to the service sector. The SCAG 2008 RTP was adopted in May 2008 prior to the recent recession beginning in 2008. Additionally, MWD has further adjusted the service area boundaries based on LADWP input. Exhibit 1D shows the differences between the SCAG demographic projections for the RTP in 2004 and 2008.

For the forecast year 2030, population was projected to be 4.30 million under the SCAG 2004 RTP and 4.40 million under the 2008 RTP, a difference of 100,000. Housing was projected to be 1.60 million in 2030 under SCAG 2004 RTP and slightly more under the SCAG 2008 RTP at 1.61 million.

Employment was forecast to be less in 2030 under the newest RTP. It is projected to be 2.20 million under the SCAG 2004 RTP versus 1.98 million with the 2008 RTP. It is important to recognize that projected total employment under both the 2004 RTP and 2008 RTP continue to increase from 2010 to 2035. The 2008 RTP simply projects a lower rate of increase compared to the 2004 RTP. Conversely, the rate at which the population increases is expected to be higher with the 2008 RTP as compared with the 2004 RTP.

1.2.3 Climate

Weather in Los Angeles is considered mild, which is a major attribute that attracts businesses, residents, and tourists to the City. Because of its relative dryness, Los Angeles' climate has been characterized as Mediterranean. Exhibit 1E provides a summary of average monthly rainfall, maximum temperatures, and evapotranspiration readings.

The City's average monthly maximum temperature is 75 degrees Fahrenheit based on the period of 1990-2010. This is based on data from the Los Angeles Downtown weather station. The standard annual average evapotranspiration rate (ETo) for the Los Angeles area is 50.26 inches per year. ETo measures the loss of water to the atmosphere by evaporation from soil and plant surfaces and transpiration from plants. ETo serves as an indicator of how much water plants need for healthy growth. Total precipitation averages 15.58 inches per year, with over 90 percent of this total amount typically falling during the period of November through April.

1.2.4 Water Demand and Supply Overview

LADWP maintains historical water use data separated into the following categories: single-family residential, multi-family residential, commercial, industrial, government, and non-revenue water. Single-family residential water use is the largest category of demand in LADWP's service area, representing about 36 percent of the total. Multifamily residential water use is the next largest category of demand, representing about 29 percent of the total. Industrial use is the smallest category, representing only 4 percent of the total demand. Non-revenue water is the difference between total water delivered to the city and total water sales and has averaged 7 percent in recent years. Chapter 2 – Water Demands provides an in-depth look at water demand trends and projections for the next 25 years.

Primary sources of water for the LADWP service area are the Los Angeles Aqueducts (LAA), local groundwater, and imported supplemental water purchased from MWD. An additional fourth source, recycled water, is becoming a larger part of the overall supply portfolio. Water from two of the supply sources, the LAA and MWD, is classified as imported because it

Exhibit 1E
Average Climate Data for Los Angeles

Average Climate Data for Los Angeles 1990-2010

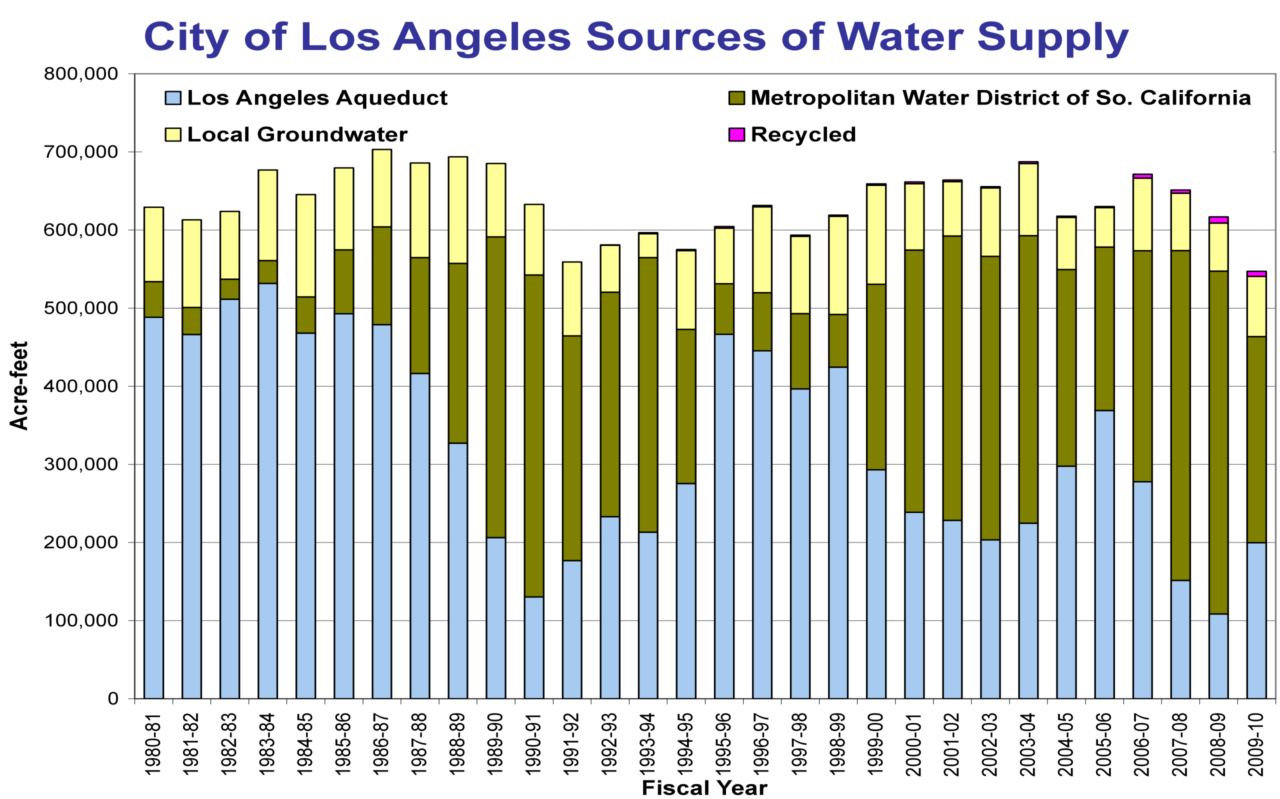
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Maximum Temperature (°F)[1]	68	68	70	73	75	78	83	85	83	79	73	68	75
Average Precipitation (inches)[1]	3.62	4.46	2.28	0.75	0.34	0.12	0.01	0	0.07	0.68	0.72	2.53	15.58
Average Eto (inches)[2,3]	1.98	2.26	3.66	4.96	5.46	6.08	6.46	6.31	4.87	3.63	2.56	2.03	50.26

1. 1990-2010, Los Angeles Downtown USC Weather Station ID 5115
2. Average of Hollywood Hills (Station Id. 73), Glendale (Station Id. 133), and Long Beach (Station Id. 174)
3. www.cimis.water.ca.gov

is obtained from outside LADWP's service area. Groundwater is local and is obtained within the service area. Historical supply sources are increasingly under multiple constraints including potential impacts of climate change, groundwater contamination, and reallocation of water for environmental concerns. To mitigate these impacts on supply sources, LADWP is modifying its water supply portfolio through conservation, water recycling, and stormwater capture.

The primary water supply sources are vital to maintaining LADWP's water system reliability. Pressure on one resource, such as little snowfall in the eastern Sierra Nevada Mountains, will result in an increased reliance on another resource, such as MWD. Supplies available from each source are determined using computer models in an attempt to balance total projected supplies with projected demands. Exhibit 1F illustrates historical water supplies from 1980 to 2010. As a result of supply shortages, overall demands decreased by over 124,000 AFY in Fiscal Year (FY) 2009/10 as compared to FY 2006/07. In FY 2009/10, approximately 36 percent of the water supply was from the LAA, 14 percent from local groundwater, 48 percent from MWD, and 1 percent from recycled water. The five-year water supply averages (FY 2005/06 to FY 2009/10) were as follows: 36 percent from the LAA, 11 percent from local groundwater, 52 percent from MWD, and less than 1 percent from recycled water. The imported water (LAA water plus MWD water) supplied on average approximately 88 percent of the City's demands.

Exhibit 1F
LADWP Historical Water Supply Sources 1980-2010



Chapter Two

Water Demand

2.0 Overview

In order to properly plan for water supply, it is important to understand water demands and the factors that influence demands over time. LADWP maintains historical water use data separated into the following categories: single-family residential, multifamily residential, commercial, industrial, government, and non-revenue water. This categorization of demands allows better evaluation of trends in water use over time and more precise targeting of water conservation measures.

2.1 Historical Water Use

Exhibit 2A presents the historical water demand for LADWP. As seen in this exhibit, total water demand varies from year to year and is influenced by a number of factors such as population growth, weather, water conservation, drought, and economic activity. In 2009, a 3-year water supply shortage coinciding with an economic recession required LADWP to impose mandatory conservation. In 2010 mandatory conservation continued and the economic recession became more severe. This resulted in Fiscal Year (FY) 2009/10 water use decreasing by 19 percent from FY 2006/07 levels.

Exhibit 2A
Historical Total Water Demand in LADWP's Service Area

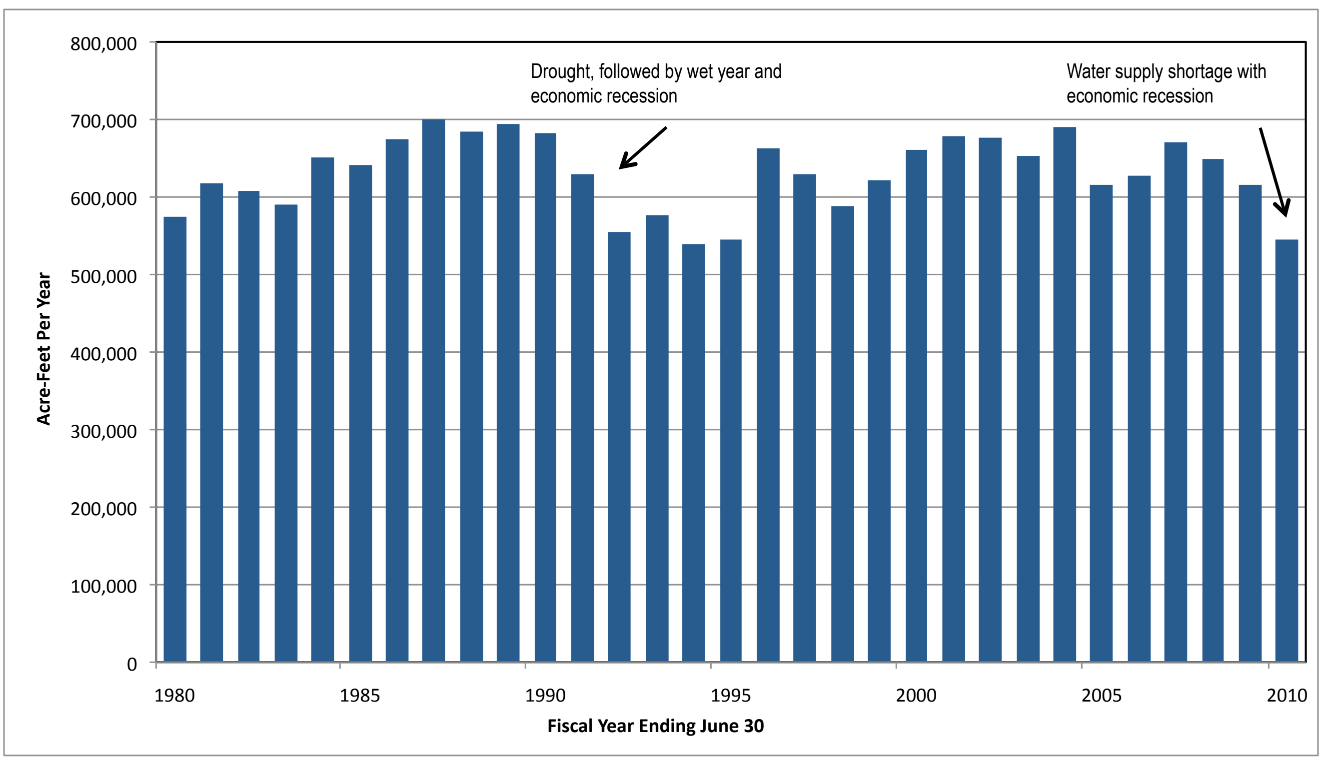
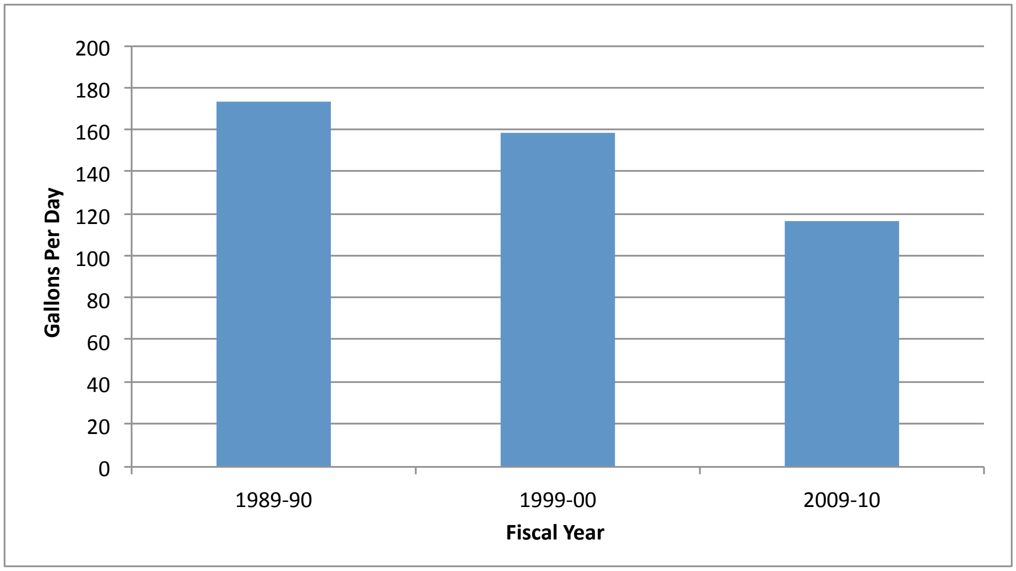


Exhibit 2B
Historical Per Capita Water Use in LADWP's Service Area



Prior to 1990, population growth in Los Angeles was a good indicator of total demands. From 1980 to 1990, population in the City grew at 1.7 percent annually. Water demands during this same ten year period also grew at 1.7 percent annually. However, after 1991, LADWP began implementing water conservation measures which prevented water demands from returning to pre-1990 levels. Average water demands in the last five years from FY 2005/06 to FY 2009/10 are about the same as they were in FY 1980/81 despite the fact that over 1.1 million additional people now live in Los Angeles. This is evidenced by examining per person (or per capita) water use since 1980 (see Exhibit 2B). In FY 1989/90, per capita water use was 173 gallons per day (gpd). By FY 1999/00, per capita water use fell to 159 gpd (or a 10 percent reduction from 1990). In FY 2009/10, per capita water use was estimated to be 117 gpd, but it is important to note that mandatory conservation and a severe economic recession were occurring at this time.

Water Use by Sector

Exhibit 2C shows the breakdown in average total water use between LADWP's major billing categories and non-revenue water in five-year intervals for the past 25 years. Non-revenue water consists of unaccounted water and accounted non-revenue water. Accounted non-revenue water usually refers to mainline flushing at dead-end water mains to improve water quality and is less than 0.005 percent of the total demand. Unaccounted water is the system loss which includes water for fire fighting, reservoir evaporation, leakage from pipelines, meter error, and theft. Single-family residential water use comprises the largest category of demand in LADWP's service area, representing about 36 percent of the total. Multifamily residential water use is the next largest category of demand, representing about 29 percent of the total. Industrial use is the smallest category, representing only 4 percent of the total demand. Although total water use has varied substantially from year to year, the breakdown in percentage of total demand between the major billing categories has not.

Non-revenue water has significantly decreased in recent years. Historically, non-revenue water has averaged 7 percent of total water demand. Since 2005, non-revenue water levels have averaged 5 percent. This may be attributed to a number of steps that LADWP has taken to improve its water system. In 2001, LADWP began replacing its large and intermediate meters, focusing on improving accuracy of the meters as well as their strategic placement. In addition, work to replace smaller customer meters was finally completed in FY 2009/10 which also contributed to water loss control. In FY 2007/08, an accelerated mainline replacement program was launched to repair and replace deteriorating pipelines. Furthermore, LADWP's ongoing program to remove or cover large open-air reservoirs reduces water loss due to evaporation and infiltration

Indoor and Outdoor Water Use

In order to assess the potential for water use efficiency and target conservation programs, it is important to characterize water use in terms of indoor and outdoor demands. As with most water utilities, LADWP does not have separate irrigation meters for most of its customers. Only a small fraction of LADWP's customers, mostly parks and golf courses, have designated irrigation meters. Therefore, measuring indoor vs. outdoor water demands involves the use of other data and assumptions.

There are two methods that LADWP uses to estimate total outdoor water use: (1) estimation of supplemental water needed for landscape irrigation in accordance with the California Model Water Efficient Landscape Ordinance; and (2) comparison of wastewater flows to total water consumption. The first method uses the following formula to estimate the water needed to supplement outdoor landscape irrigation beyond the effect of natural precipitation:

LW = (Eto –Eppt) x 0.62 x A x ETAF

Where:
LW = Estimated total supplemental water needed for landscape irrigation;
Eto = Reference evapotranspiration for the City of Los Angeles;
Eppt = Effective precipitation (25% of monthly precipitation);
0.62 = Conversion factor to gallons;
A = Total greenscape area; and
ETAF = Evapotranspiration (Et) adjustment factor

In 2007, an infrared analysis of the City was conducted as part of the City's Million Trees Program to determine tree canopy and landscape coverage. The infrared analysis methodology used two types of remotely sensed data, infrared imagery and aerial imagery to determine

Exhibit 2C
Breakdown in Historical Water Demand for LADWP's Service Area

Fiscal Year Ending	Single-Family		Multifamily		Commercial		Industrial		Government		Non-Revenue		Total
	AF	%	AF	%	AF	%	AF	%	AF	%	AF	%	AF
1986-90 Avg	238,248	35%	197,312	29%	123,324	18%	30,502	4%	43,378	6%	52,830	8%	685,594
1991-95 Avg	197,322	35%	177,104	31%	110,724	19%	21,313	4%	38,600	7%	24,100	4%	569,164
1996-00 Avg	222,748	35%	191,819	30%	111,051	18%	23,560	4%	39,830	6%	43,617	7%	632,626
2001-05 Avg	239,754	36%	190,646	29%	109,685	17%	21,931	3%	41,888	6%	58,299	9%	662,203
2005-10 Avg	236,154	38%	180,279	29%	106,955	17%	23,201	4%	42,940	7%	31,929	5%	621,458
25-yr Avg	226,845	36%	187,432	29%	112,348	18%	24,101	4%	41,327	6%	42,155	7%	634,209

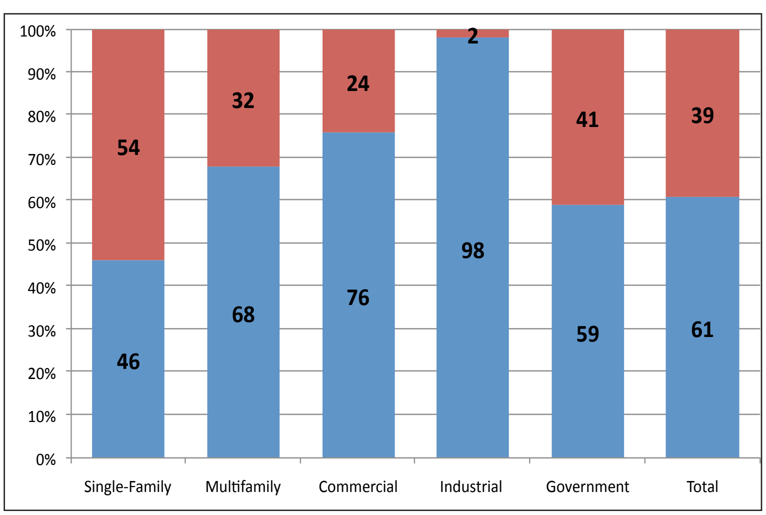
the total greenscape areas within the City. Results of this effort indicated that there is approximately 83,699 acres of greenscape in Los Angeles. The ETAF (or Et adjustment factor) of 0.8 for the City was derived from the types of plants to be irrigated and an assumed irrigation efficiency. It is consistent with the ETAF for non-rehabilitated landscapes as defined in the California Model Water Efficient Landscape Ordinance. The 2004-2007 average total water demand was selected as the basis for calculating outdoor water use percentage. This period was considered to be about average in terms of weather for Los Angeles and there were no irrigation restrictions in effect. Using the formula described previously, the supplemental water for outdoor landscaping in the City was estimated to be 249,000 AFY. During this same period, total water demand averaged 647,000 AFY. Therefore, it is estimated that the City's total outdoor water use represents approximately 39 percent of the total demand.

Comparing wastewater flows to total water consumption is another useful method to assess overall outdoor water use. Since wastewater flow represents indoor water use that flows into the sanitary sewer system, the difference between total water consumption and wastewater flows represents outdoor water use. However, groundwater infiltration and wet weather runoff may also enter sanitary sewer systems through cracks and/or leaks in the sanitary sewer pipes or manholes and results in overestimation of indoor water use. To minimize overestimation, only data from summer months were used to estimate average monthly wastewater attributable to indoor water use. In Los Angeles, the summer months typically have little or no measurable rainfall. Using the same pre-water restriction period of 2004-2007 selected in the first method, the average monthly wastewater flow (only the months of June through September) yields approximately 365 million gallons per day (MGD) or 403,000 AFY of estimated indoor water use. Subtracting this estimated indoor water use from the total water consumption of 647,000 AFY results in an estimated total outdoor demand of 244,000 AFY or 38 percent, which is similar to the 39 percent obtained with the landscape irrigation method. Therefore, two entirely different methods produced very similar results in estimating the total outdoor water use for the City.

To obtain an estimate of indoor vs. outdoor water use for each major billing category, a minimum-month method was used. Monthly water use for single-family, multifamily, commercial, industrial, and government was obtained for 2004-2007. The water use in the minimum month, usually one of the cool/wet winter months, is assumed to be mostly indoor use. The difference between any month and the minimum month is all attributed to outdoor water use. However, based on the two prior methods, a certain amount of outdoor water use occurs even in the minimum month. Therefore, estimates of the outdoor water use that occurs in the minimum month were developed for each major billing category. Then the outdoor use of each major billing category was summed up to compare with the total outdoor water use obtained from the previous two methods. Exhibit 2D presents the estimated indoor and outdoor water use for the City using all three methods.

Exhibit 2D Indoor vs. Outdoor Water Use in LADWP's Service Area

Outdoor Use
Indoor Use



2.2 Quantification of Historical Water Conservation

LADWP has invested hundreds of millions of dollars in water conservation since 1990. These conservation investments include various active programs such as high efficiency toilet rebates, commercial/industrial water audits, education and public outreach, and much more. During periods of water shortage, public education and outreach are especially important and has contributed to significant reductions in water use. In an effort to quantify its water conservation efforts, LADWP developed a statistical Conservation Model that correlates total monthly water use in the City with population, weather, the presence of mandatory water conservation, and economic recessions. The model can be used to predict what the water demand would be under actual weather conditions, population growth and economy, but without active or drought water conservation in place. This modeled water consumption without conservation is then compared to actual water consumption—with the difference being attributed to water conservation. In order to assess the model's accuracy, the model was used to "back cast" the period from 1980 to 1990 when conservation was not implemented. In this case, the modeled water consumption was very close to the actual water consumption. After 1990, it was expected that the modeled water consumption will be greater than actual water consumption as LADWP has implemented increasing levels of water conservation measures. Exhibit 2E presents modeled and actual monthly water consumption from 1980 to 2009. As seen, the Conservation Model is performing as expected. The modeled water consumption (red line) is nearly identical to the actual water consumption (blue line) up until 1990. After 1990, the modeled water consumption is greater than actual water consumption.

Exhibit 2F summarizes the annual estimated water conservation using the Conservation Model. During periods of

Exhibit 2E
Modeled vs. Actual Monthly Water Consumption for LADWP

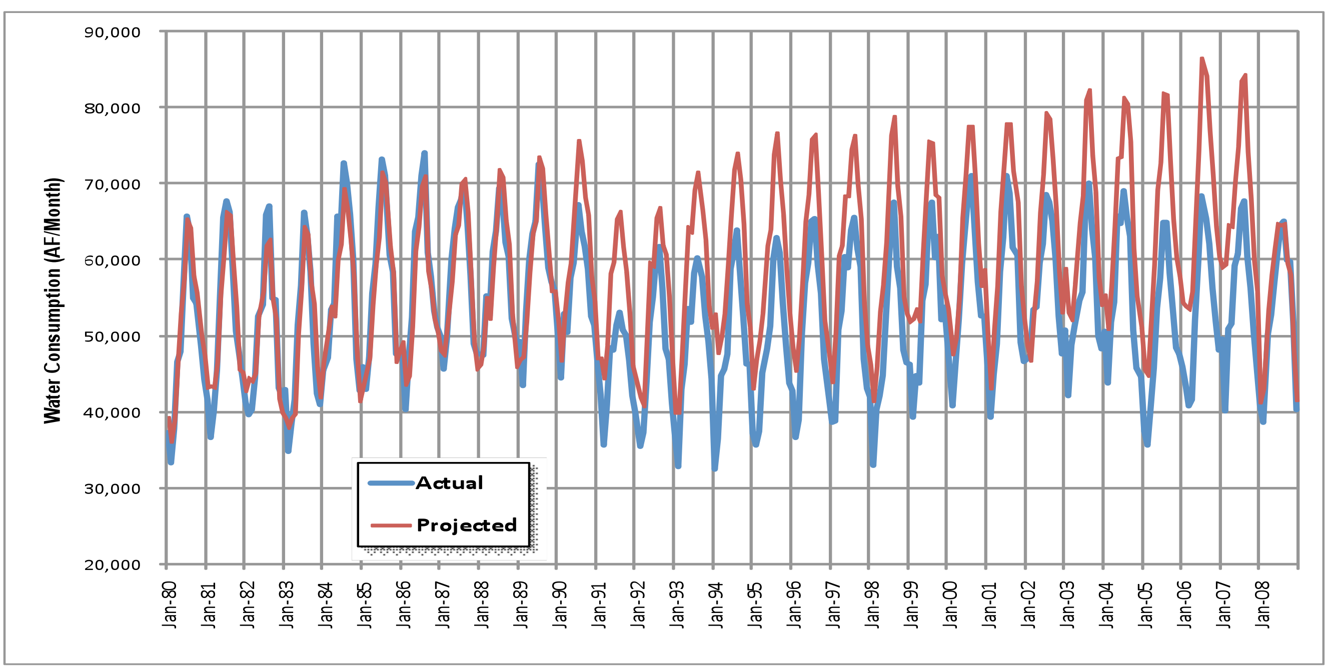
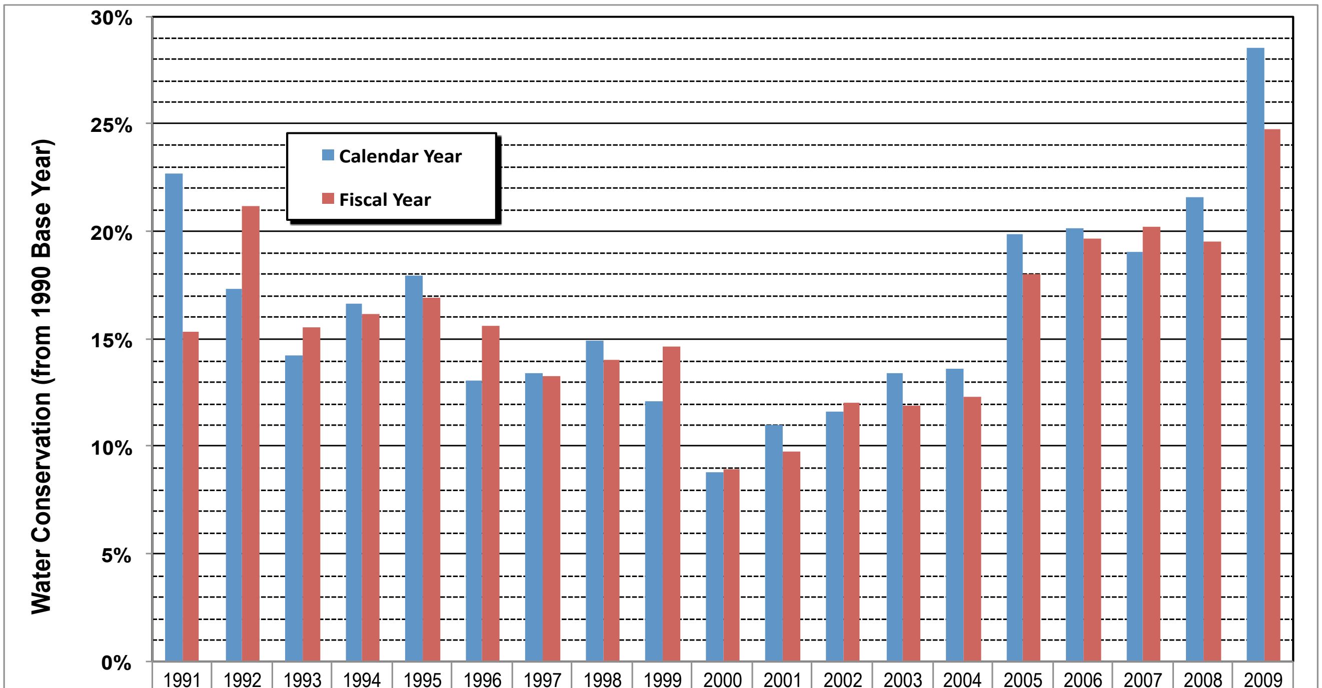


Exhibit 2F
Estimates of Total Water Conservation in LADWP's Service Area



	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Calendar Year	23%	17%	14%	17%	18%	13%	13%	15%	12%	9%	11%	12%	13%	14%	20%	20%	19%	22%	29%
Fiscal Year	15%	21%	16%	16%	17%	16%	13%	14%	15%	9%	10%	12%	12%	12%	18%	20%	20%	20%	25%

water shortage, even when mandatory water conservation is not in place, there is more conservation occurring due to extensive public education and outreach. Water conservation in 2009 represents the highest levels of conservation so far, which reflects a combination of active conservation programs, heightened public education and outreach, and mandatory conservation measures.

2.3 Water Demand Forecast

Demand Forecast Methodology

LADWP has developed a water demand forecast for each of its major categories of demand. This allows the City to better understand trends in water use and target conservation programs. The methodology used for the demand forecast is called a modified unit use approach. The following steps are used in this approach:

Step 1: Estimate baseline per unit water use – take each billed category of water demand (e.g., single-family, industrial, etc.) for a base (or starting) period and divide by associated demographic driver (e.g., number of single-family homes or number of industrial employees). This yields for instance, a baseline of 359 gallons used each day in a single-family residence.

Step 2: Modify the estimated baseline per unit water use to account for future changes in the following socioeconomic variables: price of water, personal income, family size, economy, drought conservation effect, and passive water conservation (which accounts for efficiencies in water use from state and local plumbing codes and ordinances).

Step 3: Multiply modified per unit water use for each category in Step 2 by the associated projected

Exhibit 2G
Projected Demographic Drivers
(Based on MWD allocated 2008 SCAG forecast data with corrected service area boundary, 5-17-2010)

Fiscal Year Ending	Single-Family (# Homes)	Multi-Family (# Homes)	Commercial/ Government (# Employees)	Industrial (# Employees)	Landscaping (# of MF Homes)	Non-Revenue Water* (%)
2010	627,395	764,402	1,674,032	163,382	764,402	6.9%
2015	646,067	804,013	1,724,106	157,652	804,013	6.9%
2020	665,261	846,257	1,754,998	155,012	846,257	6.9%
2025	678,956	880,580	1,790,798	152,426	880,580	6.9%
2030	691,703	914,125	1,828,765	150,009	914,125	6.9%
2035	701,101	942,846	1,865,156	147,508	942,846	6.9%

* Calculated from difference between historical production and billing data

demographic drivers (see Exhibit 2G) in order to obtain projected water demands by billed category that does not include active water conservation (which is defined as conservation achieved through LADWP incentives such as rebates and programs).

Step 4: Estimate non-revenue water (the difference between total water consumption and billed water use) by applying a non-revenue water use factor, and add non-revenue water to the billed category water demands in Step 3 in order to get a forecast of total water consumption without active water conservation.

Step 5: Subtract future projections of active water conservation from the total water consumption in Step 4 in order to determine the water demand forecast that is fully inclusive of both passive and active water conservation.

Applying the Methodology

In Step 1 of this method, historical water demands for single-family, multifamily, commercial/government, and industrial were averaged from 2005 to 2008 to determine the baseline. This period was used because on average, it represented normal weather conditions, and it was before mandatory outdoor water use restrictions were in effect. For each of these categories, the water demand was divided by a demographic driver that could be projected into the future. The result of this calculation is a water demand expressed as a unit water use rate. Exhibit 2H presents this unit use calculation for the baseline.

Step 2 in the methodology involves modifying these baseline unit use rates to account for changes in the following socioeconomic variables: price of water, personal income, family size, economy, drought conservation effect, and passive water conservation. MWD has developed an Econometric Water Demand Model as part of its 2010 Integrated Water Resources Plan that is able to account for the impact that personal income, family

Exhibit 2H
Baseline Unit Water Use Rates (2005-2008)
Source: California Department of Finance and Employment Development Department

Demand Category	Average Water Demand (AFY)	Average Demographic Driver *	Average Unit Use Rate (gal-lons/day/driver)
Single-Family	244,407	607,301 (homes)	359
Multifamily	184,428	734,461 (homes)	224
Commercial/Gov	153,199	1,631,896 (employees)	84
Industrial	23,613	160,328 (employees)	132

size, and price of water have on water demands. For each of these factors, a statistical coefficient or elasticity was estimated from MWD's Econometric Water Demand. The elasticity is generally interpreted as a percent change in water use resulting from a percent change in a specific socioeconomic variable. For example, a price elasticity of -0.131 would imply that a 10 percent increase in the real price of water would result in a 1.24 percent decrease in water demand (e.g. $1.24\% = 1-(1+10\%)^{-0.131}$). The following elasticities used in MWD's Econometric Water Demand Model were also used for LADWP's water demand forecast:

	Price of Water	Income	Family Size
Single-Family	-0.131	+0.270	+0.550
Multifamily	-0.109	+0.310	+0.450
Commercial/ Government	-0.107		
Industrial	-0.107		

Source: MWD 2010 Integrated Water Resources Plan Update Appendix A.2 Demand Projections

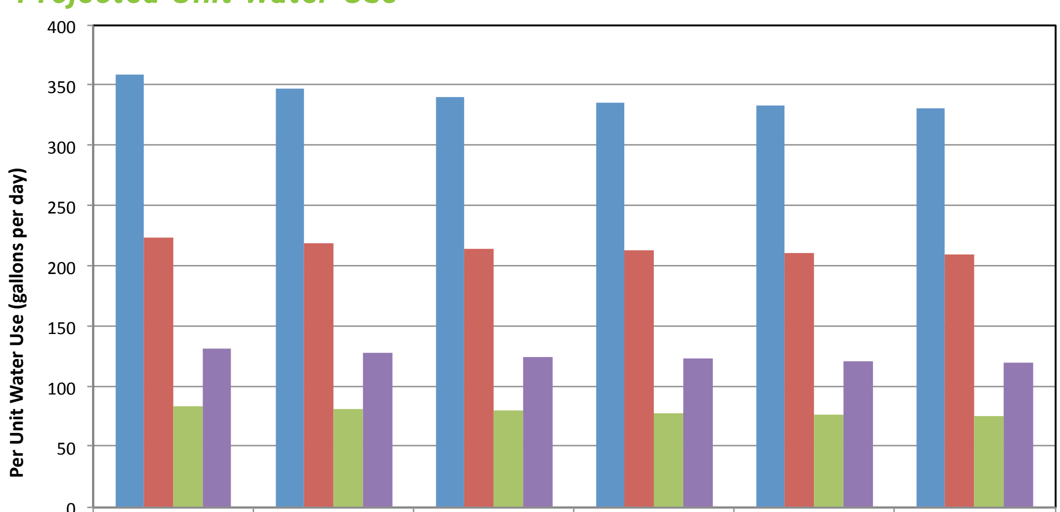
The price elasticities reflect a reduction of approximately 1/3 from those tabulated in MWD's 2010 IRP. However, MWD's 2010 IRP Appendix A.1 states that consumers respond to price increase by installing water-conserving fixtures and appliances. As more water efficient fixtures are installed, the impact of changing water-using behavior through rates is reduced. This is known as "demand hardening". Reducing price elasticity is done to avoid double-counting conservation savings and to account for demand hardening.

Exhibit 2I presents the modified per unit water use over time that incorporates future real increases in the price of water, personal income, and projected changes in family size. Also incorporated are the residual drought conservation effect from the significant public education and mandatory water use restrictions that occurred during the drought period of 2009 through 2010, and the effect of passive conservation due to mandated efficiencies from plumbing codes and ordinances.

Water Demand Forecast Results

Steps 3, 4, and 5 involve applying the modified per unit water use factors shown in Exhibit 2J to the projected demographics for LADWP (see Chapter 1), then adding non-revenue water, and subtracting projected active water conservation (that is summarized in Chapter 3). The result of these steps is the water demand forecast for each of the major categories of demand.

Exhibit 2I
Projected Unit Water Use



	Baseline	2015	2020	2025	2030	2035
Single-Family (per home)	359	348	340	336	333	331
Multifamily (per home)	224	219	215	213	211	210
Commercial (per employee)	84	81	80	78	77	76
Industrial (per employee)	132	128	125	123	121	120

Exhibit 2J
Water Demand Forecast and Conservation Savings Under Average Weather
Fiscal Year Ending June 30 (Acre-Feet)

Demand Forecast with Passive Water Conservation	2005	2010	2015	2020	2025	2030	2035
Single-Family		198,444	229,115	241,976	249,528	257,693	259,904
Multifamily		167,299	179,653	194,724	205,136	216,054	221,912
Commercial/Gov		135,000	143,081	149,597	153,791	158,628	160,049
Industrial		20,298	20,524	20,726	20,532	20,408	19,852
Non-Revenue		33,515	42,421	44,989	46,617	48,380	49,042
Total		554,556	614,794	652,012	675,604	701,164	710,760
Demand Forecast with Passive & Active Water Conservation	**2005 Actual**	**2010 Actual**	**2015**	**2020**	**2025**	**2030**	**2035**
Single-Family	233,192	196,500	225,699	236,094	241,180	246,879	247,655
Multifamily	185,536	166,810	178,782	193,220	202,999	213,284	218,762
Commercial/Gov	107,414	130,386	135,112	133,597	129,761	126,567	120,420
Industrial	62,418	19,166	18,600	16,852	14,708	12,634	10,513
Non-Revenue	26,786	32,909	41,370	42,969	43,627	44,421	44,272
Total	615,346	545,771	599,563	622,732	632,275	643,785	641,622
Aggregate Active Water Conservation Savings From Jul 07	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Single-Family		1,944	3,416	5,882	8,349	10,815	12,249
Multifamily		489	871	1,504	2,137	2,770	3,150
Commercial/Gov		4,614	7,969	16,000	24,030	32,061	39,629
Industrial		1,132	1,924	3,874	5,824	7,774	9,339
Non-Revenue		606	1,051	2,020	2,990	3,959	4,771
Total		**8,785**	**15,231**	**29,280**	**43,329**	**57,379**	**69,138**

* Non-revenue is the combination of unaccounted water and accounted non-revenue water. Unaccounted water is defined as system losses. In recent years, the City experienced no accounted non-revenue water. Thus, non-revenue water is considered system loss.

Water Demand Forecast with Average Weather Variability

Using the weather coefficients from the statistical water conservation model (see Exhibit 2E), annual weather adjustment factors can be derived to determine the range in forecasted water demands due to historical weather variability. This is accomplished by projecting water demands assuming long-term normal weather, and then comparing this normal-weather demand to actual demands. After adjusting for economy and drought conditions, projected water demands can vary by approximately ± 5 percent in any given year due to average historical weather variability. This means that water demands under cool/wet weather conditions could be as much as 5 percent lower than normal demands on average; while water demands under hot/dry

Exhibit 2K
Water Demand Forecast with Average Weather Variability

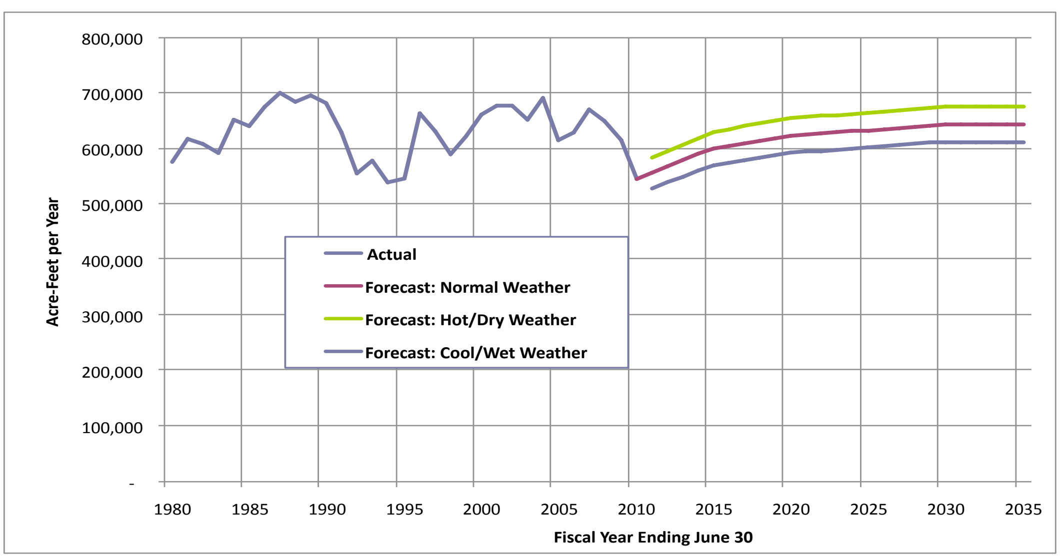


Exhibit 2L
Water Demand Forecast for Low-Income Residential Customers
Fiscal Year Ending June 30

Low-Income Single-Family Customers	2015	2020	2025	2030	2035
Number of Homes	42,640	43,907	44,811	45,652	46,273
Household Water Use (Gallons/Day)*	250	253	254	255	252
Demand Forecast (Acre-Feet/Year)	11,917	12,466	12,734	13,035	13,076
Low-Income Multifamily Customers	**2015**	**2020**	**2025**	**2030**	**2035**
Number of Homes	131,054	137,940	143,535	149,002	153,684
Household Water Use (Gallons/Day)*	159	163	165	167	166
Demand Forecast (Acre-Feet/Year)	23,313	25,196	26,471	27,812	28,527
Total Low-Income Residential Customers	**2015**	**2020**	**2025**	**2030**	**2035**
Demand Forecast (Acre-Feet/Year)	35,230	37,662	39,205	40,847	41,603

* Assumes same percent conservation as system for single-family and multifamily homes.

weather conditions could be as much as 5 percent higher than normal demands on average. Exhibit 2K presents LADWP's historical and forecasted total water demands with both passive and active conservation, under the full range of historical weather variability.

Low-Income Water Demand Projections

The requirements for the 2010 UWMP call for projections of water demands for low-income customers. For rate relief purposes, LADWP maintains records of low-income water customers. For the FY 2009/10, approximately 6.6 percent of the total number of single-family homes in the City was classified as low-income. On average, these customers used about 20 percent less water per household than overall single-family customers. To forecast low-income single-family water demand, the 6.6 percent ratio of low-income to total single-family homes was applied to determine the total number of low-income single family homes. The system wide per unit water use for single-family homes was reduced by 20 percent and multiplied by the total number of low-income single-family homes to determine low-income single-family water demand.

Because the water services of multifamily residential customers are typically not individually metered, a multifamily water account can represent upwards of 100 homes. Therefore, a different approach was used. LADWP's power system does individually meter multifamily homes and also classifies homes as low-income for rate relief purposes. Therefore, the ratio of current low-income to total multifamily homes in the City was applied to the total projection of multifamily homes in order to project the total number of low-income multifamily homes. For the FY 2009 /10, approximately 16.3 percent of the total number of multifamily homes in the City were classified as low-income. Assuming that low-income multifamily homes also use 20 percent less water than overall multifamily homes, an adjusted per unit water use for multifamily homes was multiplied by the projected number of low-income multifamily homes to determine low-income multifamily water demand. Exhibit 2L presents the water demand forecast for low-income residential water customers.

Chapter Three

Water Conservation

3.0 Overview

Multiple factors are increasingly restricting LADWP's traditional water supply sources. The City of Los Angeles has long recognized water conservation as the core of multiple strategies to improve overall water supply reliability. In May of 2008, LADWP's Water Supply Action Plan, "Securing L.A.'s Water Supply", was released in response to factors impacting LADWP's major water supply sources beginning in 2007. The Water Supply Action Plan calls for reducing potable water demands by an additional 50,000 AFY by 2030 through conservation, incorporating multiple conservation strategies to increase the sustainability of LADWP's water supply. Additional conservation efforts will increase this total to 64,368 AFY by 2035.

Los Angeles has historically taken a leadership role in managing its demand for water. Los Angeles consistently ranks among the lowest in per person water consumption when compared to California's largest cities. This significant accomplishment has resulted from the City's sustained implementation of effective water conservation programs since the 1980s.

One of LADWP's most effective conservation tools is the sustained conservation ethic of its customers. During past droughts and water shortages, residents and businesses have aggressively implemented additional conservation to achieve demand reductions. During FY 09/10, water use was below 1979 water use levels thanks to extraordinary conservation efforts by LADWP customers. Specifically, water use in FY 09/10 was almost 20 percent lower than water use in FY 06/07 with single-family residential water use 25 percent lower, multi-family water use 11 percent lower, commercial water use 16 percent lower, industrial water use 15 percent lower, and governmental water use 33 percent lower.

LADWP has continually invested in water conservation programs and measures targeting cost-effective reductions in water use. Looking forward, LADWP plans to continue to make investments in conservation programs and expand its focus on landscape water use efficiency and conservation opportunities in the commercial/industrial/institutional (CII) customer sectors. LADWP's conservation planning process includes working with other City departments to ensure that mutual needs are addressed and goals are achieved (e.g., landscape water use efficiency and dry weather runoff reduction).

The civic cultural ethic of water conservation in Los Angeles began with the installation of water meters on all services in the early 1900's. At that time, this foundational conservation measure resulted in a 30 percent reduction in water use. During the recurrence of periodic water shortages, LADWP customers have demonstrated concern and responsiveness to the need for additional conservation. When faced with significant supply shortages, City residents have responded with unprecedented reductions in their water use. Los Angeles was one of the first cities in southern California to invoke mandatory water rationing during the 1976 through 1977 drought. While severe, this two-year dry period resulted in only a temporary reduction in water use, as a subsequent series of wet years erased memories of the water shortage experienced during the brief dry period. However, it was the multiple dry years that followed the 1978 through 1986 wet cycle that would prove to be the turning point in Los Angeles' water use efficiency.

The dry years of 1987-1992 left a permanent imprint on Los Angeles water customers. In response to this water shortage, LADWP expanded its voluntary water conservation program. Prompted by an extensive public awareness program and education campaign, LADWP customers responded not only with water saving practices but also by installing conservation measures in their homes and businesses. Devices such as low-flow showerheads and ultra-low-flush (ULF) toilets replaced existing high water use devices. These hardware changes, coupled with more efficient use habits, have significantly reduced the amount of imported water that the City would need to buy as its population and commerce

Exhibit 3A
Historical City of Los Angeles Water Use

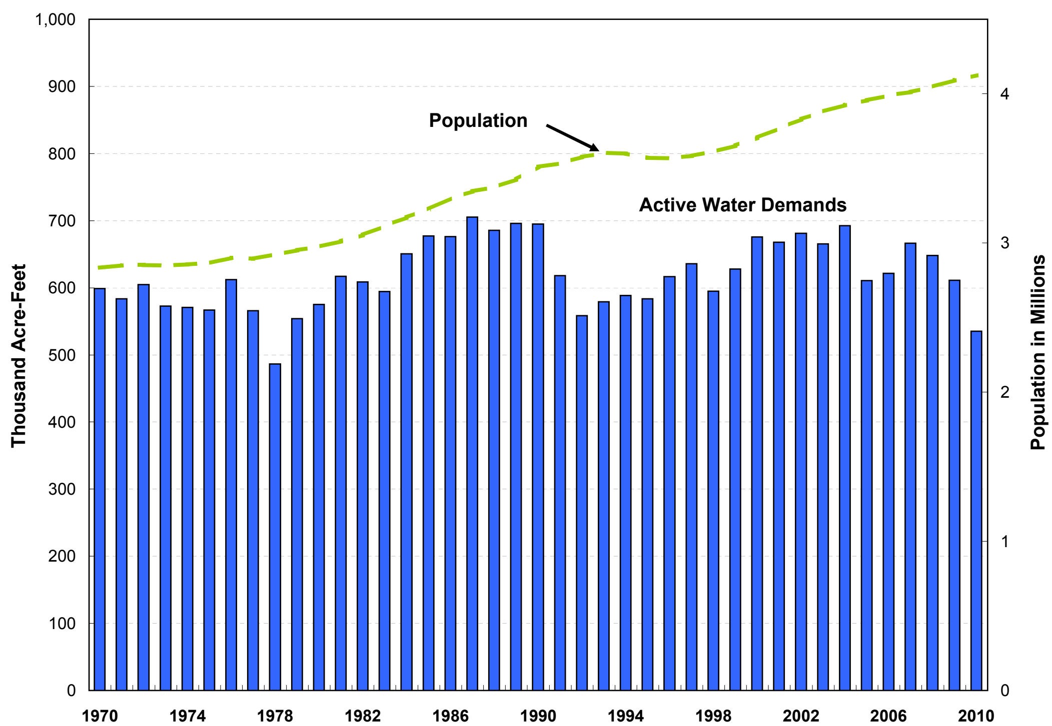


Exhibit 3B
Historical City of Los Angeles Conservation

Fiscal Year	Additional Annual Hardware Installed Savings (AF)	Cumulative Annual Hardware Savings (AF)	Annual Non-Hardware Savings (AF)[1]	Annual Total Savings (AF)
Prior to 1990/1991	31,825	31,825		
1990/1991	4,091	35,916	76,350	112,267
1991/1992	8,670	44,586	105,593	150,179
1992/1993	3,286	47,872	58,546	106,417
1993/1994	4,961	52,832	60,928	113,761
1994/1995	4,041	56,873	62,084	118,958
1995/1996	4,642	61,516	52,648	114,164
1996/1997	2,376	63,892	33,720	97,612
1997/1998	2,637	66,529	30,434	96,964
1998/1999	2,781	69,310	38,305	107,614
1999/2000	3,532	72,842	-6,262	66,580
2000/2001	3,078	75,920	-3,407	72,513
2001/2002	2,452	78,371	15,131	93,502
2002/2003	2,630	81,002	8,725	89,726
2003/2004	3,257	84,259	13,107	97,366
2004/2005	3,299	87,558	46,865	134,423
2005/2006	2,404	89,963	62,223	152,186
2006/2007	2,095	92,058	76,643	168,701
2007/2008	782	92,840	64,472	157,312
2008/2009	3,127	95,967	106,151	202,118
2009/2010	4,269	100,236	126,466	226,702

1. Negative non-hardware savings are due to overestimation in hardware savings due to years with extreme wet weather conditions.

continued to grow. In response to current water shortage conditions the City reinitiated its extensive public awareness campaigns, in addition to campaigns launched by MWD, to encourage water saving practices and installation of conservation devices in homes and businesses.

As a result of mandatory conservation and reduced deliveries of imported water from MWD, residential customers have attained conservation levels exceeding 20 percent during the period between 2007 and 2010. In response to the current water supply shortage, the City has updated its Emergency Water Conservation Plan Ordinance's enforceable water waste provisions and mandatory outdoor watering restrictions. In addition, the City has implemented water shortage year rates reducing Tier 1 water allotments for customers by 15 percent. As a direct result of conservation, imported water purchases from MWD are 23 percent below baseline allocations for FY 2009/10. In response to recently enacted State laws, LADWP has developed new water conservation goals which aim to reach approximately 64,000 AFY in hardware conservation savings by 2035.

Conservation has had a tremendous impact on Los Angeles' water use patterns and has become a permanent part of LADWP's water management philosophy. The City's water usage in 2010 was less than 1979 despite an increase in population of over 1,000,000 people (see Exhibit 3A). Exhibit 3B shows historical conservation savings from FY 1990/91 through FY 2009/10 based on installation of conservation devices subsidized through rebates and incentives. Cumulative annual hardware savings since the inception of LADWP's conservation program totals 100,236 AFY. Additional conservation was achieved through changes in customer behavior and lifestyle changes.

Conservation benefits the City by improving water supply reliability and reducing embedded energy use for water treatment and pumping. Conserving customers see a tangible benefit as well through monetary savings on their water bill. Another ancillary benefit of conserving water is that the need for costly sewer facility expansions is deferred as wastewater discharge into the sewer collection and treatment systems is reduced, thus increasing the lifespan of current sewer infrastructure. Water conservation also has the added benefits of reducing greenhouse gas emissions and energy use. Delivering water supplies to and within the LADWP service area and heating water for showers, dishwashing, etc. all require large amounts of energy. In the end, the primary beneficiaries of conservation are the water customers and the environment where the supplies originate. Furthermore, increased conservation results in decreased dry weather runoff which decreases the amount of pollutants flowing into local rivers and the Pacific Ocean.

Los Angeles has been implementing permanent conservation since the 1980's. In 1988, the City adopted a plumbing retrofit ordinance to mandate the installation of conservation devices in all properties and to require water-efficient landscaping in all new construction. The ordinance was amended in 1998, requiring the installation of ULF toilets and water saving showerheads in single-family and multi-family residences prior to resale. A new ordinance adopted in 2009, the Water Efficiency Requirements ordinance, establishes water efficiency requirements for new developments and renovations of existing buildings by requiring installation of high efficiency plumbing fixtures in all residential and commercial buildings. LADWP's past water conservation programs have assisted customers affected by the ordinances by offering free ULF toilets and showerheads, free installation of ULF toilets, showerheads and faucet aerators, as well as rebates for ULF toilets purchased and installed. Current water conservation programs co-sponsored by MWD through the SoCal Water$mart Program for residential customers and the Save Water Save a Buck Program for CII customers continue to assist customers in complying with ordinances and reducing overall water demands.

3.1 Water Conservation Goals

Water conservation reduces demand that typically rises over time with growth in population and commerce. By mitigating those increases in demand, water supply reliability is improved while costs are reduced. In the early 1990s, City residents responded with conservation levels exceeding 20 percent due to increasingly drier conditions and mandatory conservation. As normal water supply conditions returned and with continuation of LADWP's conservation program, conservation levels stabilized at approximately 15 percent. With the recent water shortage and reduced deliveries of imported water from MWD, residential customers have repeated conservation levels exceeding 20 percent in the period between 2007 and 2010 as a result of mandatory conservation. From July 2007 through February 2011, 90.6 billion gallons of water were saved through conservation. As a direct result of conservation, imported water purchases from MWD are 23 percent below baseline allocations for FY 2009/10. In response to the goals provided in the Plan and recently enacted State laws, LADWP has developed numerous water conservation programs.

3.1.1 Water Supply Action Plan Conservation Goal

To continue increased conservation levels once mandatory outdoor watering restrictions are lifted, LADWP has set a water conservation goal in the Water Supply Action Plan of reducing potable water demands by an additional 50,000 AFY by 2030. This conservation level will further lessen the City's reliance on imported water while providing a drought-proof resource that is not subject to weather conditions. This aggressive approach includes multiple strategies: investments in state-of-the-art technology; a combination of rebates and incentives promoting installation of weather-based irrigation controllers (WBICs), efficient clothes washers and urinals; expansion and enforcement of prohibited water uses; reductions in outdoor water use; extending education and outreach efforts; and encouraging regional conservation.

LADWP's commitment to conservation is a successful multi-faceted approach that includes tiered water pricing, education and awareness, financial incentives for the installation of a variety of conservation measures, free water saving showerheads, Technical Assistance Program (TAP) incentives for business and industry, and large landscape irrigation efficiency programs. Conservation is a foundational component of LADWP's water resource planning efforts and will continue to be over the long term.

3.1.2 Water Conservation Act of 2009

The Water Conservation Act of 2009, Senate Bill x7-7, requires water agencies to reduce per capita water use by 20 percent by 2020 (20x2020). This includes increasing recycled water use to offset potable water use. Water suppliers are required to set a water use target for 2020 and an interim target for 2015 using one of four methods. The 2020 urban water use target may be updated in a supplier's 2015 UWMP. Failure to meet adopted targets will result in the ineligibility of a water supplier to receive water grants or loans administered by the State unless one of two exceptions is met. Exception one states a water supplier may be eligible if they have submitted a schedule, financing plan, and budget to Department of Water Resources (DWR) for approval to achieve the per capita water use reductions. Exception two states a water supplier may be eligible if an entire water service area qualifies as a disadvantaged community.

Four methodologies are stipulated for calculating the water use target. Three of the methods are listed in Water Code § 10608.20(a)(1). The fourth method was developed by DWR. The four methodologies are:

- Method 1 – Eighty percent of the water supplier's baseline per capita water use.

- Method 2 – Per capita daily water use estimated using the sum of performance standards applied to indoor residential water use, landscape area water use, and commercial, industrial, and institutional water uses.

- Method 3 – Ninety-five percent of the applicable State hydrologic region target as stated in the State's *draft 20x2020 Water Conservation Plan*.

- Method 4 – Developed through public process. This method allows flexibility in its calculation to account for the highly diverse conditions of each agency's landscape, commercial, industrial, and institutional water needs and to give credit for past conservation efforts. For more information please go to: http://www.water.ca.gov/wateruseefficiency/sb7/committees/urban/u4/

Exhibit 3C 20x2020 Base and Target Data

20x2020 Required Data	Gallons Per Capita Per Day (GPCD)
Base Per Capita Daily Water Use	
10-Year Average[1]	152
5-Year Average[2]	145
2020 Target Using Method 3[3]	
95% of Hydrologic Region Target (149 gpcd)	142
95% Of Base Daily Capita Water Use 5-Year Average (145 gpcd)	138
Actual 2020 Target	138
2015 Interim Target	145

1. Ten-year average based on fiscal year 1995/96 to 2004/05
2. Five-year average based on fiscal year 2003/04 to 2007/08
3. Methodology requires smaller of two results to be actual water use target to satisfy minimum water use target.

In 2015, urban retail water suppliers will be required to report interim compliance followed by actual compliance in 2020. Interim compliance is halfway between the baseline water use and 2020 target. Baseline, target, and compliance-year water use estimates are required to be reported in gallons per capita per day (gpcd).

For consistent application of the Act, DWR produced Methodologies for Calculating Baseline and Compliance Urban Water Per Capita Use in October 2010. By following requirements provided in this document, LADWP has calculated its baseline per capita water use, its urban use target for 2020, and its interim water use target for 2015. Reporting compliance with daily per capita water use targets is not required until the 2015 UWMP cycle as it compares the interim target to actual water use in 2015. Exhibit 3C presents results of the calculations. Calculations and the technical bases for each calculation are presented in Appendix G. LADWP's baseline per capita water use is 152 gpcd using a ten-year average ending between December 31, 2004 and December 31, 2009 and 145 gpcd using a five-year average ending between December 31, 2007 and December 31, 2009.

LADWP has selected Method 3 to set its 2015 interim and 2020 water use targets. LADWP investigated all four methods and selected Method 3 because it is the most straightforward and reliable calculation method that adequately accounts for the City's past conservation investments.

Method 3 requires setting the 2020 water use target to 95 percent of the applicable State hydrologic region target as provided in the State's Draft 20x2020 Water Conservation Plan. LADWP is within State hydrologic region 4, the South Coast region. LADWP was required to further adjust the calculated 2020 target to achieve a minimum reduction in water use. The gpcd at 95 percent of the hydrologic region was 142 gpcd and using 95 percent of the five-year average base daily per capita water use was equal to 138 gpcd. Therefore, LADWP was required to set its 2020 target at the smaller of the two resultant values. LADWP's interim 2015 target is 145 gpcd and LADWP's 2020 target is 138 gpcd.

3.2 Existing Programs, Practices, and Technology to Achieve Water Conservation

LADWP has developed a number of progressive water conservation programs to address recently enacted State laws and to meet its goal of achieving an additional 50,000 AFY conservation by 2030. LADWP uses multiple programs, practices, and technologies in conjunction with enactment of State and local conservation ordinances and plumbing code modifications to achieve its current water conservation levels throughout its service area and customer classes.

3.2.1 State Laws and City Ordinances

State Laws

In addition to the Water Conservation Act of 2009 multiple legislative bills have been enacted in the past few years requiring water agencies to enact measures to increase water conservation, establishing new plumbing standards, and linking grants and loans to implementation of best management practices (BMPs).

The Water Conservation in Landscaping Act of 2006, Assembly Bill 1881, reduces outdoor water waste through improvements in irrigation efficiency and selection of plants requiring less water. The Act required an update to the existing Model Water Efficient Landscape Ordinance and adoption of this ordinance or an equivalent ordinance by local agencies no later than January 1, 2010. If any agency failed to adopt the ordinance or its equivalent, then the Model Water Efficient Landscape Ordinance was automatically mandated by statute. The ordinance requires development of water budgets for landscaping, reduction of erosion and irrigation related runoff, utilization of recycled water if available, irrigation audits, development of requirements for landscape and irrigation design, and scheduling of irrigation based on localized climate for new construction and redevelopment projects.

In 2009, Assembly Bill 1465, Urban Water Management Planning, was approved to include language in the UWMP Act requiring water suppliers that are members of the California Urban Water Conservation Council (CUWCC) and comply with its "Memorandum of Understanding Regarding Urban Water Conservation in California (MOU)" to describe their water demand management measures in their respective UWMPs. A more detailed discussion of the CUWCC and BMP compliance is provided in Section 3.2.3.

Assembly Bill 1420 links state funding for water management by urban water suppliers to implementation of water conservation measures. Urban water suppliers are required to be in compliance with the CUWCC MOU to be eligible for water management grants or loans. Senate Bill X7-7 further clarifies that the grant funding conditions required by AB 1420 will be repealed as of July 1, 2016 and replaced with eligibility determined by compliance with 20x2020 targets.

In the recent years, there have been numerous regulations approved that increase the water use efficiency requirements of plumbing devices, specifically, Assembly Bill 715 (2007), Senate Bill 407 (2009), and the CALGreen Building Standards. AB 716 requires that all toilet and urinal fixtures sold through retail or installed in existing and new residential and commercial building meet the high efficiency standards by January 1, 2014. SB 407 does not address the sale of plumbing fixtures but adds a requirement that beginning in January 1, 2017 all residential and commercial property sales must disclose all non-efficient plumbing fixtures. CALGreen has an effective date of January 1, 2011 and requires use of water efficient plumbing fixtures for all new construction and renovations of residential and commercial properties.

City Ordinances

Los Angeles has utilized ordinances as a tool to reduce water waste since 1988, beginning with the adoption of its first version of a plumbing retrofit ordinance. The ordinance mandated installation of conservation devices in all existing residential and commercial properties and installation of water-efficient landscaping in all new construction. Toilets were required to use less than 3.5 gallons per flush (gpf), urinals less than 1.5 gpf, and showerheads less than 2.5 gallons per minute (gpm). Customers with three acres or more of turf were required to reduce water consumption by 10 percent from 1986 levels or face a 100 percent surcharge on their water bills.

Exhibit 3D Water Efficiency Requirements Ordinance Summary

Device	Requirement
High Efficiency Toilets	1.28 gallons per flush
Urinals	0.125 gallons per flush
Faucets	
Indoor Faucets (Maximum)	2.2 gallons per minute
Private Lavatory Faucets	1.5 gallons per minute
Public Use Lavatory Faucets[1]	0.5 gallons per minute
Pre-rinse Spray Valve	1.6 gallons per minute
Showerheads	2.0 gallons per minute
Dishwashers	
Commercial Dishwashers	varies by type between 0.62 and 1.16 maximum gallons per rack
Domestic Dishwashers	5.8 gallons per cycle
Cooling Towers	5.5 cycles of concentration
Single-Pass Cooling Systems	Prohibited[2]

1. Metering faucets shall not deliver more than 0.25 gallons per cycle.
2. Single pass cooling systems are prohibited unless installed for health and safety purposes that cannot otherwise safely operate.

In 1998 the ordinance was amended, requiring the installation of ULF toilets and water saving showerheads in single-family and multi-family residences prior to the close of escrow. This progressive requirement is implemented with the help of local real estate professionals. LADWP has explored the expansion of the City's Retrofit on Resale Ordinance to include nonresidential properties.

Los Angeles further increased its water efficiency mandates in 2009 with adoption of the Water Efficiency Requirements Ordinance. This ordinance establishes water efficiency requirements for new developments and renovations of existing buildings by requiring installation of high efficiency plumbing fixtures in all residential and commercial buildings. Exhibit 3D summarizes the minimum requirements for new construction and replacement of fixtures in existing buildings.

In an effort to lead by example, LADWP has been retrofitting all its facilities with high efficiency plumbing fixtures since before the effective dates of the ordinance. As of early June 2010, LADWP is 57 percent complete in upgrading its 600 buildings to high efficiency faucets, toilets, urinals, showers, flexible hose connectors, angle valves, as well as correcting leaks and removing existing water damage.

In May 1996, the City's Landscape Ordinance (No. 170,978) became effective with an overarching goal to improve the efficient use of outdoor water. This ordinance was recently amended in 2009 to comply with the previously discussed Water Conservation in Landscaping Act of 2006 and the Model Water Efficient Landscape Ordinance.

LADWP first adopted an Emergency Water Conservation Plan Ordinance in the early 1990's in response to drought conditions. Subsequently in the current water shortage LADWP has adopted two amendments expanding prohibited uses, increasing penalties for violating the ordinance, and modifying water conservation requirements. Five phases of water conservation are incorporated into the plan with prohibitions and water conservation measures steadily increasing by phase. Regardless of water supply availability Phase I conservation requirements are in effect permanently unless a more stringent phase is in effect. In response to the ongoing water shortage conditions, LADWP implemented Phase III restrictions on June 1, 2009, restricting outdoor irrigation to two days per week. Following an ordinance amendment, Phase II implementation began on August 25, 2010 which allows outdoor watering three days per week. Exhibit 3E summarizes the five phases as defined in the latest amendment approved August 25, 2010.

Exhibit 3E
Emergency Water Conservation Plan Ordinance Restrictions by Phase

Phase	Restrictions
I	No use of a water hose to wash paved surfaces
	No use of water to clean, fill, or maintain levels in decorative fountains, ponds, lakes or similar structures used for aesthetic purposes unless a recirculating system is used
	No drinking water shall be served unless expressly requested in restaurants, hotels, cafes, cafeterias, or other public places where food is sold, served, or offered for sale
	No leaks from any pipes or fixtures on a customer's premises; failure or refusal to fix leak in a timely manner shall subject the customer penalties for a prohibited use of water
	No washing vehicles with a hose if the hose does not have a self-closing water shut-off device attached or the hose is allowed to run continuously while washing a vehicle
	No irrigation during rain
	No irrigation between 9am and 4pm, except for public and private golf courses and professional sports fields to maintain play areas and event schedules. System testing and repair is allowed if signage is displayed.
	All irrigation of landscape with potable water using spray head and bubblers shall be limited to no more than ten minutes per water day per station. All irrigation of landscape with potable water using standard rotors and multi-stream rotary heads shall be limited to no more than 15 minutes per cycle and up to 2 cycles per water day per station. Exempt from these restrictions are irrigation systems using very low-flow drip-type irrigation when no emitter produces more than 4 gallons of water per hour and micro-sprinklers using less than 14 gallons per hour. This restriction does not apply to Schedule F water customers or water service that has been granted the General Provision M rate adjustment under the City's Water Rate Ordinance, subject to the customer having complied with best management practices for irrigation approved by LADWP.
	No watering or irrigation of any lawn, landscape, or other vegetated area shall occur in a manner that causes or allows excess or continuous water flow or runoff onto an adjoining sidewalk, driveway, street, gutter, or ditch.
	No installation of single-pass cooling systems shall be permitted in buildings requesting new water service.
	No installation of non-recirculating systems shall be permitted in new conveyor car wash and new commercial laundry systems.
	Operators of hotels and motels shall provide guests with the option of choosing not to have towels and linens laundered daily.
	No large landscape areas shall have irrigation systems without rain sensors that shut off the irrigation systems.
II	All prohibited uses in Phase 1 shall apply, except as provided.
	No landscape irrigation shall be permitted on any day other than Monday, Wednesday, or Friday for odd-numbered street address and Tuesday, Thursday, or Sunday for even-numbered street addresses. If a street address ends in 1/2 or any fraction it shall conform to the permitted uses for the last whole number in the address. For non-conserving nozzles (spray head sprinklers and bubblers) watering times shall be limited to no more than 8 minutes per watering day per station for a total of 24 minutes per week. For conserving nozzles (standard rotors and multi-stream rotary heads watering times shall be limited to no more than 15 minutes per cycle and up to two cycles per watering day per station for a total of 90 minutes per week.
	Irrigation of sports fields may deviate from non-watering days to maintain play areas and accommodate event schedules with written notice from LADWP. However, a customer must reduce overall monthly water use by LADWP's Board of Water and Power Commissioners adopted degree of shortage plus an additional 5% from the customer baseline water usage within 30 days.
	If written notice is received from LADWP, large landscape areas may deviate from the non-watering days if the following requirements are met: 1) approved weather-based irrigation controllers registered with LADWP; 2) Must reduce overall monthly water use by LADWP's Board adopted degree of shortage plus and additional 5% from the customer baseline within 30 days; 3) Must use recycled water if available
	These restrictions do not apply to drip irrigation supplying water to a food source or to hand-held hose watering of vegetation, if the hose is equipped with a self-closing water shut-off device, which is allowed everyday during Phase II, except between the hours of 9am and 4pm.
III	All prohibited uses in Phases I and II shall apply, except as provided.
	No landscape irrigation shall be permitted on any day other than Monday for odd-numbered street address and Tuesday for even-numbered street addresses. If a street address ends in 1/2 or any fraction it shall conform to the permitted use for the last whole number in the address.
	No washing of vehicles allowed except at commercial car washes.
	No filling of residential swimming pools and spas with potable water.
	Irrigation of sports fields may deviate from non-watering days and be granted one additional watering days for a total of two watering days with written notice from LADWP. However, a customer reduce overall monthly water use by LADWP's Board of Water and Power Commissioners adopted degree of shortage plus an additional 10% from the customer baseline water usage within 30 days.
	If written notice is received from LADWP, large landscape areas may deviate from the non-watering days and be granted one extra day of watering for a total of 2 watering days if the following requirements are met: 1) approved weather-based irrigation controllers registered with LADWP; 2) Must reduce overall monthly water use by LADWP's Board adopted degree of shortage plus and additional 10% from the customer baseline within 30 days; 3) Must use recycled water if available
	These restrictions do not apply to drip irrigation supplying water to a food source or to hand-held hose watering of vegetation, if the hose is equipped with a self-closing water shut-off device, which is allowed everyday during Phase III, except between the hours of 9am and 4pm.
IV	All prohibited uses in Phases I, II, and III shall apply, except as provided.
	No landscape irrigation is allowed.
V	All prohibited uses in Phases I, II, III, and IV shall apply, except as provided.
	The LADWP Board of Water and Power Commissioners is authorized to implement additional water prohibitions based on the water supply situation.

Specific procedures for determining the initiation of a phase and termination of a phase are provided in the Emergency Water Conservation Plan Ordinance. Phases are initiated through recommendations provided by LADWP to the Mayor and City Council (Council).

3.2.2 Conservation Pricing

In 1993, Los Angeles restructured its water rates to provide customers with a clear financial signal to use water more efficiently. It was the first time in LADWP's history that an ascending tiered rate structure was used. This conservation-based rate structure remains in use and applies a lower first tier rate for water used within a specified allocation, and a higher second tier rate for every billing unit (748 gallons) that exceeds the first tier allocation. A unique feature of the rate structure is that the first tier allocation considers factors that influence individual residential customer's water use patterns (i.e. lot size, climate zone, and family size).

The goals of LADWP's two-tiered water rate structure are to:

- Use price as a signal to encourage the efficient use of water
- Provide basic water needs at an affordable price
- Provide equity among customers
- Use price to stabilize water use during a shortage
- Generate adequate revenue for maintaining and upgrading the water system

In a period where increasing demands and reductions in water supply are becoming more commonplace, a rate structure that provides appropriate signals to encourage efficient water use has become a necessity for many areas, including Los Angeles.

The substantial investments required for water quality improvements, security, and supply development have significantly raised the cost of delivering water. As rates increase, water agencies have noticed a change in use patterns. Because there is a known correlation between price and use, agencies use rates to encourage conservation activities and to postpone the need to construct new facilities or purchase even larger quantities of imported water.

LADWP's tiered rate structure, first implemented in 1993 with assistance from a broad-based group of stakeholders, applies a lower tier block rate for responsible water use within an allocated block of water, and a much higher rate for every billing unit above this block. The higher block rate reflects the "marginal cost," or the projected cost for additional water that would be required to meet these needs.

To further emphasize the conservation message, water charges are based solely on water used. This eliminates the inclusion of all fixed charges thereby allowing customers who use no water during a during a billing cycle to receive a bill that includes no charge for water service. There are automatic adjustments triggered when a water shortage exists. In June 2009, shortage year rates went into effect reducing first tier allocations for all customers by 15 percent (see Appendix C). These adjustments are based on the actual water use patterns that occurred during the 1991 period of mandatory water rationing. The purpose of these adjustments is to use price to encourage additional conservation and to provide LADWP with the revenue necessary to operate the system efficiently during a shortage.

3.2.3 CUWCC Best Management Practices

The CUWCC is the voice of urban water conservation in California, and LADWP has been active in the CUWCC since its inception in 1991. Instrumental in the development of the CUWCC MOU, LADWP was also one of the original signatories to this MOU. The MOU identifies BMPs as proven conservation measures as determined by the CUWCC. The most recent amendment to the MOU was adopted on June 9, 2010 updating compliance alternatives with the adopted BMPs. A water agency can now comply with the MOU through one of three methodologies: BMP compliance, accomplishing water conservation through a set of measures equal or greater than the water savings provided by the BMPs (Flex Track Menu), or accomplishing water conservation goals as measured in gpcd. All Group One (water suppliers) signatories to the MOU are committed to implement the BMPs.

Over the last 19 years, LADWP has played a significant role in the governance and policy making at the CUWCC, holding a seat on the Board of Directors, Strategic Planning Committee, By-Laws Committee, Research and Evaluation Committee, CII Committee, co-chair of the Membership Committee, and chair of the Group 1 Representation Selection Committee. LADWP also has been actively involved in all of the revisions that the MOU has undergone to date.

One of the obligations as a signatory to the MOU is to submit a Best Management Practices Retail Water Agency Report to the CUWCC. Previously submitted annually, this report is now submitted biennially and details progress in implementing the foundational and programmatic BMPs as currently specified in the MOU. LADWP actively implements the BMPs and the CUWCC BMP reports are available for review through the internet by accessing CUWCC's website at www.cuwcc.org.

In the early 1990s, the State Water Resources Control Board identified urban water conservation as a major means for resolving problems in the Bay-Delta. Large water agencies, including LADWP, actively participated in work groups to develop conservation strategies. The result of this effort is in the aforementioned MOU.

The MOU commits signatory water suppliers to develop comprehensive conservation programs using sound economic criteria and to consider water conservation on an equal footing with other water management options. The MOU established the CUWCC to monitor implementation of the BMPs and to maintain the list of BMPs.

A BMP is defined as:

(a) An established and generally accepted practice among water suppliers resulting in more efficient use or conservation of water.

(b) A practice for which sufficient data are available from existing water conservation projects to indicate that significant conservation or conservation-related benefits can be achieved; that the practice is technically and economically reasonable and not environmentally or socially unacceptable; and that the practice is not otherwise unreasonable for most water suppliers to carry out.

LADWP implements all of the BMP requirements in the MOU that are applicable to retail water agencies like LADWP. Foundational BMPs are considered as essential BMPs for any water utility and are ongoing practices not subject to time limitations. Programmatic BMPs are minimal activities required to be completed by each utility within the timeframe of the implementation schedules provide in the MOU. A listing of the BMPs is shown in Exhibit 3F.

Exhibit 3F
CUWCC BMPs and Implementation Status

Category	Sub-category	Practices	Status
Foundational			
Utility Operations	Operations Practices	Maintain the position of a trained conservation coordinator	Implemented
		Prevent water waste – enact, enforce or support legislation, regulations, and ordinances	Implemented
		Wholesale agency assistance programs	Not applicable
	Water Loss Control Metering with Commodity Rates	Conduct Standard Water Audit and Water Balance	Implemented
		Measure performance using AWWA software	Implemented
		Locate and Repair all leaks and breaks	Implemented
		100% of existing unmetered accounts to be metered and billed by volume of use	Implemented
	Conservation Pricing	Maintain a water conserving retail rate structure	Implemented
Education	Public Information Programs	Maintain active public information program to promote and educate customers about water conservation	Implemented
	School Education Programs	Maintain active program to educate students about water conservation and efficient water use	Implemented
Programmatic			
Residential		Residential Assistance – provide leak detection assistance	Implemented
		Landscape Water Surveys for residential accounts	Implemented
		High efficiency clothes washer incentive program	Implemented
		WaterSense Specification (WSS) for toilets	Implemented
Commercial/ Industrial/ Institutional (CII)		Implement unique conservation programs to meet annual water savings goals for CII customers	Implemented
Landscape		Implement Large Landscape custom programs	Implemented
		Offer technical assistance and surveys upon request	Implemented
		Implement and maintain incentive program(s) for irrigation equipment retrofits	Implemented

3.2.4 LADWP Conservation Programs

LADWP develops cost effective programs to achieve multiple goals of cost-effective demand reduction, customer service, environmental responsibility, and compliance with CUWCC BMPs. Conservation potential is considered in determining program approach and duration. Some types of conservation programs result in savings that are more easily measured than others. LADWP's programs include traditional demand-side management measures, as well as infrastructure improvement programs that contribute to water waste reductions. Demand-side management programs, like the rebate programs for water-saving toilets and high-efficiency washing machines, produce results that are measurable. Public information, education, and other general conservation awareness programs are intended to alter customers' behavioral patterns on water use and thus, are more difficult to quantify. It is such behavioral change in water use, however, that the City can point to as the primary reason for significant reduction in water consumption during water shortage periods. Combined with LADWP's conservation pricing structure discussed in Section 3.2.2, these programs increase system reliability and efficiency and will provide a secondary benefit of reducing runoff.

LADWP dedicates numerous staff in support of the Water Conservation Programs. Key personnel include the full-time water conservation coordinator who serves as LADWP's CUWCC representative, oversees conservation policies, and coordinates with other LADWP staff on the implementation of all the LADWP programs to ensure fulfillment with the annual water saving goals and CUWCC BMPs. Additional LADWP staff include the water conservation group that implement the various residential and commercial programs and the water conservation team (formerly known as the drought busters) that educate customers about the prohibited water uses, investigate claims of water waste and issue citations for water waste where warranted.

Specific conservation programs (past and present) associated with the CUWCC BMP categories are broken down in Exhibit 3G, and are fully discussed below. Appendix H contains the latest biennial reports provided to the CUWCC showing that LADWP has met all the BMP requirements.

Awareness/Support Measures

Awareness/support measures can be active or passive. Active components include full metering of water use, assessment of volumetric sewer charges, and a conservation rate structure. Passive components typically include providing educational materials for schools, community and customer presentations, maintaining a conservation hotline, and a wide range of information distributed through customer bills, advertising in public venues, LADWP's website, and direct mail. Passive awareness/support measures provide the foundation for the conservation movement to build upon by raising water use awareness, water conservation program visibility, and encouraging community involvement.

In 2008, LADWP entered into an MOU with the Los Angeles Unified School District to further improve our water conservation outreach program. In FY 2009/10 LADWP budgeted approximately $500,000 in funding for educational programs within area schools. Programs included:

- Los Angeles Times in Education – Provided newspapers to 50,000 students in grades 4-12 and lesson packages for teachers on supply sources and conservation.

- "Thirsty City" Live Performances – Play presented to more than 4,300 students introducing students to water supply sources, water supply challenges, and conservation.

- Renewable Energy and Conservation Curriculum – 660 teachers were trained in an extensive model conservation program reaching approximately 50,000 6^{th} grade students.

- Renewable Energy and Conservation Center – Funding was provided for a science teacher position to set up and establish a Renewable Energy and Conservation Center with students to be bused to center for hands-on lessons focusing on conservation and renewable energy.

- Outdoor Education Multi-Day Environmental Experiences – Approximately 700 students in 20 classes in grades 4-12 attended two or three days of outdoor education experiences focusing on environmental measures, including lessons on energy and water.

- Eastern Sierra Institute – Training of 25 teachers over three days about the environment and geology of the Eastern Sierra.

- Teacher Fellowships – Ten math and science teachers from middle and high schools served in fellowships at LADWP for six weeks during the fall and summer of 2008 working in multiple offices with the intent of developing classroom lessons based on the experiences.

- Infrastructure Academy – 40 students from the Infrastructure Academy completed water conservation audits at 120 schools, including fixture

Exhibit 3G Current and Past Conservation Programs

CUWCC BMP Category	Conservation Measures	pre 1985	Year in Service
	Awareness/Support		
	Pricing		
Utility Operations – Water Waste Prohibition	Retrofit on Resale Ordinance		1998
Utility Operations - Pricing and Operations	Tiered Rate Structure		1993
Utility Operations – Water Waste Prohibition	Drought Buster Program		1990
Utility Operations – Water Waste Prohibition	Emergency Water Conservation Plan Ordinance		1990
Utility Operations –Conservation Coordinator	Full-time dedicated staff to conservation	x	
Utility Operations - Metering	Full Metering and Volumetric Pricing	x	
Utility Operations - Pricing	Sewer Charge using Volumetric Pricing	x	
Education - Public Information Programs	**Public Information**		
	Drought Response Outreach		2008
	Hotel & Restaurant Water Conservation Campaign		2008
	ULFT Customer Satisfaction Survey		1992
	Advertising	x	
	Bill Inserts	x	
	Brochures	x	
	Community Involvement Program	x	
	Exhibits	x	
	Hotline	x	
	Speakers Bureau	x	
	School Education		
	LAUSD MOU		2008
	High School in concert with the Environment - Student Home Water/Energy Survey		1994
	Lower Elementary	x	
	Upper Elementary	x	
	Junior High	x	
	Residential		
Residential	Residential Drought Resistant Landscape Incentive Program		2009
Residential	High Efficiency Clothes Washer Incentive Program		1998
Residential	Better Idea/Neighborhood Bill Reduction Service Program --Showerhead installation		1993
Residential	Community-Based Organization Toilet Distribution Centers, Direct Install		1992
Residential	High Efficiency Toilet Rebate		1990
Residential	Home Water Surveys		1990
Residential	Retrofit Kits Distribution		1988
	Commercial/Industrial/Government		
Commercial/Industrial/Institutional	Commercial/Industrial Drought Resistant Landscape Incentive Program		2009
Commercial/Industrial/Institutional	Water Efficiency Requirements Ordinance		2009
Commercial/Industrial/Institutional	General Services Dept. MOU to Retrofit Plumbing		2009
Commercial/Industrial/Institutional	Public Agency Plumbing Audit and Training Program		2009
Education - Public Information Programs	Targeted Literature Mailing		1993
Commercial/Industrial/Institutional	Commercial/Industrial Conservation Guidebook		1992
Commercial/Industrial/Institutional	Cooling Tower Manual and Workshops		1992
Commercial/Industrial/Institutional	Commercial Rebate Program		1991
Commercial/Industrial/Institutional	Interior Water Use Audits		1991
Commercial/Industrial/Institutional	Technical Assistance Program (TAP)		1991
Landscape; Commercial/Industrial/Institutional	Typical Audits		1991
	Landscape		
Landscape	Recreation and Parks MOU		2007
Landscape	Large Turf Irrigation Controller Pilot Program		2000
Landscape	Protector del Agua -- English and Spanish Language Workshops		1995
Landscape	Improving Irrigation Performance Manual & Workshop		1993
Landscape	Large Turf Audits and Audit Training		1993
Education - Public Information Programs	Lawn Water Guide Direct Mailing (as requested)		1989
Education - Public Information Programs	Demonstration Gardens		1988
Landscape	Ten Percent Large Turf Water Reduction Program		1988
	System Maintenance Measures		
Utility Operations - Water Loss Control	Large Meter Replacement Program		2001
Utility Operations - Water Loss Control	Fire Hydrant Shutoffs		1991
Utility Operations - Water Loss Control	Meter Replacement Program		1988
Utility Operations - Water Loss Control	Cement Mortar Lining of Pipelines	x	
Utility Operations - Water Loss Control	Corrosion/Cathodic Protection	x	
Utility Operations - Water Loss Control	Infrastructure Program	x	

counts, analysis of toilet makes and models, and analysis of irrigation controllers and field conditions.

Included within the short-term strategies of the City of Los Angeles' Water Supply Action Plan is a strategy to increase water conservation in the City through an aggressive $2.3 million conservation education campaign. LADWP Public Affairs Office implemented a media campaign that included radio, TV, and newspaper advertisements, billboards, outreach to Neighborhood Councils; and marketing of City rebates for water-efficiency.

Another aspect of awareness/support is that of advocacy. LADWP has been instrumental in the development of more stringent standards for toilets (e.g. Supplementary Purchase Specification for ULF toilets) that are in use within the City as well as by other water agencies in California and other areas. LADWP also assisted in the adoption of higher residential clothes washer efficiency standards by the California Energy Commission. Recognizing the importance of this activity, LADWP actively participates in advocating local and statewide conservation research and planning.

Residential Category

Multiple residential conservation programs were first developed and launched by LADWP during the drought of 1987 through 1992. In 1990, the ULF Toilet Rebate Program was initiated, followed two years later by the ULF Toilet Distribution Program. In 2003, a well-received free installation service component was added to the ULF Toilet Distribution Program that included free water-saving showerheads, faucet aerators and replacement toilet flapper valves. Today distribution of free faucet aerators and showerheads continues for all single-family, multi-family, and commercial customers.

In 2008 MWD initiated the region-wide SoCal Water$mart Program for residential water conservation. This program replaced previous LADWP rebate programs and rebate programs offered by individual water service providers throughout the MWD service area. This MWD sponsored program sets uniform rebate requirements across the MWD service area and provides a clearinghouse for processing rebates for all MWD member agency customers. Local agencies have the option of supplementing baseline rebate amounts to their customers through the program. LADWP has increased baseline rebates for several of the qualifying products. Eligible customers include residential customers residing in single-family and multi-family homes, even if multi-family residents do not receive a water bill.

Although the SoCal Water$mart Program has discontinued rebates for high efficiency toilets (HET), LADWP continues to provide local funding for rebates for its customers of $100 per HET which has proven to be highly successful with over 1,900 units installed in FY 2009/10 which equates to over 80 AFY in water savings.

Prior to initiation of the SoCal Water$mart Program, LADWP was assisted by community-based organizations (CBOs) to reach the milestone of more than 1.27 million toilets installed through December 31, 2006. CBOs were integral to LADWP's success, reaching into the communities they serve to convey the conservation message and directly undertake conservation activities. Benefits of this approach accrued to community participants through reduced water bills, to CBOs through employment opportunities and revenues earned, and to the City through significant water savings achieved. Prior to its discontinuation, the program was funded at more than $7 million annually. The toilets replaced through the program continue to produce estimated water savings of more than 44,000 AFY today.

LADWP initiated a High Efficiency Washer Rebate Program in 1998 promoting the purchase and installation of high efficiency washing machines saving both water and energy. As of January 2009, rebates have been paid for more than 66,100 machines purchased and installed throughout the City. The program's minimum efficiency requirements for rebate eligibility were increased in January 1, 2004, resulting in the promotion of higher efficiency models. Initial co-funding of the program was provided by the City's Department of Public Works Bureau of Sanitation and by the Southern California Gas Company.

In February of 2009 the High Efficiency Washer Rebate Program transferred from LADWP to the SoCal Water$mart Program with co-funding provided by MWD. Since the inception of the SoCal Water$mart Program and through June 2010, over 11,800 rebates for washing machines were issued to LADWP customers with a total annual savings of 368 AFY. Generally rebates are $300 per washing machine with a water factor (a measure of efficiency) of 4.0 or less. From April 22, 2010 through December 6, 2010, an additional $100 rebate was available through the California Cash for Appliances program for a total rebate of $400 per washing machine.

A sprinklerhead rotating nozzle retrofit rebate of $8 per nozzle is available through the SoCal Water$mart Program for a minimum of 25 nozzles. Replacing standard sprinkler heads with rotating nozzles can use up to 20 percent less water. Rotating nozzles are able to distribute water in a water-efficient manner more uniformly across a landscape than standard sprinklers. Spray from rotating nozzles is less likely to result in misting conditions, misdirection from winds, and reduces runoff onto pervious surfaces thus reducing dry-weather runoff. Between March 2009 and June 2010 2,878 rotating nozzle rebates were issued to LADWP customers saving approximately 12.7 AFY.

Rebates for installation of weather-based irrigation controllers are also available through the SoCal Water $mart Program. Rebates amounts are $200 per controller for landscape areas of less than one acre and $25 per station for landscape areas greater than one acre. Weather-based irrigation controllers provide customized irrigation schedules based on local site conditions and in response to weather changes. These smart controllers receive weather updates to automatically adjust the schedule and amount of water applied. Between March 2009 and June 2010 81 LADWP customers received rebates for installation of the controllers saving approximately 6.2 AFY.

Initially a synthetic turf rebate program was offered through the SoCal Water$mart Program, but has been discontinued as of June 1, 2010. The program provided rebates of $1.00 per square foot. Approximately 316,547 square feet of synthetic turf was installed by LADWP customers between February 2009 and June 2010 saving approximately 44.3 AFY.

LADWP through the SoCal Water$mart program is offering turf removal rebates of $1 per square foot up to $2,000 per residence. Not all MWD member agencies are participating in the turf removal program and participating agencies have additional requirements beyond MWD's requirements. Areas targeted for turf removal must currently be turf irrigated with potable water for a minimum of one year. All replacement materials must be permeable and either hand watered or irrigated with drip irrigation. A minimum of 250 square feet must be converted to be eligible for a rebate. No invasive plants are permitted and all exposed soil must be covered with mulch. Synthetic turf is an acceptable replacement if it is not used in right of ways or parkways. Applicants are required to maintain the converted area for ten years. The program commenced in December 2009, and as of FY 2009/10, over 280,000 square feet of turf area has been converted saving over 39 AFY. In conjunction with the turf removal program, LADWP is conducting a drip system pilot program and is offering free residential drip starter kits.

Water-saving showerheads and faucet aerators remain available to LADWP customers, free of charge, upon request. Approximately 12,124 showerheads and 14,792 faucet aerators were distributed between July 2007 and June 2010 saving approximately 241 AFY. During past water shortages, more than 1.5 million water conservation retrofit kits were distributed throughout Los Angeles; the kits included one-gallon toilet displacement bags, low-flow showerheads, and toilet leak detection tablets.

As part of past programs promoting residential water conservation measures, students conducted home water surveys through a resource efficiency education program implemented by LADWP in Los Angeles area high schools. Additionally, local community based organizations visited many Los Angeles residences throughout the year, assessing water conservation opportunities in the home and installing applicable measures to immediately capture water savings.

Another element of LADWP's past efforts was a toilet flapper valve replacement pilot program. Although long-term water savings from ULF toilets are predicated on timely replacement of leaking toilet flapper valves with appropriate replacement units, findings from the pilot program indicate a small incidence of leaking flapper valves in toilets rebated or distributed by LADWP. However, toilet leak testing and flapper valve replacement was added to the past ULF Toilet Distribution Program's installation service component for toilets not replaced through the program.

Commercial/Industrial/ Institutional (CII) Category

This category represents some of the largest volume water users in LADWP's customer base, and represents a great deal of conservation potential. LADWP, in partnership with MWD, developed and has implemented a commercial rebate program entitled the Save Water Save a Buck Program, designed specifically for customers in the CII sector and multi-family residences with five or more units represented by a homeowners association. In the CII sector, the program provides rebates for water saving plumbing fixtures, food service equipment, and landscaping equipment. Within the multi-family sector the program provides rebates for high efficiency washers, high efficiency toilets, and landscape equipment. In addition, packaged water use efficiency solutions are being developed for specific business sectors. Efforts are also underway to better promote the financial incentives

Exhibit 3H
CII Conservation Programs and Savings July 2007 through June 2010

Device Type	Rebate Amount	Devices Installed	Estimated Annual Savings (AFY)
	Retrofit		
Save Water Save a Buck Program			
Current Programs			
High Efficiency Toilets (1.28 gpf or less)	$150 each ($50 new construction)	58,432	2,408.60
Zero and Ultra Low Water Urinals	$500 each ($250 new construction)	6,063	630.9
Cooling Tower pH Conductivity Controller	$3000 each	41	79.7
Cooling Tower Conductivity Controller	$625 each	57	36.7
Air Cooled Ice Machine	$300 each	0	0
Connectionless Food Steamer	$600 compartment	23	5.8
Dry Vacuum Pump (maximum 2.0 horsepower)	$125 per 0.5 horsepower	8	0.7
Water Broom	$150 each	73	11.2
Weather Based Irrigation Controller	$50 per station	391	127.1
Central Computer Irrigation Controller	$50 per station	0	0
Rotating Nozzles for Pop-up Spray Heads (25 minimum)	$8 each	22,534	99.1
High Efficiency Spray Nozzles for Large Rotary Sprinklers	$13 per head	8,558	308.1
Past Programs			
High Efficiency Coin Clothes Washer	-	1,738	186.8
Pre-Rinse Sprayhead	-	5	0.8
Steam Sterilizer Retrofit	-	6	7.8
X-Ray Processor Recirculation System	-	1	3.2
Synthetic Turf (square feet)[1]	-	15,177	2.1
Subtotal Save a Buck Program	-		**3,908.70**
LADWP Inhouse Programs			
Commercial Showerheads	-	5,180	85.3
Commercial Faucet Aerators	-	20,844	96.5
Water Brooms	-	262	40.2
CII Landscape Program Turf Removal[2]	-	1,251,043	95.6
Technical Assistance Program[3]	-	-	2358.4
Subtotal LADWP In-house	-		**2676**
Total CII	-		**6584.8**

1. Synthetic Turf rebates as of June 1, 2010 are available through LADWPs Technical Assistance Program.

2. Rebate amount varies and is determined during pre-approval process.

3. Rebates for Technical Assistance Program are $1.75 per 1,000 gallons saved over a two year period with a cap not to exceed the actual cost of the project. Devices installed vary per project.

available that make water conservation retrofits more cost effective for business and industry. LADWP takes full advantage of regional programs offered through MWD for the CII sector and for many product rebates, provides supplemental funding to boost the base rebate provided by MWD.

The Save Water Save a Buck Program was launched in 2001 to provide menu-based rebates for water conserving measures applicable to many types of CII facilities. Categories of products eligible for rebates, rebate amounts, number of rebates for the LADWP service area, and estimated savings are provided in Exhibit 3H for the period July 2007 through June 2010. During this period, an estimated annual savings of 6,585 AFY was achieved, inclusive of LADWP in-house programs and the Technical Assistance Program (TAP). The program design provides for ease of participation and has been well-received by LADWP customers. The program has been so successful that the SoCal Water$mart Program for residential customers was modeled after it.

LADWP created the Technical Assistance Program (TAP) in 1992 to provide custom-type incentives for retrofitting water-intensive equipment. Different from the Save Water Save a Buck Program, the TAP encourages site-specific projects and TAP incentives are based on a given project's water savings. Financial incentives up to $250,000 are available for products demonstrating water savings. Incentives are calculated at the rate of $1.75 per 1,000 gallons saved over a two-year period with a cap not to exceed the actual cost of the installed product. Projects must save a minimum of 150,000 gallons over a two-year period and operate for a minimum of five years. Eligible customers are CII or multi-family residential customers. Past TAP projects include cooling tower controller upgrades and x-ray processor recirculation systems. The estimated unit cost for TAP overall is about $228 per acre-foot saved with an annual savings of 2,358.4 AFY based on projects installed between July 2007 and programs until June 2010.

Similar to the residential turf removal program, LADWP has a turf removal program for commercial properties. This program started in September 2009 and the rebate is $1.00 per square foot of turf with the total project rebate amount as defined in the pre-approval letter provided by LADWP. Areas targeted for conversion must have live healthy turf irrigated with potable water (recycled water is ineligible) via automatic sprinkler valves when a project approval letter is provided by LADWP. Converted areas must contain enough plants to create at least 30 percent landscape coverage at maturity. Converted areas may not contain turf or synthetic turf (synthetic turf rebates are available through the TAP). All replacement materials must be permeable and plants must be climate appropriate or California native plants. A minimum of 250 square feet must be converted to be eligible for a rebate. No invasive plants are permitted and all exposed soil must be covered with three inches of mulch. If an irrigation system is used it must be a low flow drip or bubbler system. Applicants are required to maintain the converted area for 15 years.

Water-saving showerheads and faucet aerators are available to LADWP commercial customers, free of charge, upon request. Bathroom faucet aerators are provided in 1.5, 1.0, or 0.5 gallons per minute (gpm), kitchen faucet aerators are provided in 1.5 gpm, and showerheads are provided in 2.0 gpm. Approximately 5,180 showerheads and 20,844 faucet aerators were distributed between July 2007 and June 2010 saving approximately 181.8 AFY combined. LADWP additionally offers an in-house water broom program in addition to the rebates offered through the Save Water Save a Buck Program.

Landscape Category

Recognizing that a substantial amount of water is used outdoors for irrigation, LADWP continues to invest in landscape irrigation efficiency programs and projects. In addition to the previously discussed landscape ordinances (Section 3.21.), LADWP has sponsored free

Drought-tolerant garden outside the LADWP John Ferraro Building.

training courses specifically targeting the City's large turf customers to help these customers comply with the landscape ordinance. To further assist this group, LADWP developed a guidebook, "Improving Irrigation Performance" to demonstrate ways for enhancing existing irrigation systems.

LADWP has also sponsored conservation and garden expos to highlight various aspects of efficient outdoor water use and planting practices, and emphasize native, drought-tolerant plants. Funding was provided for three demonstration gardens to showcase the use of drought-tolerant plants and flowers, including the landmark Lummis Home in Highland Park. Lawn watering guides were mailed to all single-family and duplex residences. Planting guides for native and drought-tolerant plants are also available upon request. Additionally, to demonstrate the beauty and appeal of a water-conserving landscape, LADWP's John Ferraro Building facility (below) has a drought-tolerant garden that is open to visitors year-round.

In addition to the Residential and Commercial Landscape Incentive Programs for turf removal, other types of landscape irrigation improvement projects are also funded through the TAP, with incentives calculated on the basis of a project's water savings. LADWP staff includes certified landscape auditors, and large landscape audits are available upon request.

LADWP is also investigating new programs using data obtained through pilot program efforts. A pilot program was conducted to determine the effectiveness of weather based irrigation controllers in large landscape applications. On the basis of the pilot program results showing water savings, financial incentives are available to LADWP customers for the purchase and installation of weather based irrigation controllers through the SoCal Water$mart and Save Water Save a Buck Programs. Additional efforts are being undertaken to make available a landscape irrigation education program for homeowner associations and other large landscape customers. This program would focus on common green areas in multi-unit complexes to improve irrigation efficiency, including irrigation system maintenance and repair, and plant selection.

LADWP has been implementing an internal program to retrofit outdoor landscaping at department-owned facilities to California-friendly and native plantings with efficient irrigation systems. Additionally, a joint effort between the Department of Recreation and Parks and LADWP is targeting public parks through the City Park Irrigation Efficiency Program. City parks with inefficient irrigation systems, leaks, and runoff problems are identified and upgraded with water efficient distribution systems and sprinkler heads, installation of smart irrigation controllers, and planting of California-friendly landscaping. Since the program began in 2007, seven parks have been completed and 4 new weather stations have been installed. An additional benefit of this program is the educational, trade training, and employment opportunity given to the youth of Los Angeles.

There is also potential for the use of non-potable water for irrigation, which can help extend the utility of the City's traditional water supplies. Through increased stormwater capture, groundwater recharge with captured storm and irrigation runoff, and recycled water, imported surface water and local groundwater used for landscape irrigation can be conserved. The potential to use such non-potable water supplies is further discussed in the Recycled Water and Watershed Management chapters (Chapters 4 and 7 respectively).

New Low Impact Development (LID) projects implemented within the City and innovative work by non-profit organizations demonstrate pioneering ways to conserve water for landscapes. As discussed in Chapter 7, LADWP's Watershed Management Group is proactively developing programs in conjunction with other departments to highlight water conservation through LID and implementing stormwater BMPs. A local non-profit, TreePeople, has partnered with various City departments, including LADWP on a number of stormwater capture projects.

For over a decade, TreePeople has demonstrated that rainwater is a viable local water resource. The Open Charter Elementary School Stormwater Project is one of several sustainable stormwater management systems that TreePeople installed in Los Angeles. Other examples include: the Center for Community Forestry which harvests rainwater from its entire hardscape into a 216,000 gallon underground cistern for landscape irrigation use; a retrofitted single-family residential home in South Los Angeles that captures a 100-year storm event on site; and a 7,600 square foot subsurface stormwater infiltration gallery on the Broadous Elementary School campus in Pacoima. Most recently, TreePeople partnered with the Los Angeles and San Gabriel Rivers Watershed Council, LADWP, and other state and federal agencies to retrofit an entire residential block on Elmer Avenue in Sun Valley. This project now intercepts stormwater from 40 acres upstream and infiltrates it back to the aquifer while also demonstrating effective distributed stormwater BMPs on residential homes.

In partnership with the Los Angeles County Department of Public Works, TreePeople was instrumental in developing the Sun Valley Watershed Management Plan: an alternative stormwater management plan that prioritizes green infrastructure and multi-benefit stormwater capture projects instead of stormdrains. Many projects have been completed, and more are scheduled for construction. These activities create the foundation that will lead to further landscape water conservation and stormwater capture to increase the water use efficiency of the City's limited water supplies.

CASE STUDY:
Los Angeles River Revitalization and the North Atwater Park Project

Background

The Los Angeles (LA) River flows 51 miles through some of the most diverse communities in Southern California—its first 32 miles are within the City of LA. The River has a year-round low flow due to contributions from upstream wastewater treatment plants, urban runoff, groundwater inflow, and natural springs, but can become a torrent of racing flows during the rainy season. The River is almost entirely concrete-lined except for a few reaches. Although the design of the River has served its flood control purpose, the River holds far greater potential to serve as a focal point for environmental restoration, economic growth, community revitalization, and recreation.

Realizing that the River should stand as a symbol of pride for the City of LA and its residents and that it should be a landmark for the public to enjoy and admire, the LA City Council established the Ad Hoc Committee on the River in 2002 and adopted the LA River Revitalization Master Plan (LARRMP) in 2007 (www.lariver.org). Led by the City's Bureau of Engineering and funded by the LA Department of Water and Power, the LARRMP was created through a collaboration of elected officials, city departments and agencies, residents, multi-disciplinary experts, and a wide variety of private and non-profit environmental and recreational groups. The LARRMP is a 25-to-50 year blueprint for transforming the City's stretch of the LA River into an extensive network of parks, walkways, bike paths, and diverse land uses that will ensure the growth and sustainability of healthy communities.

Key Features

In October 2010, the City celebrated the groundbreaking of the North Atwater Park Expansion and Creek Restoration project as the first project to emerge from the LARRMP, which is expected to be open to the public by December 2011. The project was undertaken in connection with the settlement of two Clean Water Act enforcement action, Santa Monica Baykeeper v. City of Los Angeles and United States, and State of California ex. Rel. California Regional Water Quality Control Board, Los Angeles Region v. City of Los Angeles and also funded in part by Proposition 50 through the California Resources Agency to improve River Parkways and the Integrated Resources Water Management. The project will use both structural and natural solutions to restore a degraded creek that is a tributary of the River while also expanding River-adjacent parkland with multiple recreational, wildlife habitat, and water quality benefits. The project will add nearly 3 acres to an existing 5-acre City park, connecting it to the River, where visitors will enjoy watching a wide variety of bird species that presently live in that soft-bottomed stretch of the River, framed by stunning views of Griffith Park in the distance. Some of the project's highlights include:

Outdoor Classroom

The project will encourage young children to explore nature via an educational gathering space near the LA River. This "outdoor classroom" will feature a nature-based art area for independent and guided activities—designed particularly for local students to learn about nature, native plants, and the opportunities and challenges associated with revitalizing the LA River.

Native Demonstration Garden

The park's central focus will be a demonstration garden, which will contain a variety of native plants that are used throughout the park, with interpretive displays to educate visitors about the plant species' characteristics, care, and relationship to water conservation. The park will only include native plants because they are considered "drought-tolerant" given their abilities to thrive in Southern California's climate, requiring much less water than other plants. The park's landscape design aims to set an example in the use of such plants, but also to educate the public on the merits of embracing native vegetation as an important component of solving the region's water crisis.

Creek Restoration

North Atwater Creek currently conveys polluted runoff to the River from an upstream stormdrain system that receives flow from a 40-acre urban area. The Creek will be restored and landscaped with native plants to prevent erosion and to naturally filter stormwater before it is discharged to the River, featuring a 1000-foot-long meandering streambed sustained by intermittent street runoff flows. Water quality improvements will include installation of a device at the entrance of the creek to intercept and capture trash and bacteria and special treatment of flows from adjacent equestrian facilities.

Accommodating Visitors

While the park's landscape design capitalizes on the opportunity to educate visitors about the many connections between urban life, nature, and water, its structural features do also. For example, the parking lot will be transformed by installing a gravel bioswale along the borders and replacing existing parking spaces with permeable surfaces. These changes will not only address surface water contamination, but also allow stormwater to infiltrate so that it will assist with groundwater augmentation.

Summary

The North Atwater Park project will utilize innovative Low Impact Development (LID) and Best Management Practice (BMP) technologies to simultaneously achieve a variety of benefits, including responsible water conservation, improved water quality, expanded wildlife habitat connectivity, co-located multi-generational recreation, and public education.

The park's goals recognize that, while it is important to transform the existing park into a beautiful, scenic landmark and natural resource, it is equally important to educate the public about the huge potential such achievements have in encouraging wiser water use practices. Fundamentally, the park is about water—respecting LA's water supply and celebrating the River—by simultaneously improving the survivability of our wildlife and human habitat. North Atwater Park is an example of what can happen when public agencies and residents tackle complicated problems with creative planning and successful collaboration.

"The LA River cause is reaching more and more people every day. We are incredibly encouraged by the USEPA's July 2010 decision regarding the River's federal protection status and particularly because of the context in which it was announced—President Obama's America's Great Outdoors initiative is exactly the kind of support we need now and the visit of so many distinguished Administration officials to the River reinforces the belief that the River is important to millions of people here and across the country."

Carol Armstrong, Ph.D., Environmental Supervisor, Project Manager, LA River Project Office

"The City's commitment to LA River revitalization has only gained in momentum over the years and we have now reached an important crossroads for answering the big questions—such as how to capture and reuse storm flows, how to expand our recycled water uses, how to ensure we have enough water to maintain critical wildlife habitat, and how much flood capacity can we add? The River is central to each and every one of the answers."

Larry Hsu, P.E., Senior Civil Engineer, Project Manager, LA River Project Office

System Maintenance Category

Maintaining system infrastructure reduces water waste and allows for greater water accountability. Infrastructure maintenance is a high priority for LADWP. As discussed in Chapter 2, LADWP non-revenue water has an impressive historical 25-year average of 7 percent of the total water demand. LADWP maintains a 24 hour, 7 days per week leak response operation and repairs major blowouts that impact public safety immediately and typical leaks within 72 hours. Ongoing programs such as pipeline replacement, pipeline corrosion control, and meter replacement preserve the operational integrity of City water facilities, and aims to reduce unaccounted water losses.

In recent years, the LADWP has ramped up its pipeline replacement program from 70,000 liner feet annually to 95,000 linear feet annually. Additionally, the LADWP Water System's Asset Management Group along with the Water Distribution Division are working to develop a predictive model that uses existing data relative to the factors which contribute to water main deterioration to determine a replacement priority for all pipe segments in the system. The results of this model along with criticality assessments and leak history can be used to focus replacement resources on pipe segments that are more likely to fail and disrupt service levels.

LADWP has also made significant progress in replacing and/or retrofitting water meters through its meter replacement program that started in 1988. As a result of extended flow or usage, the moving parts in a water meter can wear down and begin to under-register the actual water consumption. The meter replacement program has been valuable in ensuring the accuracy of the approximately 700,000 meters within the City. Recently, all of the large-sized meters (3-in and larger) in the system were replaced as part of a Large Meter Replacement Program, and the LADWP is also replacing 35,000 small meters annually.

As part of the new requirements of the CUWCC Water Loss Control BMP amended in September 2009, LADWP has completed training in the American Water Works Association water audit method and component analysis process offered by CUWCC. LADWP has also completed the standard water audit and balance using the American Water Works Association Water Loss software to determine the current volume of apparent and real water loss and the cost impact of these losses. As the final BMP condition, LADWP is on target to complete the required component analysis by July 2013. The goal of the component analysis is to identify volumes of water loss, the cause of the water loss and the value of the water loss for each component.

3.3 Future Programs, Practices, and Technology to Achieve Water Conservation

LADWP, on its own and in cooperation with other agencies, continues to investigate future programs, practices, and technology to improve water conservation.

3.3.1 Graywater

As defined by State regulations, graywater is untreated household wastewater that has not come into contact with toilet waste or unhealthy bodily wastes. It includes water sources from bathtubs, showers, bathroom wash basins, and water from clothes washing machines and laundry tubs. It specifically excludes water from kitchen sinks and dishwashers. Graywater is a drought-proof source of supply for subsurface landscape irrigation. Graywater regulations do not allow for its application using spray irrigation. Graywater is also not allowed to pond or runoff, discharge to or reach a storm drain system or surface water body, and is not permitted for irrigation of root crops or edible food crops that are directly in contact with the surrounding soil.

The Graywater Systems for Single Family Residences Act of 1992 legally incorporated the use of graywater as part of the California Plumbing Code. In September 1994, the City approved an ordinance that permitted the installation of graywater systems in residential homes. However, installing graywater systems under this act was costly in terms of both installation and maintenance. To address the current water shortage and reduce water demands, emergency graywater regulations added Chapter 16A (Part I) "Nonpotable Water Reuse Systems" to the 2007 California Plumbing Code. These regulations were approved by California Building Standards Commission in 2009 and became effective on August 4, 2009. Further revisions were made to the regulations and the regulations became permanent on January 12, 2010 with an effective date of January 20, 2010. These new code changes allow the use of certain types of untreated graywater systems as long as specific health requirements are met as defined by the authority having jurisdiction. The ordinance can be acquired from the City of Los Angeles Department of Building and Safety (LADBS) website at the following link.

http://ladbs.org/LADBSWeb/LADBS_Forms/InformationBulletins/IB-P-PC2008-012Graywater.pdf

Graywater systems in residential buildings are regulated by LADBS. LADBS requires a plumbing permit prior to construction, reconstruction, installation, relocation, or alteration of any graywater systems, treated or untreated. As of FY 2009/10, LADWP does not offer any rebates or incentives for graywater systems, but continues to assess the potential for this water conservation technology. LADWP is also reviewing the concept of assisting in the creation of ad hoc committees to develop a standard for graywater systems.

Untreated Graywater Systems

Untreated graywater systems are systems where graywater is collected from non-toilet and non-kitchen sources and is utilized without treatment, for uses such as landscape irrigation. According to a 1999 study prepared by the Soap and Detergent Association, the average untreated graywater system in the US uses 6.3 gallons per day. In a 2010 White Paper prepared by Bahman Sheikh, for the WateReuse Association, Water Environment Federation, and American Water Works Association the potential for graywater generation in 2030, adjusted for conservation devices, is estimated at approximately 75.5 gallons per household per day. Potentially 50 percent of indoor potable water use could be re-used as graywater. Multiple manufacturers have developed untreated graywater systems and many households have installed such systems. However, these systems are not typically monitored, thus health and safety risks associated with the products have not been determined.

Under the recently approved revisions to the graywater system regulation, LADBS does not require a permit for untreated graywater systems supplied by only a clothes washer in a one or two-family dwelling as long as the system does not require modification of existing plumbing. Multiple requirements must be met for a system to be exempt from a permit, including but not limited to:

- Discharge shall be released not less than two inches below the surface of rock, mulch, or soil.
- Designs shall incorporate a means to allow the user to divert flow to the disposal area or the building sewer.
- Design of the system shall not allow contact with humans or pets.
- Water from diapers or other similarly soiled or infectious garments shall be diverted to the building sewer.
- Hazardous chemicals from washing activities, such as soiled rags, shall be diverted to the building sewer.
- An operation and maintenance manual shall be provided and remain with the building.

CASE STUDY:
Single-Family Home Graywater System

As a community environmental leader, Janie Thompson is taking extraordinary steps in efficient use of water and conservation. With the help of her husband, her household has become an excellent example of a rainwater capture residence, catching rain in 18 separate rain barrels with 60 gallons each. To save even more water, the couple is installing an impressive graywater network, distributing water to the furthest extent of their large 14,850 square foot property.

"In June 2009, when the Mayor announced the ordinance limiting watering to two days per week, we freaked out, and originally thought most of our landscaping would die. With all of our conservation, rainwater capture, and use of graywater, our usage has dropped from 117 hcf to around 54 hcf per month in the summer months. We couldn't be happier. It just goes to show you how much most people in the City over water." – Janie Thompson

Their existing graywater system currently uses the drainage pump from the clothes washer to pump water slightly up grade to tree and flower areas of the backyard. Upon exiting the washer, a 3-way valve reserves the option to divert washer effluent to the sewer system. The graywater piping travels beneath their raised foundation home, into the subsoil, and onto the areas it serves. Once construction is complete, all piping (left) will be buried with existing soil or mulch.

When the stream is pumped to the highest point of the yard, it is sent to numerous subsoil infiltration chambers, through a distribution system of 1" HDPE (High-density polyethylene) pipe. The infiltration chambers are made from 1 gallon paint buckets turned upside down with holes cut in the bottoms (below). The chambers allow for unobstructed exit flow and appropriate soil surface area for infiltration. In addition, they provide a significant volume for water storage during the surge of a pumped load of laundry. Plant roots are attracted toward these water outlets, essentially feeding on nutrients and organics in the graywater. The tops of the chambers are cutout for frequent access, and covered with mulch or stepping stone. The pipe exits can be checked as necessary to ensure free flow.

The next steps in the construction are connection of the bathtub and bathroom sinks. Effluent from these water sources will enter a surge tank and float switch assembly. A graywater dedicated pump will then automatically push water to existing and newly installed infiltration chambers throughout the yard.

Graywater used from these indoor sources will provide two main benefits. It will displace water used for irrigation and prevent additional water from entering the sewer. This decreases the load on the City sewer system and lowers the overall cost of treatment for the Bureau of Sanitation.

The water savings are approximated in the following table. Please note that the clothes washer is a high-efficiency front loading model. Showers are estimated at 10 minutes long with a showerhead using 2.5 gallons per min.

Yearly Water Savings				
Washer	14 gal/use	10 uses/wk	140 gal/wk	7,280 gal/yr
Bathtub	40 gal/person/day	3 people	840 gal/wk	43,680 gal/yr
Bath Sink	2 gal/person/day	3 people	42 gal/wk	2,184 gal/yr
			Total	53,144 gal/yr

Treated Graywater Systems

Treated graywater systems treat water collected from non-kitchen and non-toilet sources for nonpotable reuse indoors and outdoors. Treated graywater systems for indoor use of graywater are not currently permitted by LADBS as there are no water quality standards nor mean to certify onsite treatment systems. Testing agencies are working to address safety concerns while manufacturers are working to improve the technology gap in the systems. Both manufacturers and testing agencies are working together to address gaps in standards to allow the future use of treated graywater for outdoor surface irrigation and for indoor uses in toilets and urinals.

The National Center for Disease Control and Prevention in conjunction with North Carolina State University is developing a program to examine the public health values and impacts associated with decentralized water reuse at eight project sites across the country. Under this program wastewater from homes would be treated to Title 22 standards as required by local health regulators. One of the proposed sites is located in Los Angeles County.

On the international level, treated graywater systems are used in both Europe and Australia. However, treated graywater systems in the United States are not common. A lack of accepted standards for graywater systems imposes a financial risk to companies manufacturing graywater systems. The International Association of Plumbing and Mechanical Officials (IAPMO) and NSF International are the two testing agencies working to develop standards for uniform treated graywater systems applicability in the US. LADWP is closely following the development of the NSF Standard 350 and IAPMO standards to ensure that once a set of standards have been approved by model codes and adopted by the Building Standards Commission, the citizens of Los Angeles can safely install treated graywater systems to maximize water reuse without any health and safety risks.

3.3.2 Demand Hardening

Although LADWP regularly assesses new water conservation opportunities, conservation programs may, at some point in time, diminish a customer's ability to further conserve water, in particular during short-term water supply shortages caused by droughts or other emergencies. This phenomenon is known as "demand hardening." The California Urban Water Agencies defines demand hardening as, "the diminished ability or willingness of a customer to reduce demand during a supply shortage as the result of having implemented long-term conservation measures." Long term conservation measures can include hardware conservation measures, such as the installation of high efficiency toilets and behavioral conservation, such as watering during specified periods of the day.

Demand hardening occurs when options available for reducing water use are limited as the customer base is saturated with hardware conversions causing efficient water usage patterns to prevail. During "dry" years, utility customers who have actively participated in water conservation programs can be disproportionately impacted by water reductions as there is a limited ability for further conservation. The impact of demand hardening would be most prevalent during water supply shortages where customers have already been implementing long-term water conservation measures. Proponents of demand hardening believe that implementation and saturation of new hardware-based conservation devices would generally not occur rapidly enough during a water supply shortage, such as a drought, to reduce short-term water use.

However, it can be argued that hardware-based conservation devices will continue to be developed, piloted and implemented, such as the previously discussed weather based irrigation controllers, thus improving the ability to further conserve in the future. During droughts, consumers will respond to the call for more conservation by behaviorally adjusting their water use through methods such as not leaving water running and taking shorter showers. Additionally, full saturation of current conservation devices has not occurred. For these reasons, others believe demand hardening is irrelevant and there is a continued need for aggressive conservation programs.

Full implementation of current conservation measures, including reducing leaks, has the potential to reduce per capita water demands even further. Past water conservation efforts have reduced water use within LADWP's service area even though the population has continued to expand as illustrated in Exhibit 3A. It is expected that future water conservation efforts will continue this trend as increased saturation of water saving hardware devices occurs and new hardware devices are developed.

Though not easily quantifiable, saturation of current water saving hardware devices and installation of future water saving hardware devices combined with potential demand hardening have the ability to impact demand forecasts. As a worst case scenario, demand hardening and its effects are considered in LADWP's water demand forecasts to ensure that the appropriate supply of water is planned for. However, LADWP will continue to maintain its aggressive water conservation program discussed within this section. In the future, LADWP's water demand forecasts will continue to be examined and adjusted accordingly to compensate for additional implementation of long-term water conservation measures as saturation increases and new technology results in new hardware devices.

3.3.3 Projected Water Conservation Savings

To assist in planning future water demands, meeting the Water Supply Action Plan goal, and complying with

Exhibit 3I
Active Conservation Projections by Sector

Sector	Acre-feet per Fiscal Year				
	2014/2015	2019/2020	2024/2025	2029/2030	2034/2035
Single-Family Residential	3,416	5,882	8,349	10,815	12,249
Multi-Family Residential	871	1,504	2,137	2,770	3,150
Commercial/Government	7,969	16,000	24,030	32,061	39,629
Industrial	1,924	3,847	5,824	7,774	9,339
Total Active Conservation Projections	14,180	27,260	40,340	53,420	64,368

20x2020 requirements, LADWP has taken numerous steps to project future water conservation savings by major customer classification for indoor and outdoor use.

Indoor and outdoor active conservation through 2035 has been estimated by major billing sectors as provided in Exhibit 3I. Values presented are cumulative year to year. The bulk of conservation is expected to occur in the indoor portion of the commercial/government sector followed by the industrial sector. Past conservation programs have heavily focused on residential conservation reflecting the smaller residential conservation projections. Residential conservation initially provided the greatest volume saved for the cost. Water use in the CII sector is varied and relatively more expensive to achieve than in the residential sector.

To determine potential conservation savings for indoor water use in the CII sector, LADWP conducted a high-level study to first estimate CII water use for each subsector (e.g. hospitals, refineries, schools, business parks, restaurants, etc.) and indoor end-use (e.g., toilets, showers, kitchen, laundry, food processing, cooling/heating, etc.), and second determine the potential for indoor water savings for each subsector and end-use. This study involved a sample of water use for approximately 150 of LADWP's largest CII customers to estimate total sector water use, along with employment data from Dunn & Bradstreet. Additional data sources listed below were used to determine indoor end-use estimates for each subsector, as well as the potential for water savings.

- *BMP 9: A Handbook for Implementing Commercial Industrial & Institutional Conservation Programs. (2001). California Urban Water Conservation Council.*
- *Commercial and Institutional End Uses of Water. (2000). American Water Works Association Research Foundation.*
- *Waste Not, Want Not: The Potential for Urban Water Conservation in California. (2003). Pacific Institute.*
- *Water Efficiency in the Commercial and Institutional Sector: Considerations for a WaterSense Program. (2009). U.S. Environmental Protection Agency.*
- *Watersmart Guidebook---A Water-Use Efficiency Plan-Review Guide for New Businesses. (2008). East Bay Municipal Utility District.*
- *Santa Clara Valley Water District Commercial Institutional Industrial Water Use & Conservation Baseline Study. (2008). CDM.*
- *Water and Energy Efficiency Program for Commercial, Industrial, and Institutional Customer Classes in Southern California. (2009). U.S. Bureau of Reclamation.*
- *Water Use Efficiency Comprehensive Evaluation. (2006). CALFED Bay-Delta Program.*

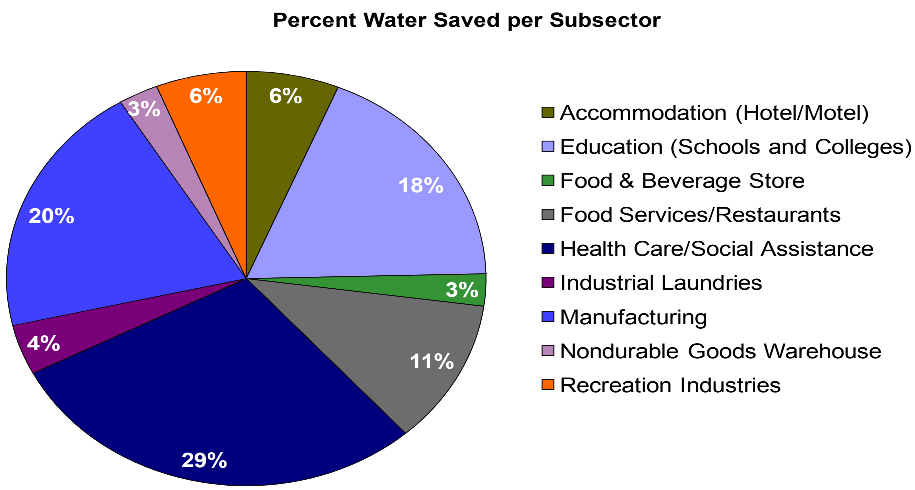
The study concluded that by targeting just the top 100 or so largest CII users, approximately 4,600 AFY of water could be saved (representing about 3 percent of total CII water use). The study also found that the subsectors that use the most water in the City are: health care (18%), education (14%), food services/drinking places (9%), accommodation (5%), fabricated metal product manufacturing (5%), textile mills (5%), amusement (4%), and food manufacturing (4%). The study also concluded that the potential for indoor water conservation was approximately 23,000 AFY or 15 percent of total CII water use. Exhibit 3J presents the breakdown of this potential indoor water conservation for subsectors and end-uses.

Outdoor water use as a percentage of total water use was approximated using three methodologies to determine the potential for outdoor water conservation savings. The methodologies and percent outdoor water use determined for each methodology are:

- Minimum-Maximum Methodology (outdoor water use is approximately 39.98 percent) – based on the premise that during wet months outdoor water use is minimal and during dry months outdoor water use is at its peak.

- Wastewater Treatment Plant Influent Methodology (outdoor water use is approximately 38.32 percent) – based on determining the average monthly influent flows to the City's four wastewater treatment plants during

Exhibit 3J
Breakdown of Estimated CII Indoor Water Conservation Potential of 23,000 AF



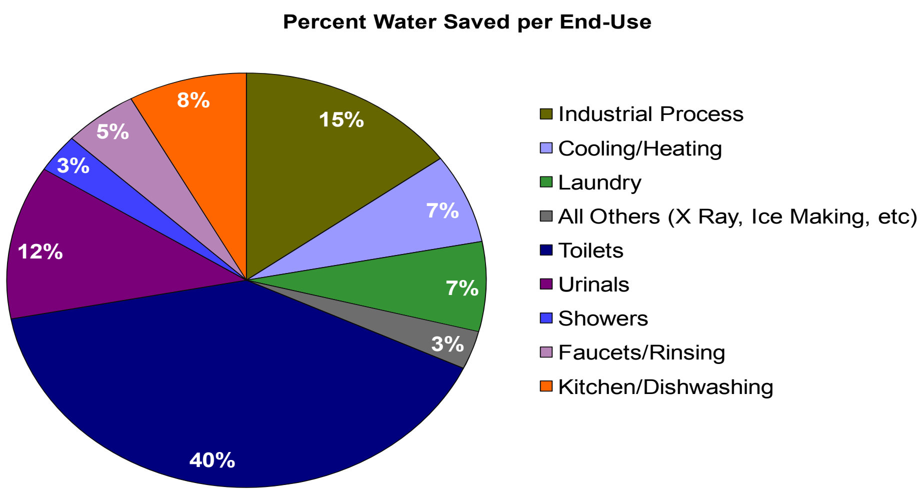


Exhibit 3K
Potential Outdoor Water Use Savings by Sector

Customer Sector	Scenario 1	Scenario 2	Scenario3
	(AFY)		
Single-Family Residential	13,246	42,464	100,901
Multi-family	5,956	19,095	45,371
Commercial	2,573	8,247	19,597
Total	**21,774**	**69,806**	**165,870**

the dry-weather months of June through September and adjusting for contract agency flows and dry-weather stormwater diversions.

- Infrared Analysis Methodology (outdoor water use is 39.67 percent) – based on an infrared analysis of the City to determine tree canopy and landscape coverages for use in estimating applicable water use requirements for greenscapes based on rainfall data, plant factors, evapotranspiration rates, and irrigation efficiencies.

The resultant range between the low and high outdoor water use percentage is approximately 1.35 percent. This narrow range resulting from the three methodologies confirms the methodologies are fairly accurate.

Greenscape areas related to commercial and residential land uses are the most likely areas to be targeted for outdoor water conservation. Rehabilitation of these areas to meet or exceed the evapotranspiration adjustment factor (ETAF) of 0.7 as required in the Model Water Efficient Landscape Ordinance would result in significant savings ranging from 21,774 to 165,870 AFY. Currently, these savings are not represented in the projected active conservation in Exhibit 3I. Exhibit 3K illustrates the potential savings under three scenarios by customer sectors. Scenario 1 represents an improvement in average irrigation efficiencies and/or installation of less water intensive vegetation to achieve and ETAF of 0.7. Scenario 2 represents an improvement in average irrigation efficiencies and/or replacement of high water use vegetation with less water intensive vegetation in the moderate to low water use range to achieve an ETAF of 0.49. Scenario 3 represents an improvement in average irrigation system efficiency and replacement of all vegetation with very low water use vegetation almost entirely dependent upon effective precipitation to achieve an ETAF of 0.07. This would require incentive programs, such as cash for grass programs. Other large greenscape area, including parks, cemeteries and golf courses, were not considered in the analysis as they would more than likely be preserved as turf or tree canopy areas to retain quality of life benefits. These areas are likely to be targets for recycled water use.

3.4 Cost & Funding

The cost range of conservation rebates, incentives, and hardware installation programs ranges from approximately $75/AF to $900/AF based on current LADWP conservation programs. More than $200 million has been invested in water conservation since 1991. Conservation is the cornerstone of LADWP's water demand management activities and ongoing investments will be made in viable programs, subject to funding availability and LADWP's ability to implement such programs. Outside sources of funding are sought to complement the City's resources. A stronger commitment is also being made to acquire outside grant funding for City conservation projects.

Currently, the funding sources for conservation are:

- Water Rates – Water conservation programs are primarily funded through water rates.

- MWD Conservation Credits Program - MWD offers both commercial and residential rebates to member agency customers that install specified conservation devices. The rebates equate to $195 per AF of water saved, or half the project cost whichever is less. In addition, MWD reimburses the LADWP for pre-approved projects when completed. In 2009 MWD reimbursed the Department $139,000 for a water broom distribution program. LADWP also expects to be reimbursed in 2011 through the MWD Member Agency Administered funding program for $968,000. The monies are reimbursement for 22.2 acres of turf reduction projects through the Department's Commercial/Industrial Drought Resistant Landscape Incentive Program.

- Outside Agency Co-Funding - Other agencies realizing benefits from conservation programs are solicited for co-funding of program costs.

- Grant Funding - LADWP has successfully received grant funding from the State under Proposition 13. A grant for $615,000 supplemented the rebate funding available for commercial ULF toilets and high efficiency clothes washers. LADWP expects to receive a final payment totaling $128,299 for the Commercial High Efficiency Clothes Washer and Ultra Low Flow Toilet Consolidated Water Use Efficiency grant. LADWP has already received $164,691 in support of 1,498 commercial high efficiency washer rebates. LADWP was awarded three grants in 2005 under Proposition 50, which are summarized below:

  - The Cooling Tower Conductivity Controller Replacement Program: Grant to improve the water efficiency of 100 cooling towers in the city of Los Angeles. Total grant amount up to $350,000. Expect completion in 2012.

  - The Los Angeles City Park Irrigation Efficiency Program: Grant to improve the irrigation efficiency at 15 City of Los Angeles municipal parks by installing Weather Based Irrigation Controllers and by upgrading irrigation piping and rotors. Total grant amount up to $362,000. Expect completion in 2011.

  - The Large Landscape "Smart Irrigation" Program: Grant to replace existing manually-adjusted irrigation controllers with "smart irrigation" Weather Based Irrigation Controllers at 75 large landscape customer sites. Total grant amount $131,000. Expect completion in 2011.

Chapter Four

Recycled Water

4.0 Overview

LADWP is committed to significant expansion of recycled water in the City's water supply portfolio. Recognizing the multiple factors that are decreasing the reliability of imported water supplies, LADWP released the City of Los Angeles Water Supply Action Plan (Plan), "Securing L.A.'s Water Supply" in May of 2008. The Plan established the goal of using 50,000 AFY of recycled water to offset demands on potable supplies. In order to meet this goal, LADWP, in conjunction with the Los Angeles Department of Public Works Bureau of Sanitation (BOS), are working together to develop a Recycled Water Master Plan (RWMP). Opportunities to expand the water recycling program are being studied through development of the RWMP. Opportunities include expanding the recycled water distribution system for Non-Potable Reuse (NPR) such as for irrigation and industrial use, and replenishment of groundwater basins with highly purified recycled water. Beyond 50,000 AFY, LADWP expects to increase recycled water use by approximately 1,500 AFY annually, bringing the total to 59,000 AFY by 2035.

LADWP's water recycling program is dependent on the City's wastewater treatment infrastructure. Wastewater in the City of Los Angeles is collected and transported through some 6,500 miles of major interceptors and mainline sewers, more than 11,000 miles of house sewer connections, 46 pumping plants, and four treatment plants. BOS is responsible for the planning and operation of the wastewater program. The City's wastewater system serves 515 square miles, 420 square miles of which are within the City. Service is also provided to 29 non-City agencies through contract services. Exhibit 4A shows the City's four wastewater treatment plants and seven sewersheds that feed those plants. A portion of the treated effluent from these four wastewater plants is utilized by LADWP to meet recycled water demands.

As early as 1960, the City recognized the potential for water recycling and invested in infrastructure that processed water to tertiary quality, a high treatment standard for wastewater. This resulted in the building of tertiary wastewater treatment plants upstream instead of enlarging the two existing terminus treatment plants. These system enhancements brought about the City's expanded recycled water projects, which now supplement local and imported water supplies. The original policy allowing the use of recycled water was adopted by the State Legislature in 1969.

In 1979, LADWP began delivering recycled water to the Department of Recreation and Parks for irrigation of areas in Griffith Park. This service was later expanded to include Griffith Park's golf courses.

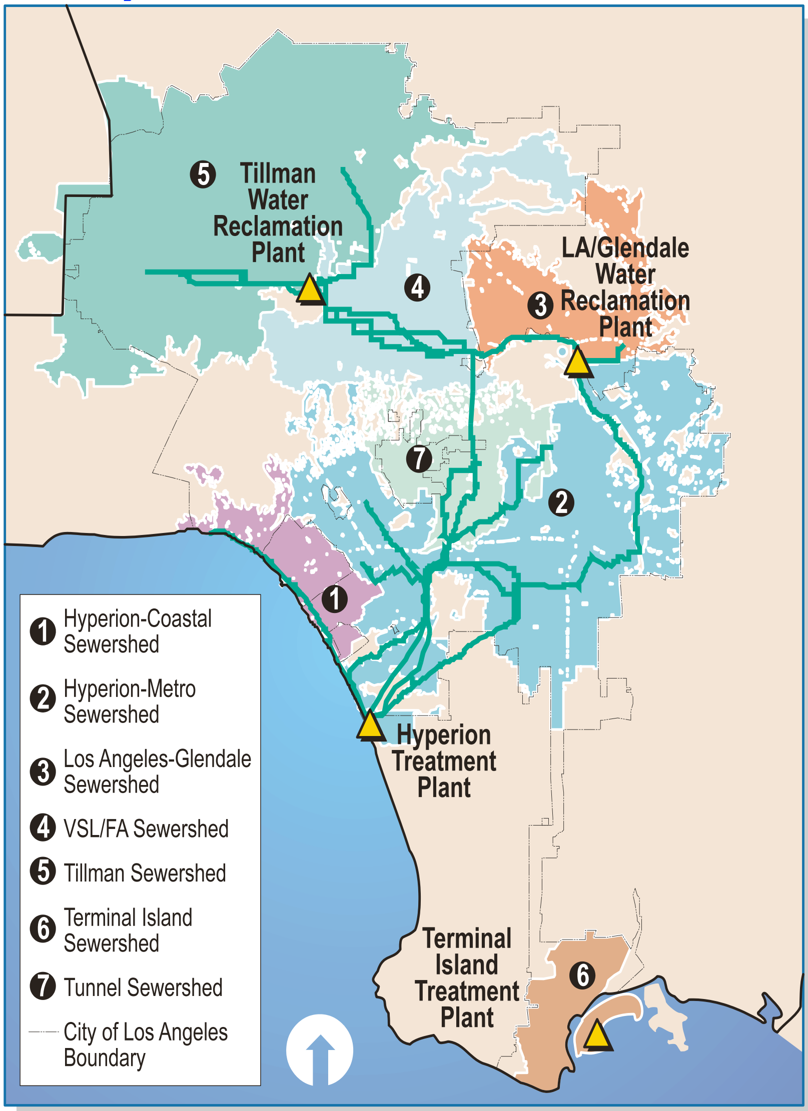


Exhibit 4A City Wastewater Treatment Plants and Sewersheds

In 1984, freeway landscaping adjacent to the park was also irrigated with recycled water. In addition, the Japanese Garden, Balboa Lake and Wildlife Lake in the Sepulveda Basin now utilize recycled water for environmentally beneficial reuse purposes. The Greenbelt Project, which carries recycled water from the Los Angeles-Glendale Water Reclamation Plant to Forest Lawn Memorial Park, Mount Sinai Memorial Park, Lakeside Golf Club of Hollywood and Universal Studios, began operating in 1992, and represents LADWP's first project to supply recycled water to non-governmental customers. LADWP continues to successfully implement the use of recycled water for various purposes. In 2009, phase 1 of the Playa Vista development began receiving recycled water. Playa Vista is the first planned development in the City that uses recycled water for all landscape needs. LADWP serves approximately 130 customers with recycled water for irrigation, industrial, and environmental beneficial uses. Future recycled water projects will continue to build on the success of these prior projects so that recycled water becomes a more prominent component of the City's water supply portfolio.

The City's water recycling projects seek to displace the use of potable water with recycled water for non-potable uses where infrastructure is available. In compliance with Chapters 7.0 and 7.5 of the California Water Code recycled water meets all of the following conditions:

- The source of recycled water is of adequate quality for these non-potable uses.
- The recycled water may be furnished for these uses at a reasonable cost to the user.
- The use of recycled water from the proposed source will not be detrimental to public health.
- The use of recycled water will not adversely affect downstream water rights or degrade water quality.

In addition, the California Water Code requires public agencies, such as the LADWP, to serve recycled water for non-potable uses if suitable recycled water is available.

LADWP is expanding irrigation and industrial/commercial uses of recycled water, and studying groundwater replenishment (GWR). Demand for recycled water is driven by customer acceptance of recycled water as a viable alternative to traditional potable supplies. Outreach efforts designed to educate the public on the viability of recycled water and its potential uses are an essential part of the process as the City's recycled water program expands.

4.1 Regulatory Requirements

Recycled water use is governed by regulations at the State and local levels. These regulations are based on multiple factors including the type of use and water quality. LADWP currently provides recycled water for non-potable reuse and is pursuing indirect potable reuse through GWR using advanced treated recycled water. Requirements for these two categories of recycled water use are different. This section provides a summary of the complex recycled water regulations. A more in-depth description of these regulations will be included as part of the RWMP.

4.1.1 Non-Potable Reuse Regulations

Non-potable water reuse regulations in the City of Los Angeles are governed by the California Department of Public Health (CDPH), State Water Resources Control Board (SWRCB), Los Angeles Regional Water Quality Control Board (LARWQCB) and the Los Angeles County Department of Public Health (LACDPH).

California Department of Public Health

Criteria and guidelines for the production and use of recycled water were established by the CDPH in the California Code of Regulations, Title 22, Division 4, and Chapter 3 (Title 22). Title 22, also known as Water Recycling Criteria, establishes required wastewater treatment levels and recycled water quality levels dependent upon the end use of the recycled water. Title 22 additionally establishes recycled water reliability criteria to protect public health.

Title 22 specifies recycled water use restrictions based on the potential degree of public exposure to the water and the distance of drinking water wells and edible crops from the area of intended use. Recycled water use applicability also depends on the different levels of treatment. A higher quality water will have a wider variety of applicable uses than a lower quality water. At a minimum, secondary treatment of wastewater is required for recycled water use. In the City of LA, however, all recycled water used is treated, at a minimum, to tertiary levels with additional disinfection. Wastewater treatment levels are discussed in detail in subsection 4.2 of this chapter. Title 22 allows for other treatment methods, subject to CDPH approval. The reliability of the treatment process and the quality of the product water must meet the Title 22 requirements specified for each allowable treatment level. Exhibit 4B provides a summary of the currently approved recycled water uses.

Areas where recycled water is used occur within defined boundaries. Title 22 stipulates use area requirements to protect public health. Use area regulations include requirements addressing recycled water application methods and runoff near domestic water supply wells, drinking fountains, and residential areas. Other requirements include posting signs notifying the public where recycled water is being used, utilization of quick couplers instead of hose bibs, and the prohibition against connecting recycled water systems with potable water systems. Dual-plumbed recycled water systems in buildings are also addressed. These systems must meet additional reporting and testing requirements.

To protect public health, Title 22 requires reliability mechanisms. During the design phase, a Title 22 Engineering Report is required to be submitted to CDPH and the local Regional Water Quality Control Board (RWQCB) for approval. Contents of the report include a description of the system and an explanation regarding how the system will comply with Title 22 requirements. Redundancy in treatment

Exhibit 4B Allowable Title 22 Recycled Water Uses

Irrigation Uses
Food crops where recycled water contacts the edible portion of the crop, including all root crops
Parks and playgrounds
School yards
Residential landscaping
Unrestricted access golf courses
Any other irrigation uses not prohibited by other provisions of the California Code of Regulations
Food crops, surface irrigated, above ground edible portion, and not contacted by recycled water
Cemeteries
Freeway landscaping
Restricted access golf course
Ornamental nursery stock and sod farms with unrestricted public access
Pasture for milk animals for human consumption
Non edible vegetation with access control to prevent use as park, playground or school yard
Orchards with no contact between edible portion and recycled water
Vineyards with no contact between edible portion and recycled water
Non food bearing trees, including Christmas trees not irrigated less than 14 days before harvest
Fodder and fiber crops and pasture for animals not producing milk for human consumption
Seed crops not eaten by humans
Food crops undergoing commercial pathogen destroying processing before consumption by humans
Supply for impoundment
Non restricted recreational impoundments, with supplemental monitoring for pathogenic organisms
Restricted recreational impoundments and publicly accessible fish hatcheries
Supply for Impoundment Uses
Non restricted recreational impoundments, with supplemental monitoring for pathogenic organisms
Restricted recreational impoundments and publicly accessible fish hatcheries
Landscape impoundments without decorative fountains
Supply for cooling or air conditioning
Industrial or commercial cooling or air conditioning involving cooling tower, evaporative condenser, or
spraying that creates a mist
Industrial or commercial cooling or air conditioning not involving cooling tower, evaporative
condenser, or spraying that creates a mist
Other Uses
Dual plumbing systems (flushing toilets and urinals)
Priming drain traps
Industrial process water that may contact workers
Structural fire fighting
Decorative fountains
Commercial laundries
Consolidation of backfill material around potable water pipelines
Artificial snow making for commercial outdoor uses
Commercial car washes, not heating the water, excluding the general public from washing process
Industrial process water that will not come into contact with workers
Industrial boiler feed
Nonstructural fire fighting
Backfill consolidation around non potable piping
Soil compaction
Mixing concrete
Dust control on road and streets
Cleaning roads, sidewalks and outdoor work areas
Flushing sanitary sewer
Groundwater replenishment

units or other means to treat, store, or dispose of recycled water are required in case the treatment unit is not operating within specified parameters. Alarms for operators are required to indicate treatment plant process failures or power failures. In case of power failures, either back-up power, automatically activated short-term or long-term recycled water storage, or a means of disposal is required. Furthermore, system performance must be monitored by water quality sampling and analyses.

As mentioned previously, cross-connections between the potable and recycled water systems are not permitted. The California Code of Regulations, Title 17, Division 1, Chapter 5, Group 4 prevents cross-connections between potable water supply systems and recycled water supply systems. Title 17 specifies that water suppliers must implement cross-connection control programs and backflow prevention systems.

In addition to Title 22 and Title 17 requirements, CDPH has additional regulations and guidance established in the following documents:

- Guidelines for the Preparation of an Engineering Report for the Production, Distribution, and Use of Recycled Water (2001)

- Guidance Memo No. 2003-02: Guidance for the Separation of Water Mains and Non-Potable Pipelines (2003)

- Treatment Technology Report for Recycled Water (2007)

State Water Resources Control Board and Los Angeles Regional Water Quality Control Board

In May 2009, the SWRCB adopted "Recycled Water Policy" developing uniform standards across all Regional Water Quality Control Boards for interpreting the "Anti-Degradation Policy". When planning and implementing recycled water projects the following must be taken into consideration:

- Mandate for recycled water use – encourages recycled water use and establishes targets to increase use.

- Salt/nutrient management plans –

requires submittal of salt/nutrient management plans by 2014.

- Landscape irrigation projects' control of incidental runoff and streamlined permitting – addresses controlling incidental runoff and streamlining permit processes for recycled water use in landscape areas.

- Groundwater replenishment – establishes requirements for groundwater replenishment projects.

- Anti-degradation – establishes that salt and nutrient management plans can address groundwater quality impacts.

- Chemicals of emerging concern – establishes a blue-ribbon advisory panel to develop a report on chemicals of emerging concern and update the report every five years.

Water recycling requirements for each of the City's applicable wastewater treatment plants engaged in water recycling are issued by the LARWQCB. These requirements specify end-users of recycled water and enforce treatment and use area requirements.

In July 2009, the SWRCB adopted a general landscape irrigation permit, "General Waste Discharge Requirements for Landscape Irrigation Uses of Municipal Recycled Water" (General Permit). The General Permit streamlines the regulatory approval for landscape irrigation using recycled water. Agencies with existing water recycling requirements, such as the City, are not required to apply for the General Landscape Irrigation Permit.

Earlier in April 2009, the LARWQCB adopted a general region-wide permit, "General Waste Discharge and Water Recycling Requirements for Non-Irrigation Uses over the Groundwater Basins Underlying the Coastal Watersheds of Los Angeles and Ventura Counties" for non-irrigation uses of recycled water. Similar to the General Permit, this permit streamlines the permitting process and specifies the application process for qualifying projects.

Los Angeles County Department of Public Health

Title 22 and Title 17 water use regulations are enforced by the LACDPH, Environmental Health Division. LACDPH has published "A Guide to Safe Recycled Water Use, Pipeline Construction and Installation" requiring compliance with Title 22, CDPH, and LARWQCB requirements. After CDPH has approved the plans and specifications and the City has an agreement to serve the customer, LACDPH reviews and approves all plans and specifications prior to construction. After construction LACDPH inspects the systems and conducts cross-connection, pressure, and back-flow prevention device tests. Recycled water use must occur in compliance with the Los Angeles County Recycled Water Advisory Committee's "Recycled Water Urban Irrigation User's Manual". Each site must also have a site supervisor responsible for recycled water use.

City of Los Angeles

Recycled water responsibilities of the City of Los Angeles include complying with all LARWQCB permits for the wastewater treatment plants and production of recycled water, approving recycled water use sites, conducting post-construction inspections, and periodically inspecting use areas and site supervisor records.

LADWP customers are permitted to use recycled water when service is available per LADWP Ordinance No. 170435 (subsequently amended by Ordinance No. 178902 in 2008). Users are responsible for the operation and maintenance of their recycled water systems up to the connection point with LADWP. Users are required to use recycled water in accordance with Titles 22 and 17 and the "Recycled Water Urban Irrigation User's Manual."

4.1.2 Groundwater Replenishment Regulatory Requirements

The regulations governing recharge of groundwater or groundwater replenishment (GWR) with recycled water are established by the CDPH and LARWQCB. The City's GWR project as described in section 4.4.3 will be subject to these regulations.

For GWR, LADWP will implement advanced treatment that includes reverse osmosis, microfiltration, and advanced oxidation. This level of treatment addresses water quality concerns for the health of the basin along with emerging contaminants of concern.

California Department of Public Health

Regulatory oversight of GWR projects is provided by the CDPH. CDPH regulates GWR projects under Title 22, making recommendations on a case-by-case basis after a public hearing. Requirements for replenishment are not provided in Title 22. Draft GWR Reuse Criteria, released in August 2008, are used by the CDPH to evaluate projects for approval or denial. The draft regulations are designed to protect public health by:

- Requiring recycled water to meet maximum contaminant levels (MCLs) established for drinking water.
- Establishing the volume of recycled water used based on Total Organic Carbon (TOC), dilution, and treatment levels.
- Requiring recycled water to be retained in a groundwater basin for six months before reaching a well used for drinking water with validation by a tracer study.
- Requiring quarterly monitoring for specified pollutants and chemicals and yearly monitoring of constituents indicating the presence of wastewater in produced recycled water and in downgradient monitoring wells.
- Implementing a source control program.
- Establishing additional requirements for projects with recycled water contributions greater than 50 percent, including a review by an Independent Advisory Panel.

As also required for non-potable reuse, project proponents must submit a Title 22 Engineering Report to the CDPH and LARWQCB for review. After completion of the report, the CDPH holds a public hearing followed by issuance of Findings of Fact and Conditions for submission to the LARWQCB.

Los Angeles Regional Water Quality Control Board

Prior to the issuance of a permit, the LARWQCB reviews CDPH's Findings of Fact and Conditions and considers provisions in the adopted Los Angeles Basin Plan (Basin Plan) for the LARWQCB region, applicable State policies (including the SWRCB Recycled Water Policy), and applicable federal regulations if recycled water is discharged to "Waters of the U.S." The Basin Plan establishes water quality objectives for surface water and groundwater to protect beneficial uses. The LARWQCB then holds a public hearing to consider the permit. Ultimately, if approved, permits are issued by the LARWQCB in the form of water reclamation requirements and waste discharge requirements.

4.2 Wastewater Treatment Plants

There are four wastewater treatment plants owned and operated by the BOS. City wastewater treatment consists of a series of processes that, at a minimum, remove solids to a level sufficient to meet regulatory water quality standards. During the preliminary, primary, secondary, and tertiary treatment processes, progressively finer solid particles are removed. Preliminary treatment removes grit and large particles through grit removal basins and screening. Primary treatment relies on sedimentation to remove smaller solids. With most of the grit, large particles, and solids already removed, secondary treatment converts organic matter into harmless by-products and removes more solids through biological treatment and further sedimentation. At the end of secondary treatment, most solids will have been removed from the water. Tertiary treatment follows secondary treatment to eliminate the remaining impurities through filtration and chemical disinfection. At this stage, sodium hypochlorite (the chemical contained in household bleach) provides disinfection. All recycled water used within the City undergoes, at a minimum, tertiary treatment and disinfection. In the Harbor Area, recycled water also undergoes advanced treatment with microfiltration/ reverse osmosis (MF/RO) and is injected into the Dominguez Gap Barrier to protect against seawater intrusion. MF/RO is a two-stage process using high-pressure membrane filters to remove microscopic impurities from the source water. Exhibit 4C summarizes the treatment levels, capacity, and average flows at the four plants.

Exhibit 4C Wastewater Treatment Plants Summary

WastewaterTreatment Plants	Treatment Level	Capacity (mgd)	Average Flows (mgd)[1]
Donald C. Tillman Water Reclamation Plant (DCT)	Tertiary to Title 22 standards with Nitrification/Denitrification	80	32
Los Angeles - Glendale Water Reclamation Plant (LAG)	Tertiary to Title 22 standards with Nitrification/Denitrification	20	17
Terminal Island Water Reclamation Plant (TIWRP)	Tertiary; Advanced treatment (MF/RO) of 5 mgd	30	16
Hyperion Treatment Plant (HTP)	Full secondary[2]	450	299

1. Average FY 2009/10.flows. Approximately 13 mgd is currently diverted from DCT to HTP.

2. 34 mgd of full secondary treated water delivered to West Basin Water Reclamation Plant operated by West Basin Municipal Water District. Water treated to Title 22 standards for recycled water use.

Source: City of Los Angeles, Bureau of Sanitation, Draft Recycled Water Use FY 2009/10.

4.2.1 Donald C. Tillman Water Reclamation Plant

In service since 1985, the Donald C. Tillman Water Reclamation Plant (DCT) has an average dry-weather flow capacity of 80 million gallons per day (mgd) and currently treats about 32 mgd. During wet weather, treatment is limited to 40 mgd to prevent downstream infiltration surcharges on the sewer system while utilizing the remaining capacity for limited wet weather storage. Currently, the Los Angeles Department of Public Works – Bureau of Engineering (BOE) is designing wet-weather storage basins to allow year round operation at 80 mgd. The current level of treatment is Title 22 (tertiary) with nitrogen removal (nitrification/denitrification (NdN)). DCT provides recycled water for the Japanese Garden, Wildlife Lake, Lake Balboa, treatment plant reuse, and irrigation and industrial uses. Irrigation uses in the adjacent areas include golf courses, parks, and a sports complex. Industrial uses include the Valley Generating Station. The remaining tertiary-treated water is discharged into the Los Angeles River. A GWR project is being planned that will purify DCT effluent, utilizing advanced treatment to recharge the San Fernando Groundwater Basin. The project will initially recharge 15,000 AFY with the eventual goal of achieving 30,000 AFY.

4.2.2 Los Angeles-Glendale Water Reclamation Plant

The Los Angeles-Glendale Water Reclamation Plant (LAG) is a joint project of the City of Los Angeles and City of Glendale. LAG began treating wastewater in 1976. Its average dry-weather flow design capacity is 20 mgd and it currently treats about 17 mgd. Each city is entitled to 50 percent of the plant's capacity. The City of Pasadena purchased rights to 60 percent of Glendale's capacity but has not yet exercised these rights. The current level of treatment is Title 22 (tertiary) with nitrogen removal (NdN). Recycled water from the LAG provides landscape irrigation to Griffith Park and the Los Angeles Greenbelt Project, including Forest Lawn Memorial Park, Mount Sinai Memorial Park, Universal Studios, and the Lakeside Golf Course. The City of Glendale retains the right to half of the recycled water produced at the plant and serves a number of customers in their service area. As with the DCT, the remaining tertiary-treated water from LAG is discharged into the Los Angeles River.

4.2.3 Terminal Island Water Reclamation Plant

Originally built in 1935, the Terminal Island Water Reclamation Plant (TIWRP) has been providing secondary treatment since the 1970s. Tertiary treatment systems were added in 1996. TIWRP has a current average dry-weather flow capacity of 30 mgd and treats about 16 mgd. The recently completed Advanced Wastewater Treatment Facility adds MF/RO treatment to a portion of the wastewater effluent to produce approximately 3.0 mgd of recycled water. Recycled water is supplied to the Dominguez Gap Seawater Intrusion Barrier to reduce seawater intrusion into drinking water aquifers, and to LADWP's Harbor Generating Station for landscape irrigation. The remaining TIWRP effluent is discharged to the Los Angeles Harbor. Future recycled water production is expected to increase to more fully supply the Dominguez Gap Seawater Intrusion Barrier along with other potential customers in the Harbor Area.

4.2.4 Hyperion Treatment Plant

Operating since 1894, the Hyperion Treatment Plant (HTP) is the oldest and largest of the City's wastewater treatment plants. Its $1.2 billion construction upgrade, completed in 1999, allows for full secondary treatment. The current average dry-weather flow capacity of HTP is 450 mgd, with an average wastewater flow of 299 mgd. A majority of the treated water is discharged through a 5-mile outfall into the Santa Monica Bay, and the rest, approximately 31 mgd, is delivered to the West Basin Water Reclamation Plant to meet recycled demands in the West Basin Municipal Water District (WBMWD) service area and parts of the City of Los Angeles. As of 2008, approximately 37,000 AFY of water from HTP Plant is sold to WBMWD for additional treatment. A portion of this water is bought back by LADWP to serve to customers in West Los Angeles, and the rest is then used to meet recycled water demands in WBMWD's service area. Customers in West Los Angeles include Loyola Marymount University and Playa Vista.

4.2.5 Projected Wastewater Volume

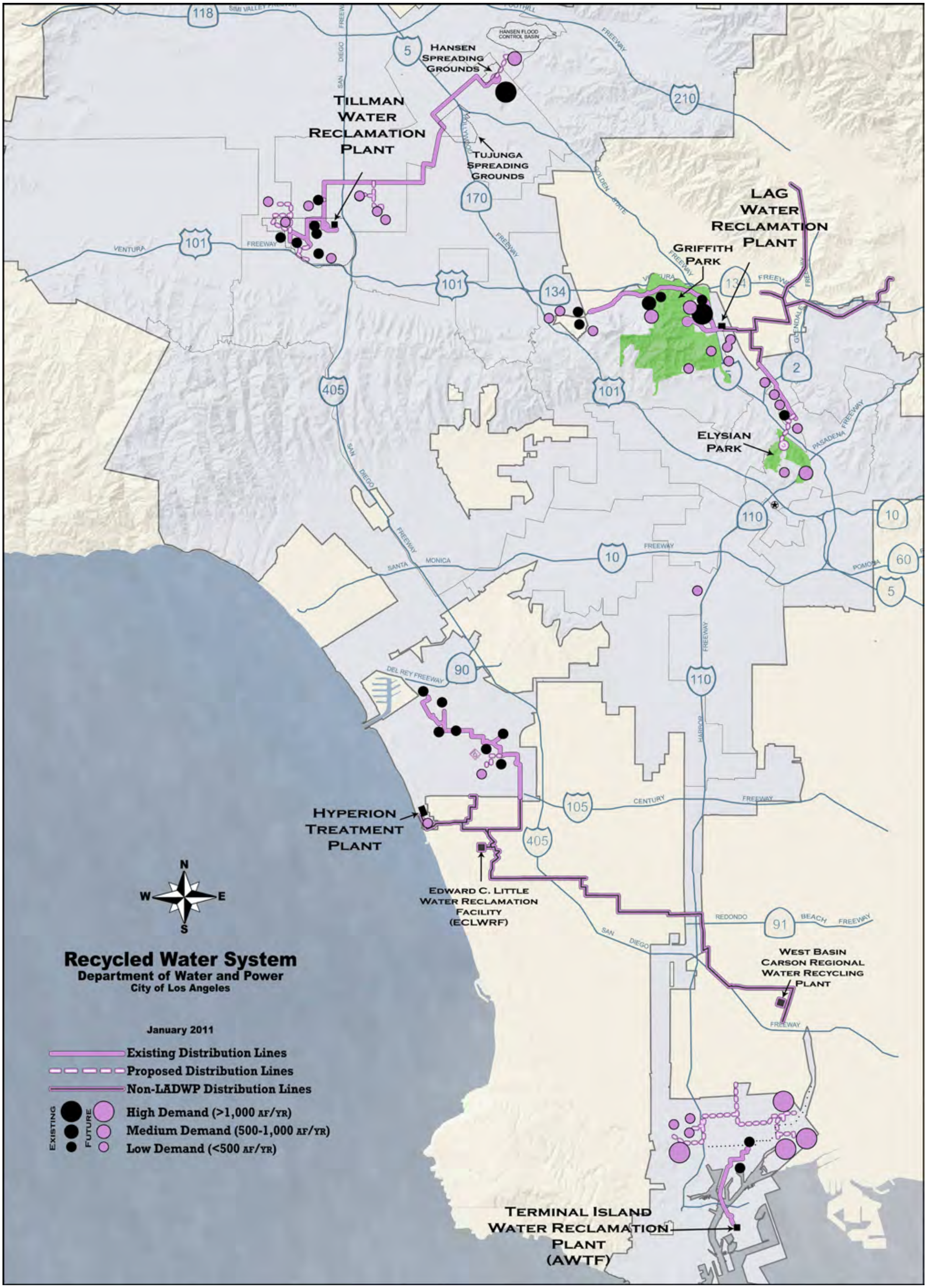
Average dry-weather wastewater influent projections for the City's wastewater treatment plants are expected to increase by approximately 20 percent over the next 25 years. Projections include flows from 29 agencies outside of the City with contracts for wastewater treatment. Wastewater effluent that is not recycled is discharged to either the Pacific Ocean via the Los Angeles River, or to outfalls leading directly to the Pacific Ocean. Wastewater treatment projections of average dry-weather flows through 2035, and associated disposal methods, are provided in Exhibit 4D.

Exhibit 4D Wastewater Treatment Plant Average Dry-Weather Flows, Reuse and Discharge Method

Wastewater Treatment Plants	Reuse and Discharge Method	Average Dry-Weather Flow Projections (AFY)					
		Actual 2010	2015	2020	2025	2030	2035
Donald C. Tillman Water Reclamation Plant	Recycling and Pacific Ocean via Los Angeles River	36,000	84,000	86,000	88,000	90,000	93,000
Los Angeles - Glendale Water Reclamation Plant	Recycling and Ocean via Los Angeles River	19,000	25,000	27,000	29,000	32,000	34,000
Terminal Island Water Reclamation Plant	Recycling and Outfall to Ocean	18,000	19,000	19,000	19,000	20,000	20,000
Hyperion Treatment Plant	Conveyance to WBMWD for Recycling and Ocean outfall	335,000	340,000	346,000	352,000	366,000	381,000
Total		408,000	468,000	478,000	488,000	508,000	528,000

Source: City of Los Angeles, Bureau of Sanitation, Draft Recycled Water Use FY 2009/10. 2015 – 2035 projections from Sanitation's "Project Flow Summary_consultants" file. Data is generated from "Mike Urban" sewer flow projection model, and represents sewershed flows.

Exhibit 4E
Recycled Water System



4.3 Existing Recycled Water Deliveries

The City has several recycled water projects currently providing recycled water for landscape irrigation, industrial, and commercial uses spread throughout four service areas:

- Harbor – located in the southern portion of the City and currently served by TIWRP.
- Central City (Metro) – located in the central/eastern portion of the City and served by LAG.
- San Fernando Valley – located in the northern portion of the City and served by DCT.
- Westside – located in the central/western portion of the City and served by HTP through the WBMWD Edward C. Little Water Recycling Facility (ECLWRF).

Locations of the service areas are depicted in Exhibit 4E. Recycled water service areas coincide with potable water service areas. Recycled water deliveries for 2009 were 38,000 AFY, inclusive of municipal and industrial, environmental, and in-plant reuse. Estimated annual average demands for online projects were 39,000 AFY.

4.3.1 Harbor Area

Recycled water in the Los Angeles Harbor Area is currently produced at the Advanced Water Treatment Facility (AWTF) located at the TIWRP. The AWTF began operating in 2002 with first deliveries to the Dominguez Gap Seawater Barrier in 2006. This project was developed jointly by LADWP, the Bureau of Sanitation (BOS), and BOE. Operation and maintenance is provided by BOS with funding from LADWP. Recycled water, treated using microfiltration and reverse osmosis, is currently used for landscape irrigation and groundwater injection with current demands of approximately 3,050 AFY. Treatment capacity of the AWTP is approximately 5,600 AFY. Excess recycled water is

Exhibit 4F Harbor Recycling

Program	Existing Annual Demand (AFY)
Irrigation	
Harbor Generating Station	50
Seawater Barrier	
Dominguez Gap Barrier (Water Replenishment District)	3,000
Total Harbor Water Recycling Project	**3,050**

Source: City of Los Angeles Recycled Water Master Plan Technical Memorandum, Draft Existing and Tier 1 Recycled Water Systems TM, December 14, 2009 and LADWP Water Recycling Staff

discharged into the Los Angeles Harbor. Exhibit 4F summarizes typical annual demands in the Harbor Area. Currently two customers are served: LADWP's Harbor Generating Station and the Water Replenishment District (WRD).

Water Replenishment District

The WRD's recycled water demands are approximately 3,000 AFY for groundwater injection for the Dominguez Gap Seawater Intrusion Barrier. 50 percent recycled water and 50 percent imported water is injected into the barrier to protect the West Coast Groundwater Basin from seawater intrusion.

LADWP is currently expanding recycled water infrastructure in the Harbor Area to serve large industrial and additional irrigation customers. This will increase recycled water usage by at least 9,300 AFY by FY 2014/15.

4.3.2 Metro Area

The Metro Recycled Water System has supplied the Metro Service Area with recycled water produced at LAG to irrigation customers since 1979. LAG provides recycled water treated to a tertiary level meeting Title 22 standards with nitrogen removal. As previously stated, recycled water produced at LAG is equally split between the cities of Los Angeles and Glendale. Current recycled water demands for the Metro Service Area are 1,930 AFY. Unused recycled water is discharged to the Los Angeles River. Exhibit 4G summarizes current demands for Metro Recycled Water System. Currently, eleven customers are served by the Metro Recycled Water System.

Griffith Park Project

Started in 1979, the Griffith Park project was the City's first recycled water project. Recycled water is used to irrigate two golf courses, parkland, and the Los Angeles Zoo parking lot. Current demands in the Griffith Park Project's service area are 1,120 AFY.

Greenbelt Project

Dedicated in 1992, the Los Angeles Greenbelt Project was the City's first commercial recycling project. Recycled water is used for landscape irrigation at Forest Lawn Memorial Park-Hollywood Hills, Mount Sinai Memorial Park, Lakeside Golf Course and Universal Studios. Current demands in the Greenbelt Project's service area are 720 AFY.

Taylor Yard Project

Rio de Los Angeles State Park was connected as the first Taylor Yard project in July 2009. Recycled water is used for landscape irrigation on the park. Current demands in the Taylor Yard Project's service area are 90 AFY.

Exhibit 4G Metro Recycling

Program	Existing Annual Demand (AFY)
Irrigation	
Greenbelt Project	1120
Griffith Park	720
Taylor Yard Project	90
Total Irrigation	**1,930**

Source: City of Los Angeles Recycled Water Master Plan Technical Memorandum, Draft Existing and Tier 1 Recycled Water Systems TM, December 14, 2009 and LADWP Water Recycling Staff

Exhibit 4H Valley Recycling

Program	Existing Annual Demand (AFY)
Irrigation	
Sepulveda Basin Project	1570
Van Nuys Area Project	14
Subtotal Irrigation	1,584
Industrial	
Hansen Area Project	
Valley Generating Station	2,100
DCT Reuse[1]	2,920
Subtotal Industrial	5,020
Environmental Use[2]	
Japanese Garden	4,590
Wildlife Lake	7,700
Balboa Lake	14,700
Subtotal Environmental Use	26,990
Total Valley Recycled Water System	**33,594**

1. Based on 2006-2008 actual use.
2. Does not include environmental benefits provided to Los Angeles River.
Source: City of Los Angeles Recycled Water Master Plan Technical Memorandum, Draft Existing and Tier 1 Recycled Water Systems TM, December 14, 2009 and LADWP Water Recycling Staff

4.3.3 San Fernando Valley Area

The Valley Recycled Water System receives water from DCT to satisfy irrigation, environmental, and industrial demands. Recycled water is treated to a tertiary level meeting Title 22 standards with nitrogen removal. Current estimated recycled water demands for the San Fernando Valley Area are 33,594 AFY. Recycled water produced in excess of demand is discharged to the Los Angeles River providing added environmental benefits. Exhibit 4H summarizes current demands for the Valley Recycled Water System. The East Valley trunkline, a 54-inch-diameter pipeline, was previously constructed as the initial backbone of the Valley Recycled Water System's distribution system to deliver water throughout the San Fernando Valley for irrigation, commercial, and industrial use. Eleven customers are currently served by the Valley Recycled Water System, excluding DCT reuse and environmental use.

Sepulveda Basin Project

LADWP began serving recycled water to portions of the Sepulveda Basin area in 2007. The latest project was added in 2010. Current recycled water customers in the Sepulveda Basin recreation area include Woodley Golf Course, Balboa Golf Course, Encino Golf Course, Anthony C. Beilenson Park, Van Nuys Golf Course and the Balboa Sports Complex. Current demands in the recreation area are 1,570 AFY.

Van Nuys Area Project

The Van Nuys Area project currently provides recycled water for irrigation purposes to St. Elisabeth's Church, the First Foursquare Church of Van Nuys, Van Nuys High School, and LADWP's Power Distribution Station 81. Current Van Nuys Area Project demands are 14 AFY.

Hansen Area Project

The Hansen Area project currently provides recycled water for industrial purposes to LADWP's Valley Generating

Station. Recycled water service began in 2008 and demands are approximately 2,100 AFY. Recycled water is used in a cooling tower for one of the generation units at the power generating facility.

Donald C. Tillman Water Reclamation Plant Reuse

Recycled water is used at DCT for in-plant purposes. Demands vary from year to year based on needs. Between 2006 and 2008 an average of 2,920 AFY was used.

Environmental Use

Recycled water from DCT has provided environmental benefits since 1984, commencing with deliveries to the Japanese Garden and followed by deliveries to Balboa Lake in 1990 and Wildlife Lake in 1991. Approximate demands are 26,990 AFY. Overflows from these facilities are discharged to the Los Angeles River to provide additional environmental benefits in conjunction with unused recycled water discharges to the river.

Japanese Garden

The 6.5-acre Japanese Garden is located at the Sepulveda Dam Recreation Area. The Garden receives more than 10,000 visitors per year. DCT provides about 4,590 AFY of recycled water for the lake and landscaping at the Japanese Garden.

Wildlife Lake

Located in the Sepulveda Basin, the Wildlife Lake uses about 7,700 AFY of recycled water from DCT for wildlife habitat management.

Lake Balboa

Lake Balboa is the centerpiece of the Sepulveda Dam Recreation Area and is a popular recreational facility located in Anthony C. Beilenson Park. About 14,700 AF per year of recycled water is provided for this lake from DCT.

4.3.4 Westside Area

Recycled water supplied to the Westside Recycled Water System is provided by WBMWD via the Edward C. Little Water Recycling Facility (ECLWRF), located in the City of El Segundo, for irrigation and commercial (toilet flushing) demands. The ECLWRF further treats up to 40 mgd of secondary-treated effluent received from HTP to a tertiary level meeting Title 22 standards. Under an agreement between WBMWD and the City, WBMWD purchases secondary-treated effluent from HTP, and LADWP has a right to purchase up to 25,000 AFY of recycled water from the ECLWRF. Approximately 37,300 AF of secondary-treated effluent was purchased from HTP in 2008, and LADWP purchased 380 AF of recycled water to serve West Los Angeles. Recycled water not purchased by LADWP is sold to users within WBMWD's service area.

Deliveries of recycled water from the Westside Recycled Water System first began in 1996. To increase the use of recycled water in West Los Angeles, LADWP has constructed

Exhibit 4I
Westside Recycled Water System Existing Annual Demand

Program	Existing Annual Demand (AFY)
Playa Vista Phase 1 (95 customers)	205
Coldwell Banker	2
Cal Trans at Playa Vista	5
Los Angeles International Airport	158
Westchester Golf Course	62
Loyola Marymount University	64
Westchester Park	43
Scattergood Generating Station	31
Carl Nelson Youth Park	16
The Parking Spot	1
Street Medians	4
Hyperion Treatment Plant[1]	85
Total Westside Recycled Water System	676

Source: City of Los Angeles Recycled Water Master Plan Technical Memorandum, Draft Existing and Tier 1 Recycled Water Systems TM, December 14, 2009 and LADWP Water Recycling Staff

more than five miles of distribution trunk lines to serve the Westchester, Los Angeles International Airport, and Playa Vista development areas. Current estimated recycled water demands in West Los Angeles are 676 AFY as shown in Exhibit 4I. Currently, 106 customers are served by the system.

Playa Vista

Playa Vista is the first planned development in the City to use recycled water for the irrigation of all of its landscaping and for residential outdoor use. This project began receiving recycled water in 2009. Recycled water is required for outdoor use under the development's mitigation requirements established during the environmental review process. Recycled water is additionally used for toilet flushing in commercial buildings. Annual demands are approximately 200 AFY.

Los Angeles International Airport

Los Angeles International Airport began using recycled water in 1996 for landscape irrigation purposes along its boundaries. Current demands for the airport are 158 AFY.

Loyola Marymount University

Loyola Marymount University has been connected to the Westside system since 1996. Recycled water is used for landscape irrigation on a portion of the campus. Average annual demands are approximately 65 AFY.

Westchester Golf Course

Westchester Golf Course began using recycled water in 2009 for irrigation. Current demands for the golf course are 62 AFY.

Westchester Park and Carl Nelsen Youth Park

Westchester and Carl Nielsen Youth Parks both use recycled water for landscape irrigation. Both parks were connected to the system in 1996. Westchester Park demands are approximately 43 AFY and Carl Nielsen Youth Park demands are 16 AFY.

Scattergood Generating Station

Scattergood Generating Station operated by LADWP and located in El Segundo receives recycled water to meet irrigation demands. Average annual demand is approximately 31 AFY. The pipeline servicing the facility is oversized to potentially provide cooling water in the future.

Street Medians and The Parking Spot

Street medians on Manchester Avenue and The Parking Spot were connected to the recycled water system in 2008 and 2003, respectively. Recycled water is served to both facilities to meet irrigation demands. The Parking Spot is a commercially operated parking facility near Los Angeles International Airport. Demands for The Parking Spot are approximately 1 AFY and demands for the street medians are approximately 5 AFY.

Hyperion Treatment Plant

HTP uses recycled water for both landscape irrigation and toilet flushing within the administration building. HTP was connected to the system in 1996. About 65 AF of recycled water are provided to HTP per year.

4.3.5 Comparison of 2010 Projections Versus Actual Use

LADWP has made progress in increasing recycled water use in the interim period between completion of the 2005 and 2010 UWMPs. Municipal and industrial recycled water use between 2005 and 2010 increased from 1,500 AFY to 6,703 AFY. The 2005 UWMP projected municipal and industrial recycled water

Exhibit 4J
2005 UWMP Recycled Water Projections for 2010 versus Actual Use

Program	2005 Projection for 2010 (AFY)	09/10 Actual Use (AFY)
Municipal & Industrial Purposes[1]	16,950	6,703
Environmental Use[2]	26,990	25,008
Total	**43,940**	**31,711**

1. These recycled water supplies offset the demand for imported water within LADWP's service area, but do not include DCT reuse of 2,920 AFY and deliveries to WBMWD of 34,000 AFY.

2. Typical environmental use is 26,990 AFY, but was not included in 2005 UWMP projection. Water is ultimately discharged into the Los Angeles River, providing additional environmental benefit. 2005 UWMP projections for 2010 are based on average demands.

Sources: City of Los Angeles Recycled Water Master Plan Technical Memorandum, Draft Existing and Tier 1 Recycled Water Systems TM, December 14, 2009; 2005 Urban Water Management Plan for the Los Angeles Department of Water Power, and LADWP Water Recycling Staff

use in 2010 would be approximately 16,950 AF, however actual use was lower than projected, as shown in Exhibit 4J. Environmental use of recycled water fluctuates slightly year to year based on lake levels, but is typically 26,990 AFY. For 2010 actual environmental use was 25,008 AF, or approximately 7 percent less than typical use. Overall total recycled water use in 2010 was approximately 27 percent less than projected.

Although LADWP did not meet the 2010 recycled water projection, program progress has been made, including the completion of multiple projects since 2005 as described in Section 4.3.1 through 4.3.4. Additional projects that are proposed for construction in the near future are described in Section 4.4, Recycled Water Master Planning Documents. Additionally, LADWP in conjunction with the BOS is currently developing the City's Recycled Water Master Plan (RWMP) to guide future optimization of this supply source with the goal of increasing municipal and industrial use of recycled water to 50,000 AFY.

4.4 Recycled Water Master Planning Documents

LADWP, in partnership with BOS, is developing the RWMP to identify projects to offset 50,000 AFY of potable water supplies with recycled water and to maximize recycled water use into the future. As previously discussed, in the City of Los Angeles' Water Supply Plan, "Securing LA's Water Supply", LADWP established a goal of 50,000 AFY of recycled water use to reduce the need for potable water and diversify LADWP's available water supply options. Exhibit 4K summarizes LADWP's timeline to achieve the goal of recycling 50,000 AFY

Exhibit 4K
Recycled Water Master Planning Documents Implementation Timeline

Timeline	Reuse Volume[1] (AFY)	Description
Existing as of Fiscal Year 2009/2010	6,700	Existing demands already being served
Recycled Water Use by 2015	20,000	Near-Term projects already identified for implementation by 2015
Groundwater Replenishment by 2021	15,000	New groundwater replenishment opportunities as identified as part of the Groundwater Master Plan task
Non-Potable Reuse Recycled Water by 2029	Up to 15,000	New projects identified between 2015 and FY 2029 to serve existing potable customers as part of the non-potable reuse master plan

1. Volume to offset municipal and industrial potable water demands. Does not include environmental use, in-plant reuse, and sales to WBMWD.
Source: City of Los Angeles Recycled Water Master Plan Technical Memorandum, Draft Existing and Tier 1 Recycled Water Systems TM, December 14, 2009 and LADWP Water Recycling Staff.

by fiscal year (FY) 2029. This goal can be achieved sooner if additional funds are made available, such as State and Federal grants. The RWMP efforts were initiated in 2009 and are forecast for completion by the middle of 2011. To meet Near-Term challenges and plan for long-term recycled water the following major tasks were outlined for inclusion in the RWMP:

- Groundwater Replenishment Report
- Non-Potable Reuse Report
- Groundwater Replenishment Treatment Pilot Study
- Max Reuse Concept Report
- Satellite Feasibility Concept Report
- Existing System Reliability Concept Report

Within these tasks the RWMP will recommend where the recycled water system can be effectively expanded. A cost benefit analysis will be conducted to identify projects and potential customers based on location and projected use. A review of the wastewater treatment plants will be performed to determine how much recycled water can be supplied. The RWMP will also review available options for maximizing reuse through a combination of alternatives including expansion of non-potable irrigation/industrial uses, and groundwater replenishment (indirect potable reuse), with advanced treated recycled water.

The RWMP will include Near-Term recycled water projects (projects to be implemented through 2015 to achieve 20,000 AFY of recycled water use), expansion of the non-potable distribution system beyond 20,000 AFY, and groundwater replenishment with advanced treated recycled water. When combined with existing reuse, these options are expected to result in 50,000 AFY of reuse by FY 2029, exclusive of environmental reuse, in-plant reuse, and sales to WBMWD. Exhibit 4K provides a timeline for projects featured in the RWMP.

Recycled water projections in five year increments beginning in 2015 through 2035 are presented in Exhibit 4L. Total recycled water use is estimated to increase by approximately 39,000 AFY or 78 percent over the projection period. Environmental reuse and seawater intrusion barrier requirements are expected to remain constant at 26,990 AFY and 3,000 AFY, respectively. Municipal and industrial use, inclusive of in-plant reuse,

Exhibit 4L
Recycled Water Use Projections

Category	Projected Use (AFY)[1]				
	2015	2020	2025	2030	2035
Municipal and Industrial	20,000	20,400	27,000	29,000	29,000
Indirect Potable Reuse (Groundwater Replenishment)	0	0	15,000	22,500	30,000
Subtotal[2]	**20,000**	**20,400**	**42,000**	**51,500**	**59,000**
Environmental[3]	26,990	26,990	26,990	26,990	26,990
Seawater Intrusion Barrier (Dominguez Gap Barrier)	3,000	3,000	3,000	3,000	3,000
Total	**49,990**	**50,390**	**71,990**	**81,490**	**88,990**

1. Projected use by category is subject to change per completion of Recycled Water Master Plan, but overall total will not change. Does not include deliveries of 34,000 AFY of secondary treated water to WBMWD for further treatment to recycled water standards.

2. To offset potable use and included in supply reliability tables in Chapter 11.

3. Environmental use includes Wildlife Lake, Balboa Lake, and the Japanese Garden. Additional environmental benefits associated with recycled water discharges to the Los Angeles River are not included.

is expected to increase to 29,000 AFY or by approximately 45 percent. Indirect potable reuse (groundwater replenishment (GWR) with advanced treated recycled water is forecast to provide 15,000 AFY of GWR beginning in 2021. Recycled water use up to 2025 is inclusive of the Near-Term options under development in the RWMP. Projections for 2030 and 2035 assume that long-term options being developed as part of the RWMP will increase recycled water use by approximately 1,500 AFY annually beyond FY 2029. Once the alternatives for the RWMP are finalized, the allocation of recycled water use by the municipal, industrial, and GWR categories may change to achieve the RWMP's recycled water goal of 50,000 AFY by FY 2028/29.

Estimates of projected use and implementation timelines in the tables above, as well as the annual demands and service dates for individual customers in the following sections, may be affected by varying usage patterns of potential customers, timelines to reach agreements, potential financial constraints, and changing regulatory requirements.

4.4.1 Near-Term Projects through 2015

"Near-Term" projects are classified in the RWMP as projects that will result in recycled water service between July 1, 2009 and 2015 to achieve approximately 20,000 AFY of recycled water use to displace potable water use. All Near-Term projects are either in the planning, design, or construction stage. Near-Term project target customers have already been identified as potential recycled water users with a total demand of 15,021 AFY. Implementation of Near-Term projects will result in the connection of approximately 40 additional recycled water customers adding to the existing 130 customers. Full implementation of Near-Term projects with existing projects will result in annual recycled water deliveries of approximately 20,000 AFY, exclusive of both environmental use and DCT in-plant use (26,990 and 2,920 AFY, respectively). Near-Term projects fall primarily in the commercial/industrial sector, followed by the irrigation sector.

Harbor Area

Two projects are planned to meet Near-Term demands in the Harbor Area: the Harbor Refineries Water Recycling Project and the Port of LA Harry Bridges Development, for an estimated total demand of 9,461 AFY. Uses include industrial, irrigation, and toilet flushing in commercial facilities. Most of the recycled water, approximately 9,520 AFY, will be used for industrial purposes, including cooling towers and boiler make-up water for large industrial customers. Exhibit 4M summarizes Near-Term demands for the Harbor Area.

Meeting demands in the Harbor Area will require construction of additional

Exhibit 4M
Harbor Area Near-Term Estimated Demands

Type	Estimated AnnualDemand (AFY)	Estimated Service Date
Harbor Irrigation	300	2014
Port of LA Irrigation/Commercial/Industrial	220	2015
Harbor Commercial/Industrial	9,000	2014-2015
Total Harbor Area Near-Term Demands	**9,520**	

Source: City of Los Angeles Recycled Water Master Plan Technical Memorandum, Draft Existing and Near-Term Recycled Water Systems TM, December 14, 2009 and LADWP Water Recycling Staff infrastructure. Approximately 12 miles of 8- to 30-inch diameter pipeline and a 1 million gallon storage tank are proposed. All infrastructure to serve the Port of LA Harry Bridges Development will be constructed by the Los Angeles Harbor Department.

Through an agreement with WBMWD, LADWP will be supplied nitrified Title 22 water from the WBMWD Juanita Millender-McDonald Water Treatment Plant to supply recycled water to the Harbor Area.

Metro Area

Nine water recycling projects and three customer connections are planned in the Metro Area to add annual demands of approximately 1,813 AFY. Almost all recycled water customers propose to use recycled water for irrigation. Commercial uses of recycled water include street sweeping, vehicle washing, train washing, and laundry. LAG will continue to meet all recycled water demands in the Metro Area. Exhibit 4N summarizes Near-Term demands for the Metro Area.

Exhibit 4N
Metro Area Near-Term Estimated Demands

Type	Estimated Annual Demand (AFY)	Estimated Service Date
Irrigation	1,713	2010-2015
Commercial/ Industrial	100	2011-2013
Total Metro Area Near-Term Demands	**1,813**	

Source: City of Los Angeles Recycled Water Master Plan Technical Memorandum, Draft Existing and Near-Term Recycled Water Systems TM, December 14, 2009 and LADWP Water Recycling Staff

Multiple facilities are required in the Metro Area to meet Near-Term demands. Approximately five pump stations ranging in size from 600 to 1,800 gallons per minute are planned for construction. Three water tanks with a combined capacity 4.75 million gallons, including the conversion of an abandoned potable water tank in Griffith Park into a non-potable water storage tank, are necessary to meet demands. Pipeline construction will consist of 10 additional miles of pipeline ranging from 8- to 30-inch diameters, including conversion of an existing 16-inch pipeline to a 30-inch pipeline beneath Forest Lawn Road.

Valley Area

In the Valley Area DCT will provide the potential Near-Term annual demands approximating 769 AFY. Almost all Near-Term use, except for 75 AFY, will be for irrigation purposes. These users are all located within close proximity to the existing recycled water system. Exhibit 4O summarizes the potential Near-Term demands for the Valley Area.

Exhibit 4O
Valley Area Near-Term Estimated Demands

Type	Estimated Annual Demand (AFY)	Estimated Service Date
Irrigation	769	2010-2013
Commercial/ Industrial	75	2010-2013
Total Valley Area Near-Term Demands	**844**	

Source: City of Los Angeles Recycled Water Master Plan Technical Memorandum, Draft Existing and Near-Term Recycled Water Systems TM, December 14, 2009 and LADWP Water Recycling staff

Only minor facilities will be required to connect Near-Term users to the existing system. Approximately 2 miles of pipeline ranging from 16- to 20-inch in diameter are proposed. Additionally, one storage tank between 1 to 1.5 million gallons, and a pump station, will be required to meet demands.

Westside Area

LADWP will continue to acquire recycled water from WBMWD to serve Near-Term demands of approximately 350 AFY in the Westside Area. Near-Term demands

Exhibit 4P
Westside Area Near-Term Estimated Demands

Project	Estimated Annual Demand (AFY)	Estimated Service Date
Irrigation		
Playa Vista Phase 2	100	2015
Westchester High School	10	2012
Subtotal Irrigation	100	
Commercial/Industrial		
LAX Cooling Towers	240	2015
Subtotal Commercial/Industrial	240	
Total Westside Area Near-Term Demands	**350**	

Source: City of Los Angeles Recycled Water Master Plan Technical Memorandum, Draft Existing and Near-Term Recycled Water Systems TM, December 14, 2009 and LADWP Water Recycling Staff

include increasing use within the Playa Vista development, at LAX, and by adding five new customers. Approximately two-thirds of the water will be for irrigation purposes and one-third for commercial/ industrial uses in cooling towers located at LAX. Exhibit 4P summarizes Near-Term demands for the Westside Area.

Serving Near-Term demands will require limited expansion of the existing recycled water system in the area as additional users connect to the existing system. Connection of the cooling towers at LAX will require construction of an additional 0.7 miles of 12-inch diameter pipeline.

4.4.2 Non-Potable Reuse Projects to be completed between 2015 - 2029

Non-potable reuse projects to be completed between 2015 and 2029 are being identified through the development of the RWMP. These projects will make up the balance of recycled water demand up to the 15,650 AFY non-potable reuse goal, which will contribute to achieving the overall city goal of 50,000 AFY of recycled water displacing potable water uses.

As presented in Exhibit 4Q, the project options would have a total demand of approximately 23,100 AFY, which is larger than the goal of up to 15,650 AFY. Ultimately, an implementation plan will be developed for the recommended project options with a target of beginning operations for all projects included in the implementation plan by FY 2029.

Exhibit 4Q
Project Option Demands by Service Area

Service Area	Total Demand[1] (AFY)
Harbor	3,300
Metro	6,100
Valley	10,100
Westside	3,600
Total	**23,100**

1. Includes customers with non-potable demand estimates greater than 5 AFY.

Source: City of Los Angeles Recycled Water Master Plan Technical Memorandum, Draft Tier 2 Non-Potable Reuse Project Options, February 26, 2010

Project Selection

An initial step for evaluating these projects involves identification of potential potable water customers that can utilize recycled water. These customers need to have sufficient demand and a viable use for recycled water. Irrigation-only customers were focused on first as they are generally easier to convert to recycled water use than commercial or industrial users. As described below, during development of the project options, potential additional recycled water customers were identified based on their non-potable water demands and distance from recycled water sources.

Next, recycled water project options were developed to meet the goal of maximizing recycled water use, while promoting cost efficiency, implementability and adaptability. Two primary steps were utilized to develop recycled water project options:

- Identification of project segments to serve each customer with non-potable demands in excess of 50 AFY.
- Identification of project options combining project segments that are linked and have similar unit costs.

The first step in the development of project options was to define general project areas based on customers with non-potable demands in excess of 50 AFY. In the project areas, transmission pipeline alignments (backbone alignments) and laterals were defined to connect customers with demands greater than 50 AFY to existing recycled water infrastructure. Alignments were then redefined to connect demand clusters of less than 50 AFY, but large enough for consideration as a large demand. Finally, distribution pipeline (laterals) alignments were determined to connect customers with demands less than 50 AFY to backbone alignments.

Initial project options and unit costs are being identified in the current phase of the RWMP. Options for non-potable reuse transmission (purple) pipelines are considered in conjunction with options developed for groundwater replenishment (see section 4.4.3). Additional information on recycled water unit cost is presented in section 4.4.5 – RWMP Cost and Funding.

Recycled Water Supply Sources

Recycled water availability varies by service area. Additional supplies may be required to meet longer term demands between 2015 – 2029 that may require a combination of expanding existing facilities, service connections to neighboring agencies outside the City, new facilities, and satellite treatment facilities. Satellite treatment facilities are being investigated in the Metro, Valley, and Westside service areas. The RWMP is investigating options to ensure adequate supplies are available for each service area. As part of the RWMP, LADWP met with neighboring agencies in 2009 to explore potential opportunities for regional development of recycled water reuse facilities. These agencies are listed in Exhibit 4T, in section 4.4.6, Stakeholder Process and Agency Coordination.

4.4.3 Groundwater Replenishment

As part of the RWMP, LADWP is pursuing a Groundwater Replenishment (GWR) Project, also known as indirect potable reuse, using highly purified advanced treated recycled water from DCT for spreading in existing spreading basins in the San Fernando Valley area. An advanced water treatment facility is necessary to further treat tertiary effluent from DCT to produce highly purified recycled water for recharge. A minimum GWR goal of 15,000 AFY by 2021 has been set for recharging the San Fernando Basin, a major potable water supply for LADWP. This project would recharge a minimum of 15,000 AFY of advanced treated water in the existing Hansen Spreading Grounds and possibly the

Pacoima Spreading Basins by allowing the water to percolate into the aquifer. The City anticipates having the ability to eventually deliver greater amounts of water up to 30,000 AFY to the GWR.

The RWMP includes a GWR plan outlining various operational and capital infrastructure improvements required to meet these goals. Infrastructure improvements required to implement the GWR program include an advanced water treatment facility and pipelines to convey the product water to the spreading basins. Pipelines to convey water to the Hansen Spreading Grounds are already in place and were constructed as a part of the previous recycled water initiatives for the East Valley Water Recycling Project. However, if the Pacoima Spreading Basins will also receive water for spreading, then additional pipeline infrastructure will be required.

Native stormwater recharge will continue to occur at the spreading grounds in conjunction with the project. Currently, LADWP and the Los Angeles County Department of Public Works use multiple spreading grounds located in the eastern portion of the San Fernando Basin to recharge the underlying San Fernando Basin with stormwater. A detailed discussion of the San Fernando Basin and existing recharge operations is provided in Chapter 6, Local Groundwater.

Goals for the advanced water treatment plant include as described in the RWMP are:

- Minimum capacity of 15,000 AFY with the potential to expand to 30,000 AFY.

- Initially in service by 2021.

- Utilization of proven technologies that have demonstrated effective removal of regulated chemicals, constituents of emerging concern, and microorganisms; additional removal of constituents of wastewater origin of interest to CDPH, including pharmaceuticals, personal care products, and endocrine disrupting compounds.

- Product water shall comply with requirements from the CDPH, RWQCB, and SWRCB and be suitable for indirect potable reuse.

To develop and implement the project expeditiously, the advanced wastewater treatment plant will be based on the recently permitted Orange County Water District Groundwater Replenishment System Project. This system provides product water for indirect potable reuse by recharging a groundwater basin used for potable water and preventing seawater intrusion. Proposed technologies include microfiltration or ultrafiltration, reverse osmosis, advanced oxidation using ultraviolet light with hydrogen peroxide, and post-treatment for product water stabilization. As a by-product of advanced water treatment, brine is created. Multiple brine disposal alternatives are presented in the RWMP, and a final alternative will be selected upon completion of the plan.

LADWP is working closely with BOS and regulatory agencies to expedite completion of the project by 2021. Current ongoing tasks include completion of the RWMP, public outreach, pilot testing of GWR treatment processes, and ongoing participation of an independent advisory panel. Environmental documentation is expected to be initiated in 2011 and completed in 2013. The RWMP also outlines the regulatory approval steps required. Regulatory requirements for GWR are discussed in sub-section 4.1.2, GWR Regulatory Requirements.

Independent Advisory Panel

GWR projects typically have the involvement of an independent third party with scientific and technical expertise to provide expert peer review of key aspects of the project, which can ensure the technical viability of the GWR and facilitate the regulatory process. To accomplish this, LADWP awarded a contract with the National Water Research Institute (NWRI) to form an Independent Advisory Panel (IAP) to provide expert peer review of the technical, scientific, regulatory, and policy aspects of the proposed GWR project, pilot project testing, and other potential groundwater replenishment projects to maximize reuse as part of the LADWP Recycled Master Planning Documents. The IAP process will provide a consistent, thorough, and transparent review of any proposed GWR projects and pilot testing during their critical formation phase, as well as during the long-term implementation phase.

NWRI has vast experience in the organization and administration of the IAP processes for other agencies such as the Orange County Water District Groundwater Replenishment System Project. NWRI will assist the IAP process by assembling the IAP members, developing a detailed scope and approach for the IAP's review, coordinating and facilitating meetings, and preparing IAP reports.

Some of the immediate activities that have been identified for the IAP to address during the initial participation include, but are not limited to review of the following:

- General approach for Recycled Water Master Planning
- Hydrogeology (in-basin groundwater blending)
- Treatment (barriers to replace the fifty-percent blend criteria)
- Reliability features of the Advanced Water Treatment Facility
- Source Control Evaluation for GWR
- Draft Engineering Report for GWR
- Response to technical concerns raised by regulators and the public

The "Independent Advisory Panel for the City of Los Angeles Groundwater Replenishment Project" consists of 13 members with scientific and/or professional expertise in issues related to the implementation of groundwater replenishment projects. The selection of members with different areas of expertise was based on the requirements of the California Department of Public Health Draft GWR Reuse Regulations dated August 2008, as well as the composition of panels used by the Orange County Water District and the City of San Diego for the implementation of similar groundwater replenishment projects.

NWRI convened the Independent Advisory Panel for the first time in October 2010 to receive introductory information about the recycled water program and groundwater replenishment project. The Panel is expected to be involved throughout the planning, permitting, design, environmental documentation, and implementation of the groundwater replenishment project.

4.4.4 Efforts Beyond 50,000 AFY

As part of the RWMP, LADWP is developing long-term alternatives to maximize recycled water use beyond 50,000 AFY. After 2029 and through 2035 LADWP expects to increase recycled water use by approximately 1,500 AFY annually. To maximize recycled water use LADWP is investigating the following options in its RWMP:

- Recycled water satellite treatment facilities.
- Expansion of recycled water systems.
- Increasing treatment levels at HTP to tertiary and advanced treatment.
- Reviewing opportunities for partnerships with agencies within and outside of the City.
- Treatment plant upgrades at DCT and LAG.
- Methods to increase reliability of the system.

Additionally, the RWMP will identify how the City can maximize recycled water usage into the future beyond the 50,000 AFY goal. The long-term recycled water alternatives analysis, as part of the RWMP, have not been completed. However, LADWP forecasts that in 2035, municipal and industrial recycled water deliveries along with groundwater replenishment will be approximately 59,000 AFY. In addition to this, 26,990 AFY will also be used for environmental beneficial reuse.

4.4.5 RWMP Cost and Funding

The capital cost of expanding the recycled water system to achieve the initial goal of displacing 50,000 AFY of potable water demand was initially estimated at approximately $1 billion. This cost is being refined as part of the RWMP and is expected to be updated by mid-August 2011.

Unit Cost

Non-potable reuse and GWR projects are diverse, and result in a wide range of costs to implement and sustain. Non-potable reuse projects present numerous challenges, including distance from treatment plant and the associated transmission pipeline construction costs. This is weighed against customer size and recycled water adaptability to a particular commercial site or process. Initial findings of the RWMP have determined the approximate range of cost for water recycling projects to be from $600 to $1,500 per acre-foot. This approximation includes capital, operation, and maintenance costs.

Funding

Capital costs for RWMP projects will be covered by the funding sources identified below, as well as other sources as they become available.

- Water Rates – LADWP water rates are the primary funding source for the recycled water program.

- Federal Funding – LADWP will pursue Federal funding as it becomes available. In the past LADWP has received funding for recycled water projects from the Federal Water Project Authorization and Adjustment Act of 1992, Public Law 102-575 (HR429), and the United States Bureau of Reclamation Title XVI Program.

- State Funding – LADWP will pursue State funding as it becomes available, through the SWRCB and DWR for recycled water projects. Propositions 13 and 50 had funds specifically marked for recycled water projects. Funding is available through Proposition 84, Integrated Regional Water Management, for implementation projects, including recycled water projects. Low-interest loans are available through the SWRCB for eligible projects.

- MWD Local Resources Program Incentive – The Local Resources Program provides funding for water recycling and groundwater recovery projects that prevent a new demand on MWD or displace an existing demand on MWD. Financial incentives up to $250 per acre-foot are available dependent upon MWD water rates and projects costs.

4.4.6 Outreach and Agency Coordination

Outreach with key stakeholders and the public, and coordination with agencies is necessary for the success of LADWP's recycled water program.

Stakeholder Process

To encourage input as recycled water strategies are developed over the next few years in conjunction with the RWMP, LADWP has initiated an extensive outreach process. LADWP has developed two formats for participation of key stakeholders in the Recycled Water Advisory Group (RWAG), and for public participation in the Recycled Water Forums.

The more than 200 stakeholders invited to participate in the RWAG represent broad interests across the City, including community groups, environmental groups, neighborhood councils, homeowners' associations, and others. Approximately 65 stakeholders are participating in the process. The RWAG first met in 2009 and will have approximately five workshops per year over the next few years. Through the RWAG, stakeholders are provided the opportunity to represent their respective organizations, share input with LADWP and BOS, and convey information back to their organizations. Two main roles of the RWAG are:

1. Allow stakeholders to provide input on recycled water options from technical, environmental, financial, and social viewpoints.

2. Consider key project issues and discuss implementation challenges and acceptability.

Recycled Water Forums provide the general public an opportunity to learn about the LADWP Recycled Water Program and submit comments that will be considered before the RWMP is adopted.

Agency Coordination

To maximize recycled water use and move forward with RWMP efforts, LADWP closely coordinated with agencies at the local and state levels. Coordination is necessary to ensure adequate funding, identification of end-users, adequate availability of supplies, permitting and regulatory approvals, and regional cooperation. If Federal funding opportunities become available, LADWP will also coordinate with the applicable Federal agencies. Exhibit 4R provides a summary list of agencies LADWP is currently coordinating with to maximize recycled water use.

Financial Incentives

LADWP also coordinates recycled water end use with potential customers by assisting with facility retrofits and public education. Recycled water is provided to customers at a cost less than potable water. LADWP is also considering implementing a new incentive program designed to assist with onsite retrofits to convert customers to the use of recycled water.

Exhibit 4R
Recycled Water Agency Coordination

Burbank Water and Power[1]	Los Angeles County Department of Public Works[1]
Central Basin Municipal Water District[1]	Metropolitan Water District of Southern California[1]
Glendale Water and Power[1]	Pasadena Water and Power[1]
Los Angeles County Sanitation Districts[1]	Water Replenishment District of Southern California[1]
Long Beach Water Department[1]	West Basin Municipal Water District[1]
Las Virgenes Municipal Water District[1]	Los Angeles Regional Water Quality Control Board
State Water Resources Control Board	Los Angeles County Department of Public Health
City of Los Angeles Department of Public Works, Bureau of Sanitation, Watershed Protection Division	City of Los Angeles Department of Public Works, Bureau of Sanitation
California Department of Public Health	

1. Met with agencies individually to discuss potential regional recycled water use.

4.4.7 Recycled Water Quality

All recycled water provided by LADWP meets, at minimum, Title 22 standards. Title 22, Chapter 4, of the California Code of Regulations establishes water quality standards and treatment reliability criteria for water recycling to ensure public safety as discussed in Section 4.1. Title 22 standards are achieved with tertiary treatment and disinfection.

Advanced wastewater treatment is currently provided for the Dominguez Gap Seawater Barrier at the TIWRP by the AWTF. The AWTF has advanced treatment that includes microfiltration and reverse osmosis, which removes many of the impurities remaining after tertiary treatment and disinfection. This treatment will be implemented for the planned groundwater replenishment project being developed through the RWMP. Purified DCT effluent used to recharge the San Fernando Basin will undergo additional treatment, including microfiltration, reverse osmosis, and advanced oxidation. Exhibit 4C, located in Section 4.2, summarizes the level of treatment provided by each of the City's water reclamation plants.

Chapter Five

Los Angeles Aqueduct System

5.0 Overview

Water has been an integral part of the City's history. The City's population and economy was initially supported through a combination of local surface flows primarily from the Los Angeles River, and groundwater pumping primarily from the San Fernando Basin. When it became apparent that much of the local groundwater supply and local surface flows were fully utilized, the citizens of Los Angeles under the leadership of William Mulholland, then Chief Engineer of the Los Angeles Water Bureau, approved by a 10 to 1 margin a $23 million bond measure to construct the First Los Angeles Aqueduct in 1913. This investment was equal to 12 percent of the entire City's assessed valuation at that time. Then in 1940, an additional $40 million was spent to extend the first aqueduct 40 miles north from the Owens River to streams that were tributaries to Mono Lake, see Exhibit 5A.

To meet the additional water needs of its population, the City decided to construct the second barrel of the Los Angeles Aqueduct in 1963, later to become known as the Second Los Angeles Aqueduct. Construction of the Second Los Angeles Aqueduct was completed in 1970. The second aqueduct increased the City's capacity to deliver water from the Mono Basin and the Owens Valley to Los Angeles from 485 cubic feet per second (cfs) to 775 cfs.

The value of the City's historical investment in the Los Angeles Aqueduct System is substantial. For nearly a century, the City has benefited from the delivery of high-quality, cost-effective water supplies from the eastern Sierra Nevada.

Exhibit 5A
Los Angeles Aqueduct System

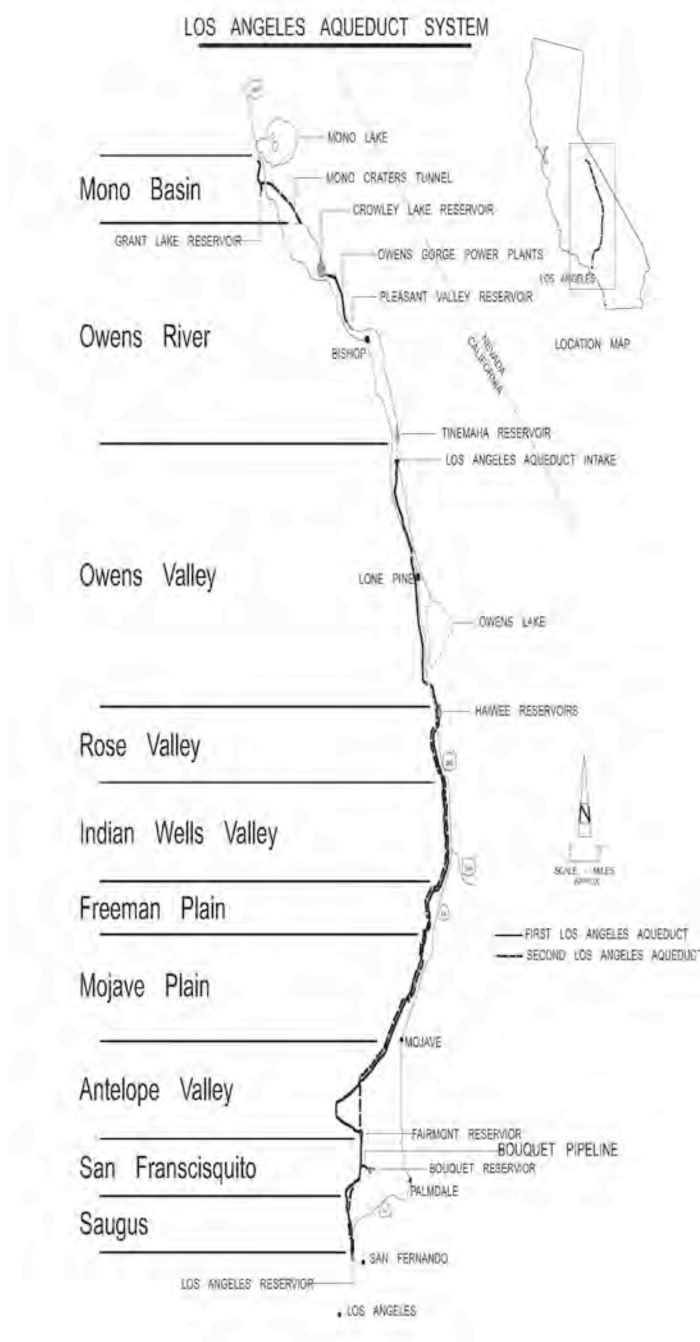
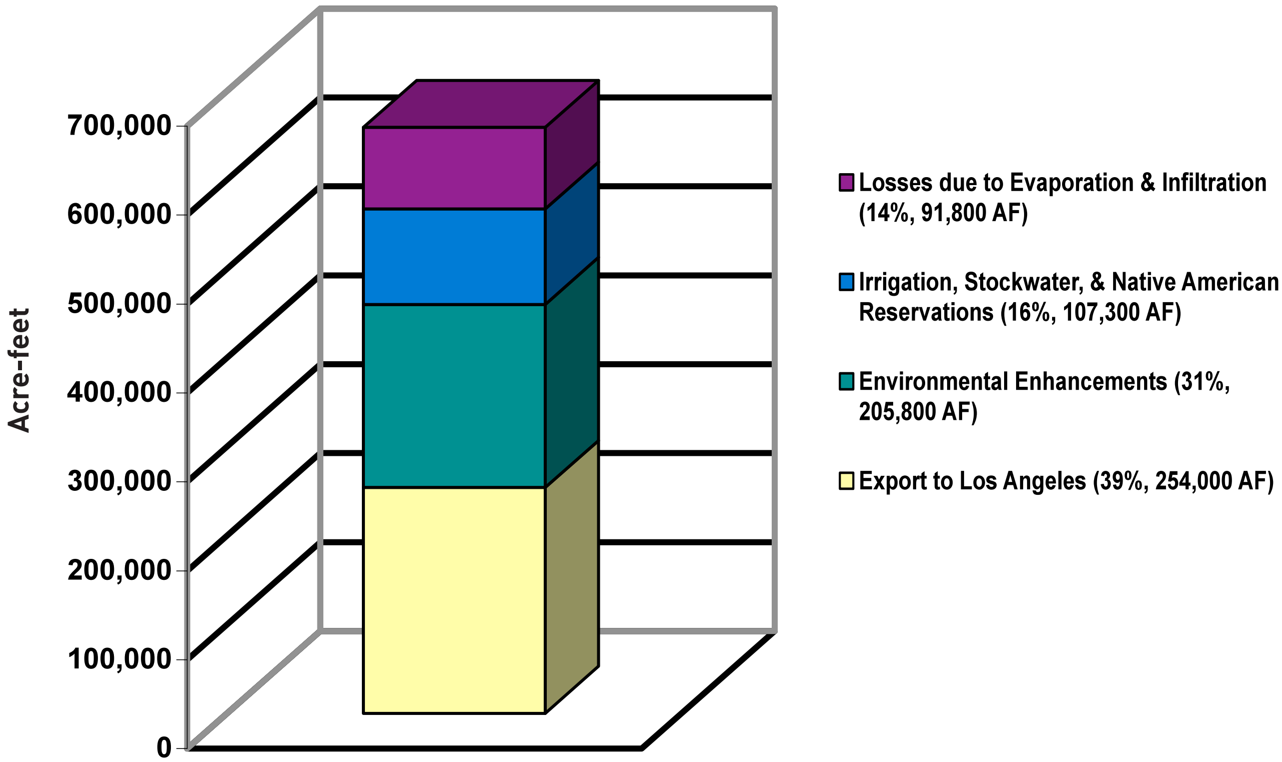


Exhibit 5B
Mono Basin and Owens Valley Water Use Allocations



Over time, environmental considerations have required that the City reallocate approximately one-half of the Los Angeles Aqueduct (LAA) water supply to environmental mitigation and enhancement projects. As a result, the City has used approximately 205,800 AF of water supplies for environmental mitigation and enhancement in the Owens Valley and Mono Basin regions in 2010, which is in addition to the almost 107,300 acre-feet per year (AFY) supplied for agricultural, stockwater, and Native American Reservations. Limiting water deliveries to the City from the LAA has directly led to increased dependence on imported water supply from the Metropolitan Water District of Southern California (MWD). LADWP's purchases of supplemental water from MWD in FY 2008/09 hit an all time high.

As indicated in Exhibit 5B, LAA deliveries comprise 39 percent of the total runoff in the eastern Sierra Nevada in an average year. The vast majority of water collected in the eastern Sierra Nevada stays in the Mono Basin, Owens River, and Owens Valley for ecosystem and other uses.

5.1 Historical Deliveries

Annual LAA deliveries are dependent on snowfall in the eastern Sierra Nevada. Years with abundant snowpack result in larger quantities of water deliveries from the LAA, and typically lower supplemental water purchases from MWD. Unfortunately, a given year's snowpack cannot be predicted with certainty, and thus, deliveries from the LAA system are subject to significant hydrologic variability.

The impact to LAA water supplies due to varying hydrology in the Mono Basin and Owens Valley is amplified by the requirements to release water for environmental restoration efforts in the eastern Sierra Nevada. Since 1989, when City water exports were significantly reduced to restore the Mono Basin's ecosystem, LAA deliveries from the Mono Basin and Owens Valley have ranged from 108,503 AF in FY 2008/09 to 466,584 AF in FY 1995/96. Average LAA deliveries since FY 1989/90 have been approximately 264,799 AF, about 42 percent of the City's total water needs.

The cyclical nature of hydrology is exhibited best by LAA deliveries over the last ten years. This general period was characterized by a series of wet years, followed by a series of dry years. From FY 2000/01 through 2009/10, LAA deliveries supplied an average of 36 percent of the City's water needs. The reliability impact of hydrologic cycles on LAA supplies is evident through historical deliveries. A broader look at how deliveries from the LAA have fluctuated from year to year is shown in Exhibit 5C.

A long term perspective of the general cycle of wet and dry years for the Owens Valley is evident in Exhibit 5D, particularly since the late 1960s. As illustrated, reliance solely on one water supply source is not practical. Therefore, the City relies on the LAA in combination with the Colorado River Aqueduct and the State Water Project as the City's primary imported water sources. These imported sources combined with local groundwater, recycled water, and conservation make up the City's total water supply portfolio. This portfolio of water resources is fundamental to LADWP's ability to deliver a reliable water supply to meet the needs of over 4 million residents of Los Angeles.

Exhibit 5C
Historical Los Angeles Aqueduct Deliveries

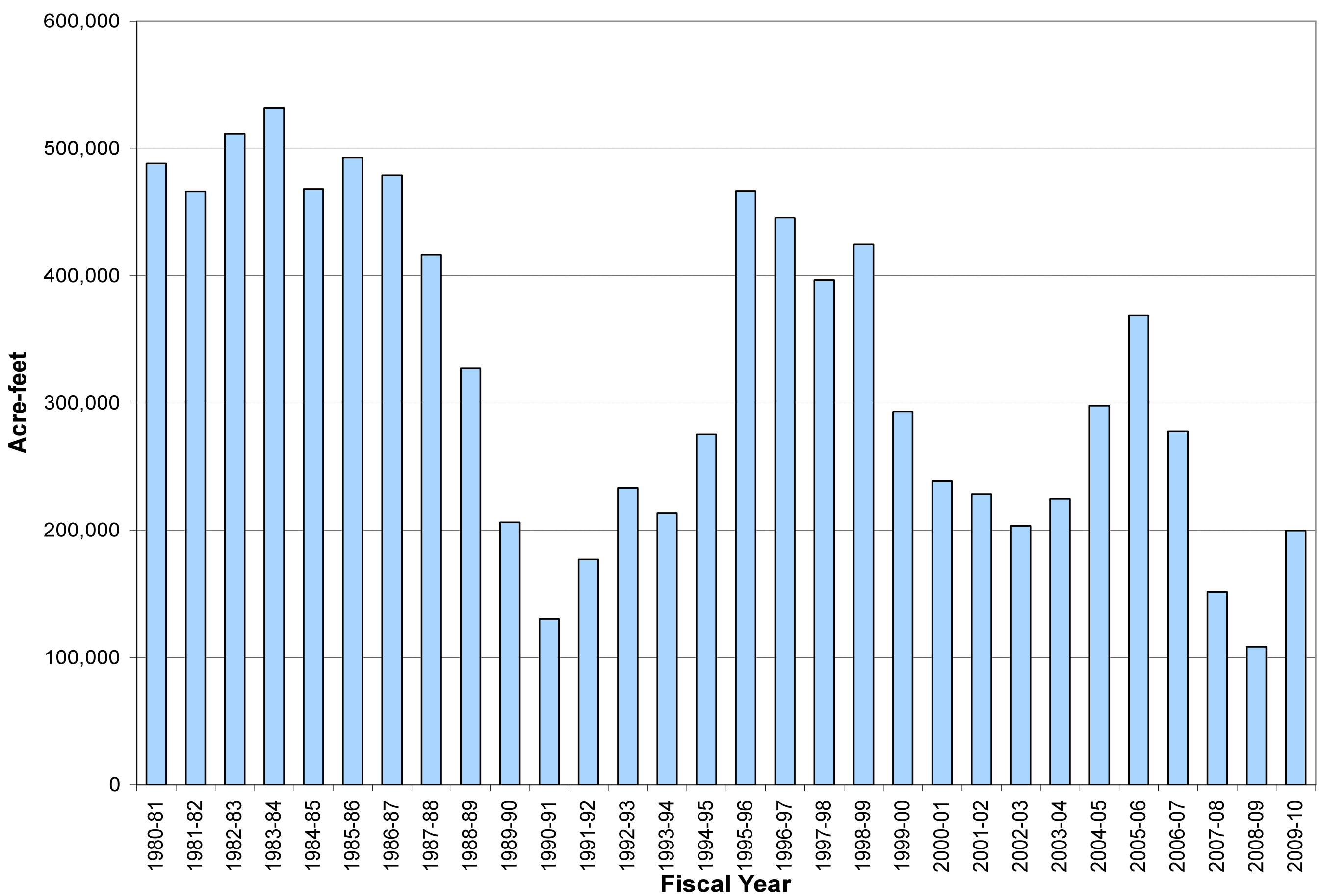
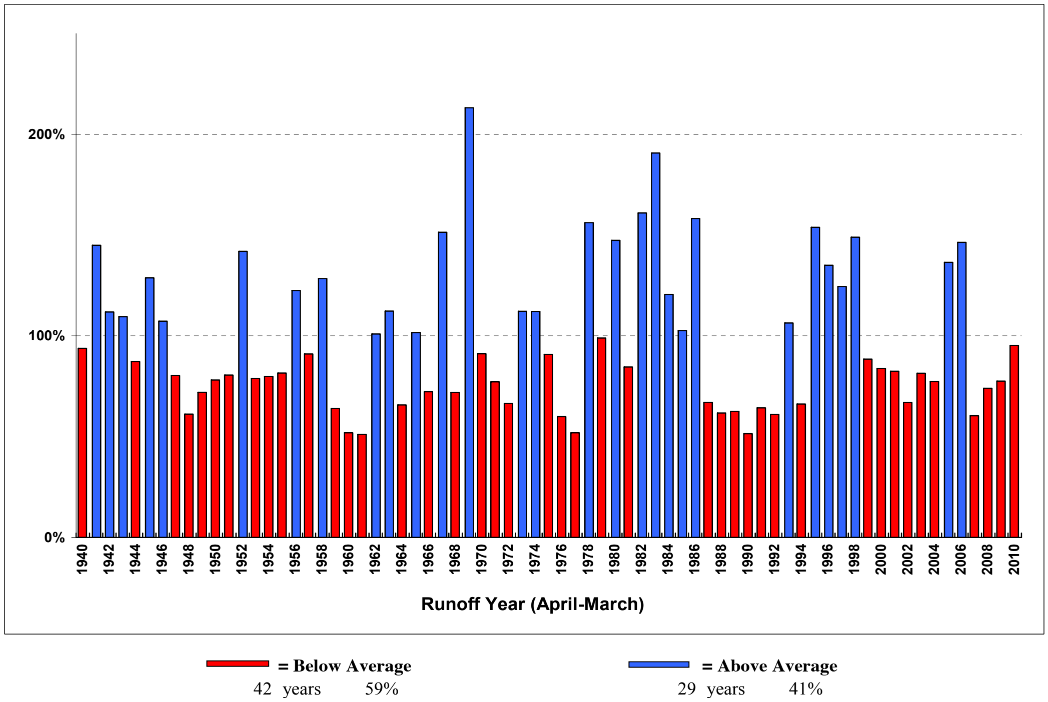


Exhibit 5D Eastern Sierra Nevada Runoff Owens Valley - Percent of Normal



5.2 Mono Basin and Owens Valley Supplies

Surface runoff from snowmelt in the eastern Sierra Nevada Mountains is the primary source of supply for the LAA. The LAA extends approximately 340 miles from the Mono Basin to Los Angeles. Water is conveyed the entire distance by gravity alone. LADWP regulates system output through storage control at seven reservoirs, beginning with Grant Lake Reservoir to the north and ending with Bouquet Reservoir to the south. The total combined reservoir storage capacity of the system is 300,560 AF. Hydroelectric power is also generated from 12 power plants along the LAA. Combined maximum capability of the power generation facilities is 205 megawatts. Water-gathering activities for the LAA have a junior priority to meeting the Owens Valley and Mono Basin water obligations for environmental, domestic, agricultural, and recreational water needs.

The LAA is fed by runoff from the eastern slope of the Sierra Nevada Mountains. Runoff from the eastern slope reaches its maximum in the late spring and summer, after most of the year's precipitation has already occurred. The snowpack in the eastern Sierra Nevada provides natural storage for the LAA system. This snowpack storage is necessary in light of the minimal primarily regulatory storage capacity along the LAA system.

Water Rights

The City's export of water from the eastern Sierra Nevada is based on 166 Pre-1914 and 16 Post-1914 water right diversion licenses on various streams in the Mono Basin and Owens Valley. The majority of the City's water rights were filed prior to 1914 with the Counties of Mono and Inyo Recorder's Office. All Post-1914 licenses were granted by the State Water Resources Control Board (SWRCB). The most significant basis for export of surface water from the eastern Sierra Nevada is an appropriation claim in 1905 to divert up to 50,000 miner's inches (1,250 cfs) from the Owens River at a location approximately 15 miles north of the town of Independence into the LAA for transport to Los Angeles. The City has since filed Supplemental Statements of Water Diversion and Use forms with the SWRCB for all LADWP diversions and licenses.

The City's water right licenses in the Mono Basin were amended by the SWRCB in 1994 through the Mono Lake Basin Water

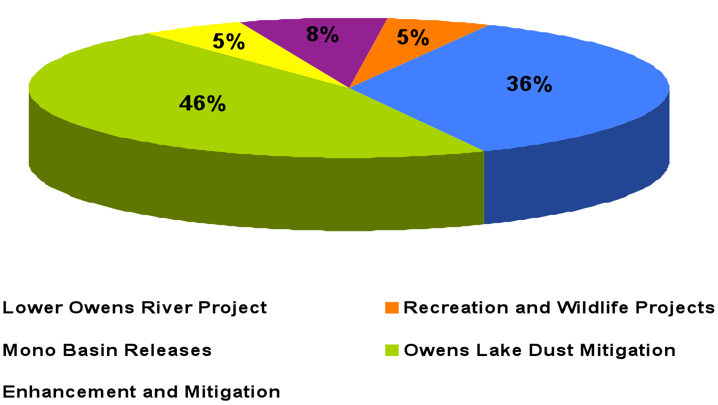
Right Decision 1631. Currently, water export from the Mono Basin is limited to 16,000 AFY based on a court order to raise the target elevation of Mono Lake and restore four streams that flow to Mono Lake.

The primary groundwater right through which Los Angeles has developed groundwater resources in the Owens Valley is based on ownership of a majority of the land (approximately 314,000 acres) and associated water rights in the Owens Valley. Management of the groundwater supply in the Owens Valley is according to a 1991 agreement between Inyo County and LADWP. The goal of this agreement is to avoid defined decreases and changes in vegetation, and to cause no significant effect on the environment which cannot be acceptably mitigated, while providing a reliable supply of water for export to Los Angeles and for use in Inyo County.

5.3 Environmental Issues and Mitigation

Over time an increasingly larger portion of the LAA water supply has been reallocated to the environment. As a result, the City's current supply for environmental enhancement in the Owens Valley and Mono Basin is approximately 205,800 AFY. To accommodate LAA delivery reductions due to these environmental enhancements, LADWP has funded conservation and water recycling programs to improve water use efficiency within the City. Exhibit 5E illustrates the breakdown of LAA water supply commitments by category for environmental enhancement and mitigation projects have been implemented as part of the City's commitment to meet the environmental water needs of the Owens Valley. Among these environmental projects, LADWP is diverting 10,700 AF of water from the LAA for Owens Valley enhancement and mitigation projects, 10,400 AF for recreation and wildlife projects, and 15,700 AF for the Lower Owens River Project (LORP). These annual environmental project diversions are in addition to water that provides environmental benefits in the Mono Basin and Owens Lake.

Exhibit 5E
Mono Basin and Owens River Environmental Enhancement Commitments



Environmental Enhancement Commitments	AFY
Lower Owens River Project	15,700
Recreation and Wildlife Projects	10,400
Mono Basin Releases	74,000
Owens Lake Dust Mitigation	95,000
Enhancement and Mitigation	10,700
Total	205,800

Mono Basin

Currently, Mono Basin exports will remain at no more than 16,000 AFY until Mono Lake reaches its target elevation of 6,391 feet above mean sea level. Exhibit 5F provides the maximum export levels from the Mono Basin under specified conditions as defined in the SWRCB Decision D1631 that was issued on September 28, 1994. Since the long-term average of Mono Basin exports before 1994 was approximately 90,000 AFY, the net reduction in water exports in the Mono Basin is estimated at 74,000 AFY of water mainly from Grant Lake Reservoir, Lee Vining Creek, Walker Creek, Parker Creek, and Rush Creek. As of January

Exhibit 5F
Mono Lake Elevations and Exports

Mono Lake Elevation (feet)		Exports (AFY)
Transition	< 6,377	0
	6,377 - 6,380	4,500
	6,380 - 6,391	16,000
	> 6,391	export all runoff less minimum stream flow requirements and stream restoration flows
Post-Transition	< 6,388	0
	6,388 - 6,391	10,000
	> 6,391	export all runoff less minimum stream flow requirements and stream restoration flows

Exhibit 5G
Lower Rush Creek Base and Peak Flow Requirements

Hydrologic Condition	Base Flow (cfs)							Peak Flows (cfs)
	Apr	May - Jul	Aug - Sep	Apr - Sep	Oct- Mar	May - Aug	Sep - Mar	
Dry (runoff < 83,665 AF)	N/A	N/A	N/A	31	36	N/A	N/A	None
Dry-Normal I (runoff 83,655 - 91,590 AF)	N/A	N/A	N/A	47	44	N/A	N/A	200 for 7 days
Dry-Normal II (runoff 91,590 - 100,750 AF)	N/A	N/A	N/A	47	44	N/A	N/A	250 for 5 days
Normal (runoff 100,750 - 130,670 AF)	N/A	N/A	N/A	47	44	N/A	N/A	380 for 5 days follows 300 for 7 days
Wet-Normal (130,760 - 166,700 AF)	N/A	N/A	N/A	47	44	N/A	N/A	400 for 5 days followed by 350 for 10 days
Wet (166,700 - 195,400 AF)	N/A	N/A	N/A	68	52	N/A	N/A	450 for 5 days followed by 400 for 10 days
Extreme Wet (runoff > 195,400 AF)	N/A	N/A	N/A	68	52	N/A	N/A	500 for 5 days followed 400 for 10 days

Source: Mono Basin Operations, Guidelines A-G

2011, Mono Lake is at elevation 6,382 feet. Extensive restoration and monitoring programs in the Mono Basin have improved the streams, riparian, fishery, and waterfowl habitats.

To effectively maintain continuous base and peak water flows to the ecosystem restoration area of Lower Rush Creek in the Mono Basin, LADWP completed construction of the Mono Gate One diversion facility upgrade in November 2009. Exhibit 5G summarizes the base and peak flow requirements for Lower Rush Creek. Base and peak flow requirements vary in relation to seven hydrologic conditions ranging from dry to extreme wet as identified by forecasted runoff for Mono Basin. Mono Gate One was originally constructed to release excess water from the LAA system during high flows by diverting water into Lower Rush Creek with a system of diversion boards. However, it had no monitoring or flow control capabilities and was not designed for precise flow metering or full-time diversion. Construction completed in the fall of 2009, the new Mono Gate has enabled LADWP to greatly improve measuring and flow capabilities, satisfying one of the operational requirements of the SWRCB.

Lower Owens River Project

Beginning December 2006, the LORP, depicted in Exhibit 5H, releases water from the LAA to create a warm water fishery along a 62-mile section of the Owens River. Water is released near the LAA intake facility and a pump back station is located downstream to return

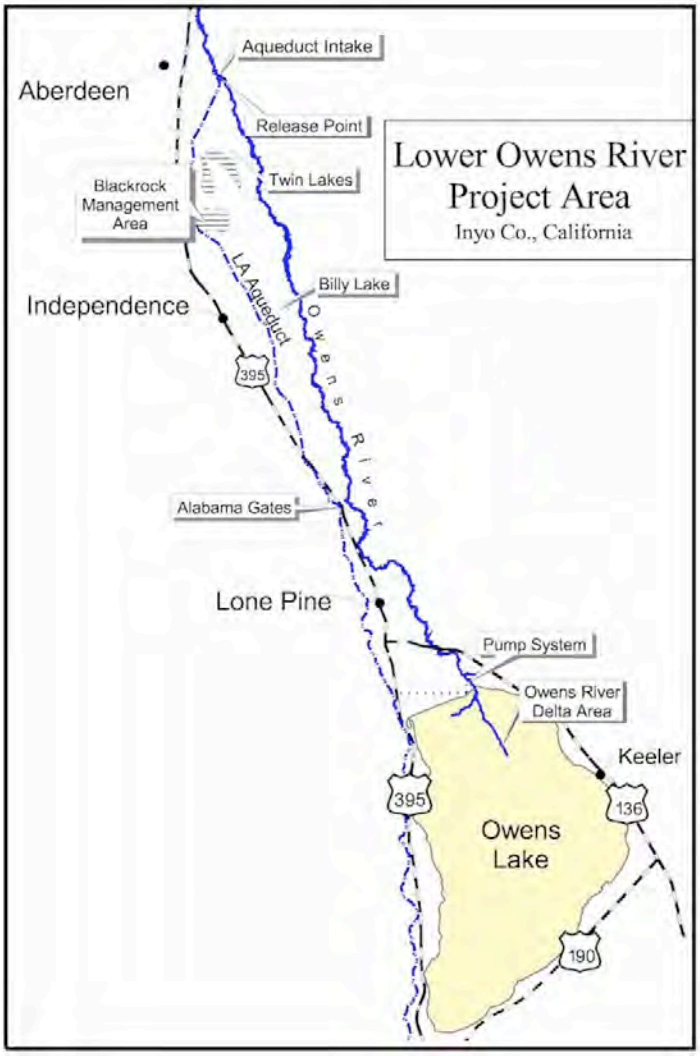


Exhibit 5H
Lower Owens River Project Area

Exhibit 5I
Lower Owens River Base and Peak Seasonal Habitat Flow Requirements

Hydrologic Condition Forecasted[1] (Percent of Average Runoff)	Base Flow (cfs)	Peak Seasonal Habitat Flow[2] (cfs)
50 percent or less	40	Base flow only
70 percent	40	100
100 percent or greater	40	200

1. Runoff forecast determined by LADWP's Runoff Forecast Model for Owens River Basin based on April 1st snow survey.

2. Peak season habitat flows are proportionately ramped up from 40 cfs to 200 cfs based on the percent of average runoff forecasted greater than 50 percent and less than 100 percent.

flows to the LAA or to Owens Lake for dust control measures. In accordance with the Memorandum of Understanding between LADWP and Inyo County and the approved Environmental Impact Report, annual monitoring reports are to be prepared to measure project success. The first LORP Annual Monitoring Report was prepared in 2008.

The Memorandum of Understanding prescribes requirements for LORP flows. Both base flows and seasonal habitat peak flows are required for the LORP. A flow schedule is provided in Exhibit 5I. Seasonal habitat peak flows vary between 40 cfs (zero additional flows beyond the base flow requirements) to 200 cfs. For below average runoff years, seasonal habitat flows may be incrementally lowered from the average runoff year requirements of 200 cfs to 40 cfs (base flow) in proportion to the forecasted runoff flows in the watershed. Base flows are constant at 40 cfs regardless of forecasted runoff flows. It is estimated that the long-term use and transit losses from the project will be approximately 15,700 AFY.

5.4 Owens Lake Dust Mitigation

Historically, the Owens River was the main source of water for Owens Lake. Diversion of water from the river, first by farmers in the Owens Valley and then by the City, resulted in the lake being reduced to a small brine pool. The exposed lakebed became a major source of windblown dust resulting in the United States Environmental Protection Agency (USEPA) classifying the southern Owens Valley as a serious non-attainment area for particulates (dust) also known as PM10 emissions in 1991. The PM standard includes Particulate Matter with a diameter of 10 micrometers or less (0.0004 inches or one-seventh the width of a human hair). USEPA's health-based national air quality standard for PM-10 is 50 microgram per cubic meter (measured as an annual mean) and 150 microgram per cubic meter (measured as a daily concentration).

As a result of PM10 emissions exceeding regulations, the USEPA required California to prepare a State Implementation Plan to bring the region into compliance with Federal air quality standards by 2006. In July 1998, LADWP entered into a Memorandum of Agreement with the Great Basin Unified Air Pollution Control District that: 1) delineated the dust producing areas on the lakebed that needed to be controlled; 2) specified what measures must be used to control the dust; and 3) outlined a timetable for implementation of the control measures. The Memorandum of Agreement was incorporated into a formal air quality control State Implementation Plan by the Great Basin Unified Air Pollution Control District. The plan was approved by the USEPA in October 1999.

LADWP's water use for Owens Lake Dust Mitigation has been gradually increased over the years. Exhibit 5J summarizes yearly water use for the Owens Lake Dust Control Project. Currently, up to 95,000 AF per year of water could be diverted from the LAA for dust mitigation at Owens Lake, greatly exceeding the 55,000 AFY anticipated in the 2005 UWMP. In August 2009, the Board of Water and Power Commissioners of the City of Los Angeles required LADWP to implement water conservation measures on Owens Lake to reduce LAA diversions to below the peak of 95,000 AFY for existing and future dust control projects.

Exhibit 5J
Yearly Water Use on Owens Lake (Fiscal Year)

Fiscal Year	Total AF
2002/03	23,937
2003/04	31,362
2004/05	29,494
2005/06	29,413
2006/07	54,849
2007/08	67,262
2008/09	59,187
2009/10	75,428
2010/11	95,000

* Fiscal year 2010/11 is projected

Since 2001, LADWP has diverted water from the LAA for the Owens Lake Dust Control Project. A combination of shallow flooding, managed vegetation, and a small amount of gravel are used at various lakebed locations as Best Available Control Measures for dust control mitigation on almost 40 square miles. Exhibit 5K provides a description of the Best Available Control Measures. LADWP has completed 9.2 square miles of shallow flooding, 0.5 square miles of modified shallow flooding, and 0.4 square miles of sand fence as part of the Phase 7 project in accordance with the 2008 State Implementation Plan. However, LADWP had proposed 3.1 square miles of a new waterless dust control measure called Moat and Row which was disallowed by the California State Lands Commission in April 2010. LADWP is working with the District to develop an alternative solution for the areas originally proposed for Moat and Row. LADWP has been ordered to complete an additional 2 square miles of dust control known as the Phase 8 project. LADWP is seeking a lease from the California State Lands Commission to construct Gravel Best Available Control Measures for Phase 8 as it does not require water for operation.

Exhibit 5K
Dust Control Mitigation Best Available Control Measures

Dust Control Measures		Description
Shallow Flooding	Sheet Flooding	Releases water from arrays of low-flow water outlets spaced at intervals of between 60 and 100 feet along pipelines laid along lake bed contours. Pipelines are spaced between 500 and 800 feet apart. This arrayed configuration of water delivery creates large, very shallow sheets of braided water channels. Water depths in sheet flooded areas are typically at most a few inches deep. The lower edge of sheet flooded areas has containment berms to capture and pond excess flows. The water slowly flows across the typically very flat lake bed surfaces downhill to tail-water ponds where pumps recirculate the water back to the outlets. To maximize project water use efficiency, flows to sheet flow areas are regulated at the outlets so that only sufficient water is released to keep the soil wet. Any water that does reach the lower end of the control area is collected and recirculated back through the water delivery system.
	Shallow Flooding (Pond Flooding)	Water containment berms that allow ponds to be formed that submerge the emissive lake bed areas. These ponds are up to four feet deep. The containment berms are typically rock-faced to protect them from delivery to the pond area until the pond reaches a size and depth sufficient to submerge the required amount of emissive water. Water delivery then ceases until evaporation reduces the pond size to a set minimum.
Managed Vegetation		Control measure consists of creating a farm-like environment from barren playa. The saline soil must first be reclaimed with the application of relatively fresh water and then planted with salt-tolerant plants that are native to the Owens Lake basin. Thereafter, soil fertility and moisture inputs must be managed to encourage rapid plant development and maintenance. Existing Managed Vegetation areas are irrigated with buried drip irrigation tubing and a complex network of buried drains to capture excess water for reuse on the Managed Vegetation area or in Shallow Flooding areas. Managed Vegetation is sustainable at Owens Lake only if salt from the naturally occurring shallow groundwater is prevented from rising back into the rooting zone.
Gravel Blanket		A four-inch layer of coarse gravel laid on the surface of the Owens Lake playa will prevent emissions by preventing the formation of efflorescent evaporate salt crusts, because the large pore spaces between the gravel particles disrupt the capillary movement of saline water to the surface where it can evaporate and deposit salts. The gravel also creates a surface that has a high threshold wind velocity so that direct movement of the large gravel particles is prevented and the finer particles of the underlying lake bed soils are protected. Gravel Blankets are effective on essentially any type of soil surface.

As part of an Interim Management Plan, LADWP and Inyo County have agreed to conduct a joint study to explore the feasibility of extracting and utilizing brine laden groundwater beneath Owens Lake to supplement the water supply necessary for dust mitigation activities. This feasibility study is scheduled for completion by November 2011. If groundwater pumping is considered feasible and acceptable, LADWP will first need to obtain required approval from Great Basin Unified Air Pollution Control District, California State Lands Commission, California Department of Fish and Game, and Inyo County.

5.5 Water Quality

As land owners of much of the Mono Basin and Owens River watersheds, LADWP has placed strict limits on the extent of development impacting the City-owned watersheds. Snowmelt from the eastern Sierra Nevada contains low total organic carbon (TOC), bromide concentrations, and other constituents that can form disinfectant byproducts during the water treatment process. LADWP conducts routine monitoring of all of its water supplies for over 170 constituents and contaminants. Ninety-eight of the constituents and contaminants have enforceable standards.

The LAA supply is the main source of arsenic in LADWP's water supply. Arsenic is collected as the Owens River flows volcanic formations in the vicinity of Hot Creek in Long Valley. Geothermal springs in these areas have arsenic concentrations of around 200 parts per billion (ppb). Concentrations are dramatically reduced as water in the area mixes with snow melt and other pristine water sources. Historic untreated LAA water arsenic concentrations have ranged from 10 to 74 ppb. During the latest 3-year routine compliance monitoring cycle from 2007 to 2009, the highest arsenic concentration after treatment was 8.1 ppb, while the average arsenic concentration within LADWP's water distribution system was 3.3 ppb, both well below the current Federal and State drinking water standard of 50 ppb. In light of potential, more stringent arsenic regulations, LADWP is taking a proactive approach in addressing this issue by investigating and planning enhanced coagulation treatment.

LADWP completed an evaluation and preliminary design report for enhanced coagulation at the Los Angeles Aqueduct Filtration Plant in December 2006 as a means of addressing future water quality regulations faced by LADWP, including arsenic. An enhanced coagulation facility using the process as outlined in the report is planned as part of the treatment process at the Los Angeles Aqueduct Filtration Plant by 2021.

To comply with the Stage 2 Disinfectants and Disinfection Byproducts Rule, another water quality improvement effort being implemented is the conversion from chlorine to chloramine residual disinfectant. This transition, which is expected to be completed by April 2014, will allow LADWP to maintain the same high level of disinfection in its water supply while freeing itself from other potential disinfection issues associated with the use of chlorine. The use of chloramines will provide additional operational flexibility by allowing the blending of purchased MWD water (which is chloraminated) into the LADWP distribution system without the problems associated with creating a chlorine/ chloramines interface when blending the two supplies.

5.6 Projected Deliveries

Near-term water deliveries are forecasted for the LAA using two models, the Runoff Forecast Model and the Los Angeles Aqueduct Simulation Model (LAASM). These two models used accurately predict the amount of water available from this the LAA.

The Runoff Forecast Model is used to predict total Owens Valley and Mono Basin stream runoff. The model's estimating equations were developed using historic rainfall and snowfall, as well as streamflow data of each year. Model input consists of 6 months of antecedent rainfall and streamflow data, as well as the final snowpack levels on April 1st. The model's output is the forecasted runoff for the Owens Valley and Mono Basin during the twelve month period following April 1st, assuming that median rainfall occurs during those twelve months.

Runoff flows from the Owens Valley to the City of Los Angeles are modeled by the LAASM. LAASM uses the output of the Forecast Model as input, along with estimates of various uses within the Owens Valley. LAASM uses historically derived estimating equations to forecast various losses, including evaporation and infiltration, as well as other inflows such as unmetered springs. The final output from LAASM is the volume of LAA water projected to be delivered to the City of Los Angeles.

Taking the foreseeable factors discussed earlier in this chapter into consideration, the average annual long-term LAA delivery over the next 25 years, using the 50-year average hydrology from FY 1956/57 to 2005/06, is expected to be approximately 254,000 AFY and gradually decline to 244,000 AFY due to climate change impact. Deliveries for a series of dry years, using FY 1988/89 through 1992/93 hydrology, are expected to range from approximately 48,520 AFY to 105,770 AFY. A single dry year minimum of 48,520 AFY is expected with a repeat of the FY 1990/91 hydrology. Detailed projections of LAA deliveries by year are provided in Chapter 11, Water Service Reliability Assessment.

5.7 LAA Delivery Cost

The costs associated with the LAA water supply are primarily operation and maintenance costs. Therefore, the unit cost of importing water through the LAA to the City varies mainly with the quantity of water delivered, which is highly dependent on hydrological conditions. During dry years, the amount of water delivered to the City decreases, which results in an increase to the unit cost. Over the years, eastern Sierra Nevada environmental enhancement project have also contributed to rising overall LAA delivery cost. The Owens Lake Dust Mitigation and Lower Owens River Project are two examples. Exhibit 5L summarizes the historical unit cost of treated water from the LAA. The peaks occurred when LAA deliveries significantly decreased during FY 1990/91, 2002/03, and 2008/09 with the LAA delivering 130,300 AF at $499/AF; 203,400 AF at $419/AF; and 108,500 AF at $1,003/AF respectively.

Exhibit 5M shows the unit cost of LAA treated water from FY 2005/06 to 2009/10. The 5-year average was $563/AF. The sharp increase in FY 2008/09 was due to LAA deliveries being the lowest on record.

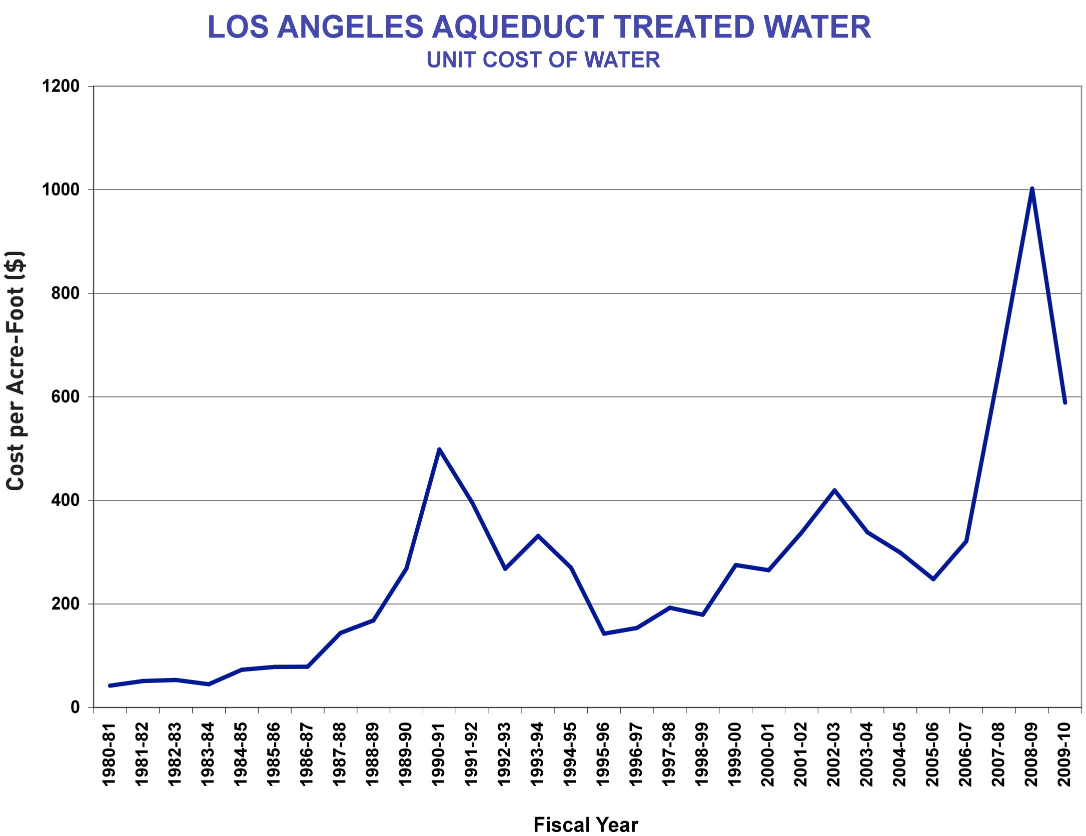


Exhibit 5L Historical Cost of LAA Treated Water

Fiscal Year	2005/06	2006/07	2007/08	2008/09	2009/10
Unit Cost	$248	$321	$654	$1,003	$589

Exhibit 5M Annual Unit Cost

Chapter Six

Local Groundwater

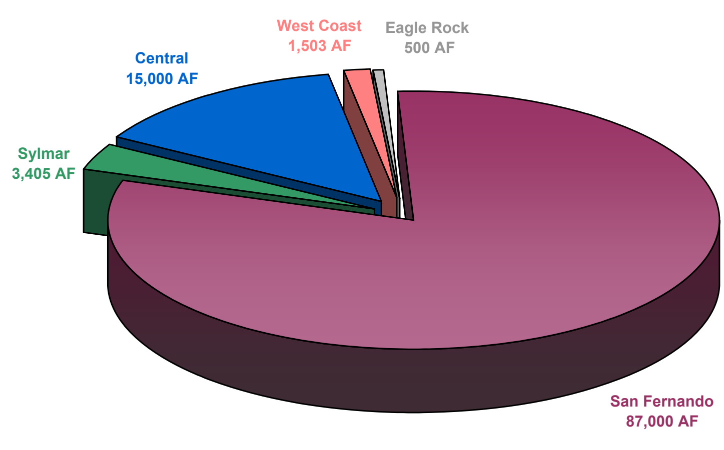
6.0 Overview

A key resource that the City has relied upon as the major component of its local supply portfolio is local groundwater. Over the last ten years local groundwater has provided approximately 12 percent of the total water supply for Los Angeles, and historically has provided nearly 30 percent of the City's total supply during droughts when imported supplies become less reliable. In recent years, contamination issues have impacted LADWP's ability to fully utilize its local groundwater entitlements. Additionally, reduction of natural infiltration due to expanding urban hardscape and channelization of stormwater runoff has resulted in declining groundwater elevations. In response to contamination issues and declining groundwater levels, LADWP is working on treatment for the San Fernando Basin's (SFB) groundwater and is making investments to recharge local groundwater basins through stormwater recharge projects, while at the same time replacing or rehabilitating old and deteriorating stormwater capture facilities. LADWP anticipates that groundwater treatment facilities in SFB will be in operation by Fiscal Year Ending (FYE) 2021 which will allow LADWP to pump its full groundwater entitlement. With the addition of utilizing stored water credits in the San Fernando Basin and Sylmar Basin, groundwater pumping will increase up to 111,500 Acre-Feet (AF) starting FYE 2021.

6.1 Groundwater Rights

The City owns water rights in the San Fernando, Sylmar, Eagle Rock, Central, and West Coast Basins. All of these basins are adjudicated by decree through Superior Court Judgments (Appendix F). The combined water rights in these

Exhibit 6A
Annual Local Groundwater Entitlement



Total: 107,408 AF per year

basins total approximately 107,408 AFY. Water rights in the Upper Los Angeles River Area (ULARA), which comprises the San Fernando, Sylmar, and Eagle Rock basins, total approximately 90,905 AFY which translates into approximately 87,000 AFY in the SFB, 500 AFY in the Eagle Rock Basin, and 3,405 AFY in the Sylmar Basin. Water rights in the Central and West Coast Basins are 15,000 AFY and 1,503 AFY, respectively. However, LADWP does not exercise its pumping rights in Eagle Rock Basin and West Coast Basin at this time. Exhibit 6A summarizes the City's annual local groundwater entitlements by basin.

The ULARA Groundwater Basin Adjudication

The City's entitlements in the San Fernando, Sylmar, and Eagle Rock Basins were established in a Judgment by the Superior Court of the State of California for the County of Los Angeles in Case No. 650079, The City of Los Angeles, Plaintiff, vs. Cities of San Fernando, et. al., Defendants, dated January 26, 1979 (San Fernando Judgment) and the 1984 Sylmar Basin Stipulation (1984 Stipulation). Appendix F contains the Judgment and 1984 Stipulation. The Judgment was based on maintaining a safe yield operation for the basin, whereby groundwater extractions over the long-term will be maintained in a manner that does not create an overdraft condition in the basin. The Judgment and 1984 Stipulation limit groundwater extraction and establish a court-appointed Watermaster and an Administrative Committee made up of a representative from each of the five water supply agencies overlying the ULARA Basins. The five public agencies are the City of Los Angeles, the City of Glendale, the City of San Fernando, the City of Burbank, and the Crescenta Valley Water District.

The Watermaster assists the Court in administering and enforcing the provisions of the San Fernando Judgment and 1984 Stipulation. Among other duties, the Watermaster monitors groundwater levels, recharge operations, recycled water use, extractions, water imports and exports, and reports all significant water-related events in the Basin to the Court and to the parties of the Judgments. The activities of the Watermaster are key components for the effective management of the groundwater resources in the ULARA Basins. Key tasks of the Watermaster for the SFB include:

- To monitor radiological and synthetic organic compounds (SOCs) every three years.
- To continue to work with key regulators, such as the Los Angeles Regional Water Quality Control Board (LARWQCB), California Department of Public Health (CDPH), California Department of Toxic Substance Control (CDTSC), and the United States Environmental Protection Agency (USEPA), to expedite clean-up of groundwater at or near known contamination sites.
- To continue to support the ongoing activities of the City of Los Angeles and others to recharge the groundwater basin at existing spreading basins on the east side of the San Fernando Valley.
- To help determine the technical feasibility of using advanced treated recycled water to recharge the groundwater basin.
- To continue to work with the Los Angeles Department of Public Works, Bureau of Sanitation, Watershed Protection Division, to enhance groundwater recharge of local basins via the Standard Urban Stormwater Mitigation Plans (SUSMP) procedures for stormwater infiltration at new development and redevelopment project sites.
- To work with local purveyors in an effort to increase the quantity and quality of the groundwater database for the entire ULARA basin.

Exhibit 6B
Local Groundwater Basin Supply
Fiscal Year (July through June in AF)

Groundwater Basin	2005/06	2006/07	2007/08	2008/09	2009/10	Average	Percentage
San Fernando	35,486	75,640	57,060	49,106	62,218	55,902	79%
Sylmar	1,844	3,901	4,046	576	2,998	2,673	4%
Central	13,290	13,358	12,207	11,937	11,766	12,512	17%
Total	50,620	92,899	73,313	61,619	76,982	71,087	100%

Historical Groundwater Production

On average over the past five years, about 83 percent (58,575 AFY) of the City's local groundwater supply was extracted from ULARA groundwater basins, while the Central Basin provided 17 percent (12,512 AFY). Exhibit 6B summarizes the City's local groundwater production by basin over the last five years.

Historically, LADWP operates groundwater production by utilizing conjunctive use of surface water and groundwater to optimize the supply and demand balance. Through conjunctive use, the timing of groundwater extractions can be used to meet varying demands. In the past, LADWP prevented groundwater overdraft during multiple dry years through strategic pumping. When successive dry years occured, LADWP pumped at greater than average rates for the first few years of the drought, and then pumped at lower rates in subsequent years.

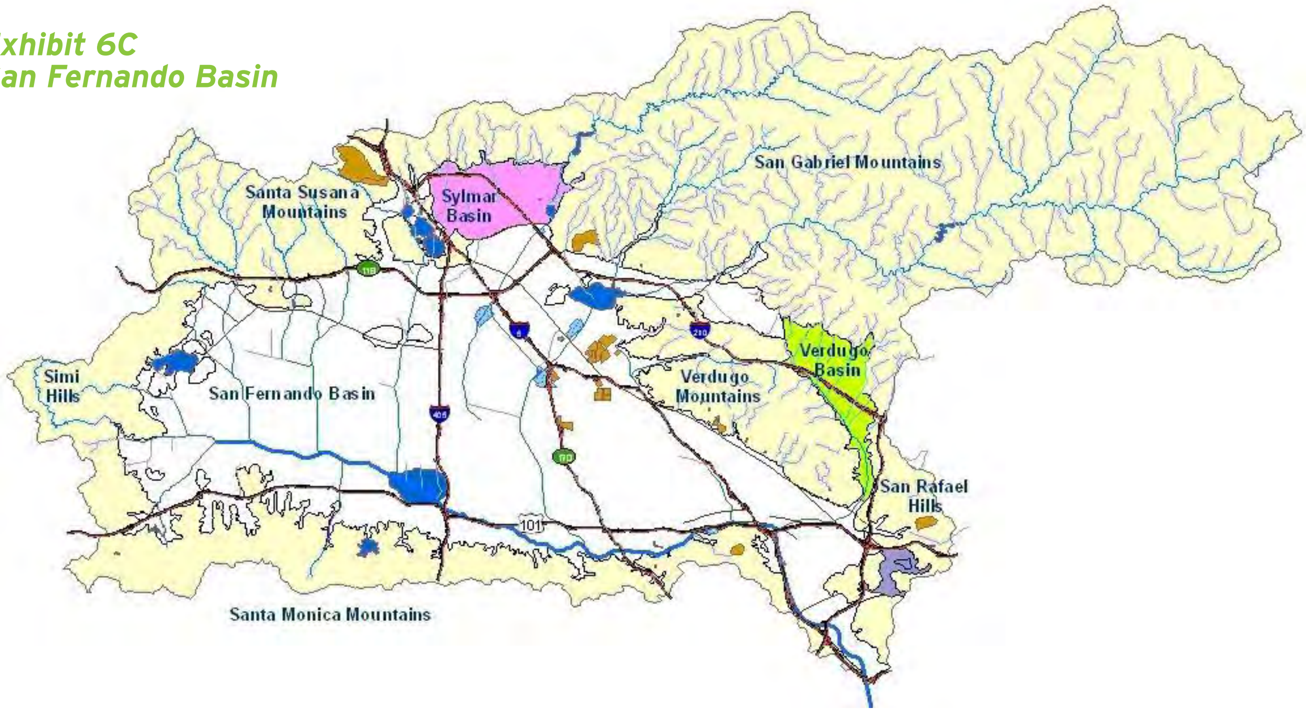
Since 2007, groundwater contamination issues in the SFB have greatly limited LADWP's ability to pump its full groundwater entitlement. As a result, LADWP has been pumping the maximum amount of water not impacted by contamination and therefore has not been able to utilize conjunctive use strategies for groundwater operations. When the clean-up of the SFB is complete, LADWP will be able to return to these strategic pumping strategies to ensure reliability and protect against groundwater overdraft in dry years.

6.2 San Fernando Basin

The primary source of local groundwater for the City is the SFB, which provided over 79 percent of the City's groundwater supply ranging from 35,486 AFY to 75,640 AFY during the period FY 2005/06 to FY 2009/10. The SFB is the largest of the four ULARA basins. The SFB consists of 112,000 acres and comprises 91.2 percent of the total area in ULARA. It is bounded on the east by the Verdugo Mountains; on the north by the Little Tujunga Syncline and the San Gabriel and Santa Susana Mountains; on west by the Simi Hills; and on the south by the Santa Monica Mountains. A map of the basin is shown in Exhibit 6C. (ULARA Watermaster Service Report, Water Year [October to September] 2008/09)

LADWP has ten major wellfields within the SFB containing 115 wells: the Crystal Springs, Headworks, Tujunga, Rinaldi-Toluca, North Hollywood, Erwin, Verdugo, Whitnall, Pollock, and North Hollywood Operable Unit Wellfields. Of the ten major wellfields, LADWP is currently not pumping only at Headworks. These wells were generally installed over a period spanning from 1924 to 1991, with the most recent installations being the Rinaldi-Toluca Wellfield in 1988 and the Tujunga Wellfield in 1991. Collectively these ten wellfields have the ability to pump and serve approximately 547 cubic feet per second (cfs) of water, of which the recent Rinaldi-Toluca and Tujunga wells comprise about 38 percent or 210 cfs.

Exhibit 6C
San Fernando Basin



Groundwater Rights

In accordance with the San Fernando Judgment, the City has the right to all native water within the SFB, based on its Pueblo Rights, and has the right to City water that is imported and returns through infiltration into the SFB. With the native safe yield being fixed at 43,660 AFY and the return of imported water averaging approximately 43,000 AFY, the combined total equates to an average SFB entitlement for the City of approximately 87,000 AFY. The return of imported water right for LADWP is based on 20.8 percent of all water delivered within the San Fernando Basin including recycled water. The Judgment provides for storage of water within the basin when the amount pumped is less than the annual entitlement, and a portion of these stored water credits can be pumped in future years to supplement the City's water supply. The direct spreading of both imported and recycled water receives 100 percent stored water credit. Increasing LADWP's groundwater pumping rights due to stormwater capture activities will require an amendment to the San Fernando Judgment based on a demonstrated increase in groundwater levels.

In September 2007, the Cities of Los Angeles, Glendale and Burbank entered into a ten-year Interim Agreement for the Preservation of the San Fernando Basin Water Supply (Interim Agreement). The Interim Agreement is intended to address the overall long-term decrease in stored groundwater within the basin. The Interim Agreement restricts withdrawal of stored water credits and incorporates basin losses into groundwater basin accounting.

Under the Interim Agreement, stored water credits will be reduced for each party by 1 percent annually to account for outflow from the basin. Additionally as described in the Interim Agreement, a proportion of stored water credits available for use during a water year (Available Credits) will be calculated each year, and that proportion not available for use during a given year (Reserve Credits) will be reserved for later use. As of October 1, 2009, the City had a stored water credit of nearly 406,313 AF in the SFB, however LADWP's Available Credit or maximum allowable withdrawal of stored water credits for the year beginning October 1, 2009 was 108,574 AF. LADWP's Reserve Credits total was 321,316 AF. Reserve Credits (stored water credits minus available stored water credits) will not be available until groundwater levels in the basin recover to a level that will allow for their safe withdrawal. Total Reserve Credits held by all parties in the basin were 376,433 AF as of October 1, 2009.

Water Quality

During well testing in the SFB, trace levels of the contaminants trichloroethylene (TCE), perchloroethylene (PCE), and other volatile organic compounds (VOCs) were detected in the past. The presence of these contaminants is due to improper chemical disposal practices historically conducted by numerous companies in the San Fernando Valley utilizing such materials. Additionally, in the 1990s, detectable amounts of hexavalent chromium and perchlorate were found in various wells within the SFB. Since the 1990s, SFB wells have also shown a trend of increasing nitrate levels. The source of nitrates is the result of decades of agricultural activity in the San Fernando Valley.

While LADWP is permitted to withdraw its allotted entitlement of 87,000 AFY from the SFB including a portion of its additional stored water, 2007 was the first year LADWP was unable to pump its allotted entitlement due to contamination impacts. LADWP has 115 wells in the SFB of which 57 wells have been inactivated due to contamination. These inactive wells represent a lost pumping capacity of approximately 236 cfs or 44 percent of LADWP's pumping capacity. Of the remaining 58 active wells, with a combined pumping capacity of approximately 304 cfs, 45 have recorded concentrations for various contaminants above the Maximum Contaminant Level (MCL). Most notable among these contaminants of concern are the VOCs (especially TCE, PCE, and carbon tetrachloride), nitrates, and perchlorate. The remaining 13 wells have recorded marginal levels of contamination, mostly due to VOCs. Hexavalent chromium threatens to be a significant future risk to LADWP's wells. Lastly, LADWP's two largest wellfields, Tujunga and Rinaldi-Toluca, which were the most recently-installed wells in an area believed to be outside the known contamination areas, are being significantly impacted by unknown contamination sources.

LADWP has developed programs to accelerate treatment for the SFB groundwater which includes a comprehensive Groundwater System Improvement Study, installing monitoring wells, interim wellhead treatment, and working with regulatory agencies and government officials to identify those responsible for the contamination.

Agency Cooperation of SFB Remediation

LADWP actively coordinates with the CDPH, LARWQCB, CDTSC, and USEPA to pursue protective and remedial measures for the SFB. The CDPH, LARWQCB, and CDTSC are the three regulatory agencies with enforcement responsibilities within the SFB. The LARRWQCB and the CDTSC issue enforcement directives for pollutant sites and guide the development of cleanup workplans and the cleanup of polluted groundwater sites. The CDPH oversees the quality of potable water from groundwater sources.

In 1987, LADWP entered into a Cooperative Agreement with the USEPA to conduct the "Remedial Investigation of Groundwater Contamination in the San Fernando Valley." Under this agreement, LADWP has received funds from the USEPA's Superfund Program to carry out: (1) construction, operation, and maintenance of the North Hollywood Operable Unit, which consists of a groundwater treatment facility and a system of eight production wells (construction completed in 1989); and (2) completion of the Remedial Investigation to characterize the SFB and the nature and extent of its groundwater contamination. The Remedial Investigation included: (a) the installation in 1992 of 88 shallow and clustered monitoring wells that were developed to monitor contamination plumes of TCE, PCE, and nitrates in the SFB; (b) the development of a groundwater flow model (Flow Model) and the preparation of the Remedial Investigation report that was completed for the USEPA in 1992; and (c) on-going monitoring for TCE, PCE, nitrates, and emerging contaminants.

The Flow Model is a three-dimensional computer simulated model of the SFB based on the MODFLOW model program code that was developed by the United States Geological Survey. It consists of four layers that represent the various depth zones of the SFB. Geologic and hydrogeologic data for the basin, which was generated through field investigation, was analyzed to develop the physical site characterization of the basin for the MODFLOW Flow Model. The Flow Model produced simulated groundwater levels, gradients, and their fluctuations as a function of time. Based on field monitoring and Flow Model simulations, groundwater production strategies are reviewed and adjusted monthly to balance the City's water supply need with SFB management.

San Fernando Basin Treatment

In coordination with other agencies, LADWP has completed or is planning various projects to maintain its rights to use the SFB as a reliable local water supply for the City. The following are some of LADWP's completed, current, and planned projects for the SFB. Recharge projects are discussed separately in Chapter 7, Watershed Management.

Groundwater System Improvement Study
LADWP is working on a 6-year, \$19.0-million Groundwater System Improvement Study (GSIS) in the SFB that will provide vital information to assist in developing both short- and long-term projects to maximize the use of the SFB. The \$11.5-million GSIS professional service contract was awarded in February 2009.

The GSIS will aim to cover the following main objectives:

- Provide an independent study to identify, characterize, and evaluate emerging water quality constituents for the San Fernando Basin.

- Provide an independent expert evaluation of LADWP's existing groundwater facilities and its current operational strategies to address current issues on water quality regulations and groundwater treatments. Provide expert advice on the need of refurbishing existing groundwater wells.

- Research and evaluate the need for the installation of new monitoring wells in the SFB to characterize the basin for the constituents of concern.

- Develop a research monitoring program to characterize the nature and extent of the various constituents of concern that may pose a risk to LADWP maximizing the utility of the SFB.

- Provide independent expert recommendations on economically feasible short and long-term capital improvement projects to address all regulatory agency requirements.

Through the GSIS, LADWP has begun developing a conceptual layout for Groundwater Treatment Facilities in the SFB that will include treatment facilities in the vicinity of LADWP's North Hollywood, Rinaldi-Toluca, and Tujunga Well Fields. It is anticipated that construction of the Groundwater Treatment Facilities could begin as early as July 2016. Construction of the Groundwater Treatment Facilities will greatly reduce LADWP's reliance on costly and scarce imported water supplies. The Groundwater Treatment Facilities will also enable LADWP to benefit from its activities to enhance local supplies through groundwater recharge and stormwater projects. An integral part of LADWP's Groundwater Treatment Facilities will be to work closely with the USEPA and the Cities of Burbank and Glendale to ensure that the facilities operations do not adversely affect the on-going cleanup activities being conducted by the aforementioned agencies. Towards this end, LADWP plans to enter into a Groundwater Management Plan with the USEPA.

As of November 2010, the work progress has included: a technical review of USEPA's Focused Feasibility Study for the North Hollywood Operable Unit; preparation of conceptual layouts and renderings for the proposed Groundwater Treatment Facilities in the vicinity of the North Hollywood, Rinaldi-Toluca and Tujunga Well Fields; providing assistance in the planning aspects for the installation of approximately 40 new monitoring wells in the San Fernando Basin; and providing an independent study to identify, characterize and evaluate emerging water constituents.

Tujunga Wellfield Joint Project

LADWP and MWD have developed a joint project utilizing simple liquid-phase granular activated carbon to recover the use of two of the City's contaminated groundwater production wells in the Tujunga Wellfield. The total estimated cost of this project was approximately $7.0 million and was completed in November 2009. LADWP received the permit from the CDPH in May 2010 and started to discharge into the distribution system on May 18, 2010.

Tujunga Wellfield Contamination

The Initial Discovery of the source of contamination at the Tujunga Wellfield by the USEPA and CDTSC is ongoing. Phase I is completed and has not conclusively identified the source of the contamination. The next phase will involve drilling 4 to 7 deep monitoring wells immediately up gradient of the wellfield to determine the direction of the contamination plumes. The well drilling is expected to be completed late 2012. LADWP is intending to construct up to 22 additional monitoring wells near other wellfields south of the Tujunga Wellfield. Water quality data from the new monitoring wells will assist with further characterizing the groundwater contamination in the SFB. Drilling of these additional wells is expected to begin in Fall 2011 and continue until Winter 2013.

North Hollywood Operable Unit
In 1989, the North Hollywood Operable Unit was placed into service with a capacity of 2,000 gallons per minute, or 3,230 AFY. This facility has one aeration tower with vapor-phase granular activated carbon air emissions control system. This technology uses air to remove the VOCs from the groundwater and uses the vapor-phase granular activated carbon to remove the VOCs from the air stream before it exits into the atmosphere. The fifteen year consent decree expired on December 31, 2004, however, the VOC plume has not been completely remediated. In Water Year 2008/2009, 1,038 AF of VOC contaminated groundwater was treated.

The USEPA is expected to start construction of the North Hollywood Operable Unit Second Remedy possibly as soon as 2014 to improve containment of contamination from two sites, the Honeywell and Lockheed sites. The primary plume contains high concentrations of VOCs, chromium, and other contaminants of concern. The USEPA issued the Record of Decision in September of 2009. The first technical meeting with the potentially responsible party was held in July 2010. A consent decree is expected in late 2011. The Record of Decision recommends more than doubling the capacity plus adding liquid phase granular activated carbon (a secondary treatment), construction of up to 37 monitoring wells, three new extraction wells, deepen existing well #1, rehabilitation of existing wells, and treatment of chromium and 1-4 Dioxane. As of 2010, Honeywell is continuing its removal of chromium plume at the source of contamination.

Chromium Treatment Research
A cost-effective treatment technology to remove low levels of hexavalent chromium from water does not exist for large scale applications. In 2001, LADWP, along with the Cities of Burbank, Glendale, and San Fernando, and the National Water Research Institute, entered into a research partnership with the American Water Works Association Research Foundation to identify and bench-test new technologies that can remove hexavalent chromium to extremely low levels. This research is being conducted in anticipation of a new standard for hexavalent chromium.

Pollock Wells Treatment Plant
In 1999, the Pollock Wells Treatment Plant was constructed and placed in service. This project was funded by LADWP, and it includes a groundwater treatment facility with four liquid-phase granular activated carbon units. Over 3,000 gallons per minute (4,840 AFY) of groundwater is treated by direct adsorption with granular activated carbon to remove VOCs before delivery to customers.

Remedial Investigation
In 1992, the Remedial Investigation to characterize the nature and extent of groundwater contamination in the SFB was completed for the USEPA. The Remedial Investigation activity included the construction of 88 shallow and clustered monitoring wells, which were developed to monitor contamination plumes of TCE, PCE, and nitrates in the SFB. These monitoring wells are also being used to monitor for emerging chemicals.

Biological Treatment Pilot Test
LADWP will be studying the effectiveness of biological treatment on removal of VOCs contaminants from the Tujunga Wellfield groundwater. Biological treatment is a proven technology for removal of perchlorate and nitrate contaminants from groundwater which are also present in the Tujunga Wellfield groundwater. If biological treatment can also effectively remove VOCs from the groundwater, LADWP can significantly reduce the capital as well as future operations and maintenance costs associated with cleanup and removal of contaminants from the Tujunga Wellfield groundwater.

Pilot Test of Advance and Emerging Groundwater Treatment Technologies
LADWP is investigating the utilization of other advance and/or emerging

groundwater treatment technologies for removal of VOCs and perchlorate for possible pilot study(ies) at the Rinaldi-Toluca Wellfield within the next few years.

6.3 Sylmar and Eagle Rock Basins

The Sylmar Basin has provided slightly over 4 percent of the City's local groundwater ranging from 576 AF to 4,046 AF from FY 2005/06 through FY 2009/10. The Sylmar Basin, in the northern part of ULARA, consists of 5,600 acres and comprises 4.6 percent of the ULARA area. It is bounded on the north and east by the San Gabriel Mountains; on the west by a topographic divide in the valley fill between the Mission Hills and the San Gabriel Mountains; and on the south by the Little Tujunga syncline, which separates it from the SFB. (ULARA Watermaster Service Report, Water Year 2008/09) LADWP originally had a total of 3 production wells installed in the Sylmar Basin between 1961 and 1977. One of these wells was removed from service and is no longer utilized. The remaining wells have the capacity to pump 5 cfs.

The Eagle Rock Basin is the smallest of the four basins. It is located in the extreme southeast corner of ULARA. It consists of 800 acres and comprises 0.6 percent of the total ULARA area. LADWP is not pumping in the Eagle Rock Basin currently. The safe yield of Eagle Rock Basin is derived from imported water delivered by LADWP. There is no measurable native safe yield. LADWP has the right to extract the entire safe yield of the basin. Currently, the groundwater is being pumped by a private party and LADWP is reimbursed for such pumping in accordance with the San Fernando Judgment.

Groundwater Rights

In 1996 upon the recommendation of the Watermaster, the ULARA Administrative Committee approved a temporary safe yield increase for the Sylmar Basin thus temporarily increasing LADWP's rights from 3,105 AFY to 3,255 AFY for a ten-year period. Per the 1984 Stipulation, the safe yield minus private party overlying rights are to be equally split between LADWP and the City of San Fernando. In 2006, a subsequent evaluation of the safe yield was conducted and completed in accordance with Section 8.2.10 of the 1984 Stipulation. Upon recommendation of the parties, the Court approved a new stipulation further increasing the temporary safe yield of the basin and resulting in a temporary increase in LADWP's rights to 3,405 AFY subject to multiple conditions. Conditions imposed on LADWP and the City of San Fernando include installing groundwater monitoring wells to assist in determining basin outflows. This new stipulation became effective on October 1, 2006 and is set to expire on October 1, 2016.

Stored water credits accumulated in the basin are determined by adding the previous years stored water credit and the extraction right for the previous year together and then subtracting the actual extractions for the previous year. As of October 1, 2009, LADWP has accrued 9,423 AF of stored water credits in the Sylmar Basin. In 2006, the Watermaster recommended LADWP to begin pumping these rights due to the large amount of stored water credits. LADWP has proposed the Mission Wells Improvement Project to initiate pumping the credits and to replace the existing wells that have significantly deteriorated. As proposed, the project consists of constructing a water tank, three wells, and other operational facilities at the Mission Wellfield. Phase 1 was completed in February 2009 and involved replacement of the water tank that was beyond its useful life. Phase 2 is in the planning stages and consists of three new wells with operational facilities and is forecast for completion in August 2014. These new facilities will allow LADWP to pump its current entitlement of 3,405 AFY on an annual basis and draw from its existing stored water credits.

Water Quality

Groundwater quality issues have occurred in the Sylmar Basin related to TCE contamination at one of the two production wells. The effluent from the wellfield is managed in such a way that the groundwater quality meets or surpasses water quality standards. Primary limitations on pumping are related to the deterioration of pumping facilities and not contamination. However, the Mission Wells Improvement Project as previously discussed, will replace the deteriorated wells and increase production capacity to allow LADWP to pump its annual water rights.

6.4 Central Basin

From FY 2005/2006 through FY 2009/10, the Central Basin has provided on average approximately 17 percent of LADWP's local groundwater supply ranging from 11,766 AF to 13,358 AF through wells in two major production fields. The Central Basin Watermaster Service area overlies about 227 square miles of the Central Basin in the southeastern part of the Los Angeles Coastal Plain in Los Angeles County. The Watermaster Service Area is bounded by the Newport-Inglewood Uplift on the southwest, the Los Angeles-Orange County line on the southeast, and an irregular line that approximately follows Stocker Street, Martin Luther King Boulevard, Alameda Street, Olympic Boulevard, the boundary between the City of Los Angeles and unincorporated East Los Angeles, and the foot of the Merced and Puente Hills on the north. Twenty-three incorporated cities and several unincorporated areas are within the Central Basin Watermaster Service Area. Groundwater within the basin provides a large portion of the water supply needed by overlying residents and industries. In FY 2008/09, there were 140 parties with rights to water within the Central Basin (Central Basin Watermaster Service Report, FY 2009/10).

Two LADWP facilities provide groundwater supplies in the Central Basin, the Manhattan Wells and the 99th Street Wells. The active Manhattan Wells were installed between 1928 and 1974 and have a production capacity of 16.9 cfs. Wells at the 99 th Street location were installed between 1974 and 2002 and have a production capacity of 7.4 cfs.

While the 99th Street Wells are newer and have relatively little mechanical or other problems, the Manhattan Wells are much older and have experienced maintenance problems and are approaching the end of their useful life. To restore the City's pumping capacity, LADWP is working on plans to install two new production wells, replace two deteriorated wells, and improve other related facilities at the Manhattan Wells site.

Groundwater Rights

More than 50 years ago, groundwater overdraft and declining water levels in the Central Basin threatened the area's groundwater supply and caused seawater intrusion in the southern part of the Central Basin. However, timely legal action and adjudication of the water rights halted the overdraft and prevented further damage to the Central Basin. Today, groundwater use in the Central Basin is restricted to the allowed pumping allocations by a 1966 Superior Court Judgment and is monitored by a court-appointed Watermaster, the Department of Water Resources (DWR). Annually, the Watermaster prepares a Watermaster Service Report indicating groundwater extractions, replenishment operations, imported water use, recycled water use, finances of Watermaster services, administration of the water exchange pool, and significant water-related events in the Central Basin.

The City's entitlement in the Central Basin of 15,000 AFY was established in a judgment by the Superior Court of the State of California for the County of Los Angeles through the Central Basin Judgment (Case No. 786,656 –second amended judgment). In addition to its annual entitlement, the Central Basin Judgment allows for carryover of unused water rights up to a maximum total cumulative amount of 20 percent of the purveyor's pumping allocation and also allows for over extraction of an additional 20 percent under emergency situations that would be debited against the purveyor's following year entitlement. The City uses its carryover storage right for operational flexibility and conjunctive use. LADWP has allowable carryover storage of 3,000 AF into FY 2010/11.

The Central Basin or West Coast Basin Judgements do not permit storing water in the basin for later extraction. Through the assistance of a facilitator, multiple parties with groundwater rights have developed a draft framework to allow conjunctive use groundwater storage in the basins and are seeking amendment of the Judgments to allow groundwater storage. Two separate cases are currently in the Superior Court on the storage framework issue.

Water Quality

Although the Manhattan and 99th Street Well fields in the Central Basin are located only approximately 4 miles apart, there is a large difference in water quality between the facilities. One of the Manhattan Wells currently exceeds the MCL of 5 ppb for TCE. The effluent from the wellfield is managed in such a way that the groundwater quality meets or surpasses water quality standards.

Water from 99th Street Wellfield complies with the National Primary Drinking Water Regulations, but requires treatment to comply with the National Secondary Drinking Water Regulations for manganese and iron. These contaminants are not considered to present a risk to human health, but at existing concentrations the contaminants may present taste, color, and odor problems. Corrosion control treatment using zinc orthophosphate as a sequestering agent and sodium hypochlorite to oxidize manganese has been in place at the wellfield for twenty years. Hydrogen sulfide is also present but not an imminent threat to the reliability of this well supply when chlorinated. In 2002, two new wells were drilled and placed into operation. During the first several months of operation of the new wells, numerous color complaints were received from customers. Adjustments in the treatment process were made which improved water quality.

6.5 West Coast Basin

LADWP has not been able to pump its water entitlement from the West Coast Basin since 1980 due to localized groundwater contamination issues and deterioration of the wells at the Lomita Wellfield. The West Coast Basin underlies 160 square miles in the southwestern part of the Los Angeles Coastal Plain in Los Angeles County. The West Coast Basin is bounded on the west by Santa Monica Bay, on the north by Ballona Escarpment, on the east by the Newport-Inglewood Uplift, and on the south by San Pedro Bay and the Palos Verdes Hills. Twenty incorporated cities and several unincorporated areas overlie the West Coast Basin (West Coast Basin Watermaster Service Report, FY 2009/10).

Groundwater Rights

In 1945, when intrusion of sea water caused by declining water levels threatened the quality of the groundwater supply, legal action was taken to halt the overdraft and prevent further damage to the West Coast Basin. In 1955, the Superior Court of Los Angeles County appointed the DWR as the Watermaster to administer an Interim Agreement, and in 1961, the Court retained the DWR as the Watermaster of the Final West Coast Basin Judgment (Case No. 506,806 –amended judgment). Similar to the Central Coast Basin, an annual Watermaster Service Report is prepared. The West Coast Basin Judgment provided the City with a right to 1,503 AFY of groundwater.

Water Quality

Groundwater quality problems in the West Coast Basin were previously related to high levels of total dissolved solids and chlorides. LADWP halted operations in the basin in September of 1980 with closure of the Lomita Well Field, and intends to study the feasibility and cost of restoring groundwater pumping.

6.6 Unadjudicated Basins

The Central and West Los Angeles Areas include the Hollywood Basin and Santa Monica Basin. Both Basins are unadjudicated. In the past, LADWP studied the potential for utilizing these basins for increased groundwater supply. It was determined that developing groundwater was not recommended due to water quality and cost considerations. However, LADWP intends to revisit the potential for increased groundwater production from these two basins. It is anticipated that available supplies remain low and water quality issues remain, but as the cost of imported water increases, it is prudent to reconsider this local water source.

6.7 Water Quality Goals and Management

The groundwater management efforts that LADWP has undertaken have resulted in all groundwater delivered to customers meeting or exceeding all water quality regulations. As part of its regulatory compliance efforts, LADWP works with the CDPH to perform water quality testing on production and monitoring wells.

Groundwater Monitoring

LADWP conducts extensive field and laboratory tests throughout the year for hundreds of different chemicals, such as arsenic, chromium, lead, and disinfection by-products, to ensure that they are will within the safe levels before we serve the water to our customers.

Every well that is pumped to supply water to the City is actively monitored by LADWP as required by CDPH. LADWP's groundwater monitoring program is comprised of several distinct components, including monitoring of metals, coliform bacteria, inorganics, volatile organic

Exhibit 6D
Operating Limits of Regulated Compounds

Compound	State of California Limit	LADWP Operational Goals	LADWP Added Safety Margin
Trichloroethylene (TCE)	5 ppb	3 ppb	40%
Perchloroethylene (PCE)	5 ppb	3 ppb	40%
Nitrate (NO_3)	45 ppm	30 ppm	33%
Perchlorate (ClO_4)	6 ppb	4 ppb	33%
Total Chromium	50 ppb	30 ppb	40%

compounds (VOCs) and unregulated compounds such as vanadium, boron, and perchlorate. The frequency and level of monitoring (i.e., annually, quarterly, or monthly), depending on the level of contamination found in each well.

Monitoring for all contaminants is performed at entry points into the distribution system in close proximity to where the water is being pumped from the wells. If water quality problems are detected, the well source is immediately isolated and retested.

Operating Goals

LADWP has established operating goals for TCE, PCE, nitrates, perchlorate, and total chromium that are more stringent than the maximum contaminant levels (MCLs) permitted by Federal or State regulations. These stricter operational goals provide an additional safety margin from these contaminants for City customers. Exhibit 6D summarizes these water quality goals and compares them with the State-regulated requirements, which are generally more stringent than Federal requirements.

TCE and PCE compounds are commonly used in industries requiring metal degreasing. PCE is also used in dry cleaning and automotive repair industries.

Nitrate is a concern because of its acute effect of impeding the uptake of oxygen to the blood. Infants (who are in the earliest stages of development) are most sensitive to the effects of nitrates. The current standard for nitrate is 45 parts per million (ppm). A single exceedence of the nitrate standard is classified as an acute violation requiring immediate public notification. Treatment for nitrates may eventually become necessary for affected City groundwater supplies.

In October 2007, a MCL was adopted for perchlorate of 6 ppb. Perchlorate is an inorganic compound that is most commonly used in the manufacture of rocket fuels, munitions, and fireworks. In addition to its detection in groundwater, the compound has also been detected in Colorado River Aqueduct water.

Managing Emerging Contaminants of Concern

LADWP addresses emerging contaminants on many levels: 1) by encouraging the development of standardized testing to enable early detection and supporting the regulatory framework by providing early occurrence data, 2) by advocating good science and a balanced approach to risk assessment, 3) by seeking to gain a risk perspective with other existing contaminants to manage the emerging contaminants in the absence of regulations, 4) by supporting early interpretation of emerging contaminants in collaboration with research and regulatory agencies, and 5) by supporting the research to develop cost-effective treatment for the removal and management of these emerging contaminants.

An example of how LADWP addresses an emerging contaminant is chromium VI (otherwise known as hexavalent chromium). Hexavalent chromium does not have an enforceable drinking water standard at this time. However, hexavalent chromium is included in the State total chromium standard of 50 ppb. CDPH is expected to establish drinking water standards for the compound in the near future. Chromium is a heavy metal that has been used in industry for various purposes including electroplating, leather tanning, and textile manufacturing, as well as controlling biofilm formation in cooling towers. LADWP began low level monitoring of hexavalent chromium long before monitoring was required by regulators. LADWP supported new health-effects research needed to support risk assessment, and advocated a balanced approach to risk management. LADWP funded research to develop new treatment technologies to reduce hexavalent chromium detection levels.

Most recent among emerging contaminants are pharmaceutically active compounds and personal care products that are finding their way into rivers, lakes, and waterways from urbanized areas. There are concerns about the occurrence and effects of endocrine disrupters, hormone-shifting compounds, and pharmaceuticals. Technology now allows the detection of compounds down to the parts per trillion levels, thus some of these compounds are now being detected. The risk assessment field is finding it difficult to keep pace with advances in analytical detection technology. The question of these contaminants posing a health risk at low levels needs more investigation. LADWP will continue to proactively address emerging contaminants through early monitoring and utilization of a balanced approach to risk management.

LADWP will be incorporating appropriate treatment processes into future groundwater treatment facilities. LADWP has and will continue to solicit input from stakeholders to properly plan and develop processes for removal and treatment of emerging contaminants. LADWP's Recycled Water Advisory Group (RWAG) is an example of ongoing efforts to solicit input.

Exhibit 6E
Historical Cost of Groundwater Pumping

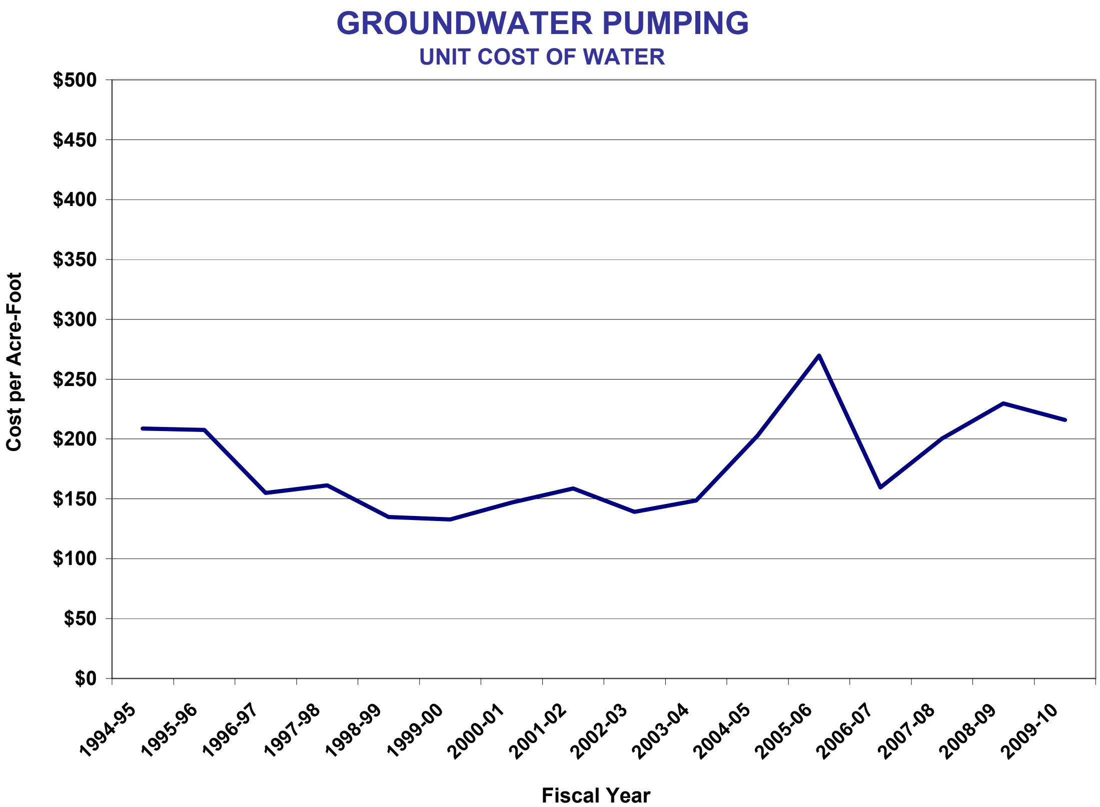


Exhibit 6F
Annual Unit Cost ($/AF)

Fiscal Year	2005/06	2006/07	2007/08	2008/09	2009/10
Unit Cost	$270	$160	$200	$230	$216

6.8 Groundwater Pumping Cost

The costs associated with groundwater pumping are primarily operation and maintenance costs. Therefore, the unit cost of groundwater pumping varies mainly with the quantity of water delivered. Exhibit 6E summarizes the historical unit cost of groundwater pumping.

Exhibit 6F shows the unit cost of groundwater pumping from FY 2005/2006 to FY 2009/2010. The 5-year average was $215/AF.

6.9 Groundwater Production Projections

Historically, with conjunctive use management of groundwater, storing imported water in the groundwater basins during wet and normal years, groundwater production can actually be increased during dry years. LADWP operated its groundwater resources in this manner. On average, LADWP pumped its adjudicated right of approximately 107,000 AFY, but in dry years LADWP could pump larger quantities of groundwater. For the purposes of an average, single-dry, and multi-dry year analysis, after the implementation of groundwater treatment for the SFB and completing the construction of new wells in the Sylmar and Central Basins, 110,405

AFY is assumed to be the City's local groundwater production in 2035. After completion of groundwater treatment for the SFB, if successive dry years occur, LADWP would likely pump at greater-than-average levels for the first few dry years, then start pumping at lower levels in order to prevent groundwater overdraft. LADWP would then replenish the groundwater in wet or normal years following the successive dry period. Exhibit 6G provides groundwater pumping projections by basin between 2010 and 2035 for average, single-dry, and multi-year dry weather conditions in five-year increments.

Not included in the figure below is increased groundwater pumping due to groundwater replenishment of advanced treated wastewater, as well as enhanced stormwater recharge. This Urban Water Management Plan projects increased groundwater pumping through groundwater replenishment of advanced treated wastewater of 15,000 AFY, and increased groundwater pumping through enhanced stormwater recharge of and additional 15,000 AFY, both by 2035.

Exhibit 6G
Groundwater Production 2010 to 2035 for Average, Single-Dry, and Multi-Year Dry Weather Conditions

Basin	FY 2009/10	FY 2014/15	FY 2019/20	FY 2024/25	FY 2029/30	FY 2034/35
	AFY					
San Fernando	62,218	21,000	76,800	92,000	92,000	92,000
Sylmar	2,998	4,500	4,500	4,500	4,500	3,405
Central	11,766	15,000	15,000	15,000	15,000	15,000
Total	76,982	40,500	96,300	111,500	111,500	110,405

- 2015 San Fernando pumping levels are decreased due to anticipated well contamination from plume migration.
- Assumes existing annual rights to 87,000 AFY in SFB will remain unchanged. The groundwater treatment facilities are expected to be in operation in FY 2020/21. Storage credit of 5,000 AFY will be used to maximize the pumping thereafter.
- Sylmar Basin production temporarily increases to 4,500 AFY to avoid the expiration of stored water credits then return back to the entitlement of 3,405 AFY in FY 2030/31.

Chapter Seven

Watershed Management

7.0 Overview

This Urban Water Management Plan projects that additional stormwater capture projects will provide for increased groundwater pumping rights in the San Fernando Basin of 15,000 AFY. Stormwater capture projects will also provide 10,000 AFY of additional water conservation from capture and reuse solutions such as rain barrels and cisterns, for a total of 25,000 AFY by fiscal year ending 2035. The Stormwater Capture Master Plan (refer to Section 7.3 below) will comprehensively evaluate stormwater capture potential within the City.

Stormwater runoff from urban areas is an underutilized resource. Within the City of Los Angeles, the majority of stormwater runoff is directed to storm drains and ultimately channeled into the ocean. Unused stormwater reaching the ocean carries with it many pollutants that are harmful to marine life. In addition, local groundwater aquifers that should be replenished by stormwater are receiving less recharge than in the past due to increased urbanization. Urbanization has increased the City's hardscape, which has resulted in less infiltration of stormwater and a decline in groundwater elevations.

In addition, development has encroached onto waterway floodplains requiring the channelization of these waterways that once recharged the groundwater aquifers with large volumes of stormwater runoff. When the floodplains were undergoing rapid development, LADWP and the Los Angeles County Flood Control District (LACFCD) reserved several parcels of land for use as spreading facilities. These facilities are adjacent to some of the largest tributaries of the Los Angeles River, and the Pacoima and Tujunga Washes.

During average and below average years, these spreading facilities are very effective at capturing a large portion of the stormwater flowing down the tributaries. However they are incapable of capturing a significant portion of the flows during wet and extremely wet years. Weather patterns in Los Angeles are highly variable, with many periods of dry years and wet years. Some climate studies predict that these patterns may become more extreme in the future.

Furthermore, a significant portion of the watershed is not located adjacent to large tributaries and therefore, cannot be served by existing spreading facilities. These areas are the urbanized low-lying flatlands that also produce stormwater, therefore a strategy to create and implement distributed stormwater infiltration solutions is needed. These distributed solutions include widespread, smaller projects at the neighborhood scale and landscape changes at the individual parcel scale.

With increased attention being placed on stormwater capture, other challenging conditions beyond imperviousness and climate patterns have been identified.

These include antiquated spreading facilities, landfills adjacent to spreading facilities, floodplain encroachment, substructures, and other man-made conditions that limit the ability to capture stormwater for later use. Some conditions such as the antiquated delivery systems at the spreading facilities can easily be retrofitted with new gates and telemetry. Other conditions such as the presence of large sanitary landfills adjacent to spreading facilities, are more difficult to rectify.

In January 2008, LADWP created the Watershed Management Group which is responsible for developing and managing the water system's involvement in emerging issues associated with local and regional stormwater capture. The Watershed Management Group coordinates activities with other agencies, departments, stakeholders and community groups for the purpose of planning and developing projects and initiatives to improve stormwater management within the City. The Group's primary goal is to increase stormwater capture by enhancing existing centralized stormwater capture facilities and promoting distributed stormwater infiltration systems to achieve the City's long-term strategy of enhancing local stormwater capture. While working to increase stormwater capture for improving long-term groundwater reliability, other watershed benefits can be achieved including increased water conservation, improved water quality, open space enhancements, and flood control.

Additionally, the City is investigating recharge of the San Fernando Basin (SFB) with advanced treated recycled water. A more in-depth discussion of efforts to maximize groundwater recharge with advanced treated recycled water is provided in Chapter 4, Recycled Water.

7.1 Importance of Watershed Management to Groundwater Supplies

Managing native stormwater is a necessary step towards maintaining groundwater elevations in the underlying groundwater basin. Urbanization and its associated increase in impervious surfaces has altered the ability of groundwater basins to naturally replenish pumped groundwater. Stormwater systems in the City were designed primarily for flood control to convey stormwater runoff to the Pacific Ocean as quickly as possible, therefore minimizing the potential for flooding or damage to structures while maximizing land available for development. Within LADWP's service area, the SFB is the most amenable to regional stormwater capture and recharge through spreading basins because of its predominantly sandy soils. However, stormwater that once percolated into the groundwater in the underlying SFB is now being channeled across impervious surfaces then through concrete-lined canals or conduits to areas outside of the San Fernando Valley.

The essential task of watershed management is to retain as much stormwater runoff as possible for groundwater recharge. Groundwater recharge is the process of increasing an aquifer's water content through percolation of surface water. This occurs in the SFB primarily with captured stormwater but also with imported water. Groundwater recharge is essential to maintain groundwater supplies, address the overall long-term decrease in stored groundwater within the SFB, and ensure the long-term water supply reliability of the SFB. Furthermore, increasing groundwater recharge and improving groundwater levels in the SFB could potentially lead to larger pumping rights for LADWP in the future.

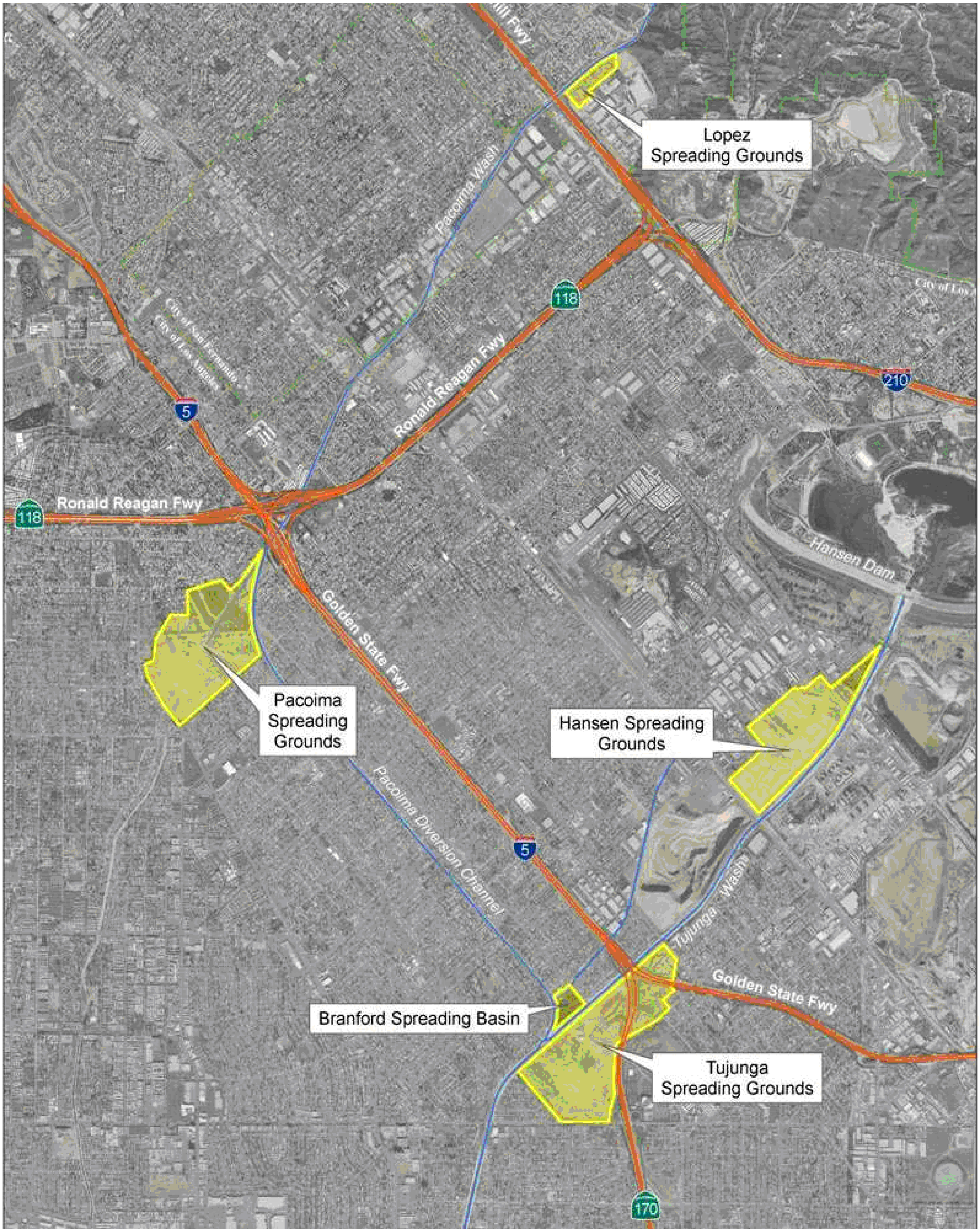
During storm events, large portions of stormwater are captured with existing facilities for spreading purposes. LADWP coordinates these activities with the LACFCD to effectively recharge the SFB through the spreading of native stormwater. Flood control facilities are the primary means to divert native runoff into the spreading ground facilities listed and mapped on Exhibits 7A and 7B. LACFCD oversees operations at the Branford, Hansen, Lopez, and Pacoima Spreading Grounds. The Tujunga Spreading Grounds are operated by LACFCD in partnership with LADWP. LADWP has the ability to spread imported supplies at the Tujunga Spreading Grounds and the Pacoima Spreading Grounds for storage in the SFB, but LADWP has not utilized imported water for groundwater recharge since 1998.

Exhibit 7A
SFB Spreading Grounds Operations Data

		Annual Spreading (AF)	
Facility	**Location**	**Average[1]**	**Historic High**
Branford	Mission Hills, CA	549	2,142
Hansen	Sun Valley, CA	13,834	35,192
Lopez	Lake View Terrace, CA	527	1,735
Pacoima	Pacoima, CA	6,453	22,972
Tujunga	Sun Valley, CA	4,419	21,115
	Total	25,782	83,156

1. Historic average through water year ending September 2009.

Exhibit 7B
Spreading Ground Facility Locations



7.2 Additional Benefits of Watershed Management

Watershed management provides additional important benefits to the City of Los Angeles, including surface water quality improvements, water conservation, open space enhancements, and flood control.

Water quality improvements are necessary because stormwater runoff is a conveyance mechanism that transports pollutants from the watershed into waterways and ultimately the Pacific Ocean. Pollutants include, but are not limited to, bacteria, oils, grease, trash, and heavy metals. The City must also comply with adopted Total Maximum Daily Loads (TMDLs) for pollutants. TMDLs set maximum limits for a specific pollutant that can be discharged to a water body without causing the water body to become impaired or limiting certain uses, such as water body contact during recreation. In 2008, the Los Angeles Board of Public Works adopted the Water Quality Compliance Master Plan for Urban Runoff (WQCMPUR). This 20-year plan provides a strategy for cleaning stormwater and runoff to protect the City's waterways and the Pacific Ocean. Capturing stormwater runoff for groundwater recharge removes a portion of the pollutant conveyance mechanism which reduces downstream pollution and thereby assists the City with water quality compliance and improving the overall health of its waterways.

Water conservation is achieved by enhancing the capture and management of localized runoff for local uses. Centralized and distributed mechanisms that provide for water conservation include spreading grounds, rain barrels, and residential cisterns.

Open space enhancement is an added benefit of groundwater recharge projects, which typically provide additional open space areas that may include passive and/or active recreation, educational opportunities, and habitat restoration. Most projects involve increasing vegetation and recreational amenities to create opportunities for wildlife habitat and a recreational/educational resource for the local community. Additionally, open space enhancements assist the City in improving the overall quality of life for residents.

Flood control benefits are achieved when additional storage capacity is added to the storm drain system. Groundwater recharge projects reduce potential flooding by diverting a portion of storm flows into recharge areas, thereby increasing the overall capacity of the storm drain system.

7.3 Stormwater Capture Master Plan

The Stormwater Capture Master Plan (Stormwater Plan) will investigate potential strategies for advancement of stormwater and watershed management in the City. The Stormwater Plan will be used to guide decision makers in the City when making decisions affecting how the City will develop both centralized and distributed stormwater capture goals. The Stormwater Plan will include evaluation of existing stormwater capture facilities and projects, quantify the maximum stormwater capture potential, develop feasible stormwater capture alternatives (i.e., projects, programs, potential policies, etc.), and provide potential strategies to increase stormwater capture. The Stormwater Plan will also evaluate the multi-beneficial aspects of increasing stormwater capture, including potential open space alternatives, improved downstream water quality, and peak flow attenuation in downstream channels, creeks, and streams such as the Los Angeles River.

The Stormwater Plan will recommend stormwater capture projects, programs, policies, and incentives for the City of Los Angeles.

Benefits of the Stormwater Plan include:

- Investigation of stormwater capture models such as the Groundwater Augmentation Model and the Watershed Management Modeling System to identify maximum potential groundwater recharge.
- Increased water conservation.
- Improved water quality .
- Reduced peak flow in the Los Angeles River.
- Project partners and supporters include:
- City of Los Angeles Department of Water and Power
- City of Los Angeles Department of Public Works
- County of Los Angeles Department of Public Works
- TreePeople, Inc.

A Request for Proposal for the Stormwater Plan was released on February 24, 2011. The contract is anticipated to be awarded by the last quarter of 2011, and completion of the Stormwater Plan will take approximately 24 months.

7.4 TreePeople – Memorandum of Agreement

The Memorandum of Agreement (MOA) with TreePeople has been forged to facilitate a high-level of collaboration between LADWP and TreePeople with the aim of fostering a more sustainable Los Angeles. The partnership it outlines leverages TreePeople's experience in public education and agency integration to further the long-term sustainability objectives of LADWP. Specifically, LADWP and TreePeople are working together to research opportunities within LADWP's facilities and operations for widespread groundwater recharge. This research includes an educational component wherein LADWP and TreePeople learn about each other's initiatives and core business. Ultimately, this exchange of ideas will help the two partners develop concepts for projects that will increase stormwater capture for groundwater recharge.

LADWP was an early sponsor of the TreePeople Trans-agency Resources for Environmental and Economic Sustainability (T.R.E.E.S.) Project, during which time TreePeople developed best management practices for capturing, cleaning and using stormwater; published the handbook Second Nature; created a computerized cost-benefit model; and facilitated a number of design workshops for public agencies. TreePeople has also been integral to the construction and management of three demonstration sites -- a single-family home (Hall House) retrofitted to capture all the rainwater onsite, and two elementary schools (Broadous and Open Charter) that feature strategic landscaping and a cistern or underground infiltrators. LADWP has supported public tours and educational materials for Hall House, and is a key partner in the school projects which were partially funded through the Cool Schools and Sustainable Schools programs.

The overlap between the objectives of LADWP and those of TreePeople is notable in the Tujunga Wash and Sun Valley watersheds, where both have been especially active. Stakeholder processes in which the two have worked successfully to further mutual goals include the City's Integrated Resources Plan, the Greater Los Angeles County Integrated Regional Water Management Plan, and development of the objectives of the California Urban Water Conservation Council.

7.5 Centralized Stormwater Capture Projects

Existing stormwater capture facilities are inadequate for capturing runoff during very wet years. Weather patterns vary dramatically in Los Angeles with very wet years and very dry years. Therefore, new projects are necessary to expand the capability to capture a larger portion of stormwater flows during wet years. LADWP is working proactively in close partnership with LACFCD on multiple stormwater projects, as listed in Exhibit 7C. These projects will increase centralized stormwater recharge capacity by approximately 26,000 AFY in the SFB, raising groundwater levels and ensuring the future water supply reliability of the SFB. These projects are designed to maximize groundwater recharge into the SFB by increasing the total average recharge to approximately 51,700 AFY.

Multiple opportunities exist to develop new recharge projects and improve existing recharge projects in the SFB. LADWP, in collaboration with LACFCD has supported and contributed resources toward the design, construction, and implementation of a variety of projects to increase groundwater recharge of the SFB. Additionally, multiple agreements between LADWP and LACFCD have been approved to facilitate the preparation of recharge studies, design work, and construction of projects in the SFB for groundwater recharge, flood protection, and other benefits.

Exhibit 7C
Planned Centralized Stormwater Capture Programs

Project	Current Annual Recharge (AFY)	Increased Annual Capture/ Recharge (AFY)	Expected Annual Recharge (AFY)	Estimated Project Completion	Total Project Cost (millions)	LADWP Share (millions)
Sheldon-Arleta Gas Collection System	-	4,000 [1]	-	Complete Nov 2009	$8.20	$6.30
Big Tujunga Dam Rehabilitation [3]	-	4,500	-	July 2011	$105.70	$9.00
Hansen Spreading Grounds Upgrade	13,834	1,200	17,284 [2]	Dec 2011	$9.30	$4.80
Tujunga Spreading Grounds Upgrade	4,419	8,000	18,669 [4]	2015	$24.00	$24.00
Pacoima Spreading Grounds Upgrade	6,453	2,000	8,453	2015	$32.00	$16.00
Lopez Spreading Grounds Upgrade	527	750	1,277	2016	$8.00	$4.00
Strathern Wetlands Park	-	900	900 [5]	2016	$46.00	$4.00
Hansen Dam Water Conservation	-	3,400	3,400	2017	$5.00	$2.50
Valley Generating Station Stormwater Capture	-	700	700	2018	$9.70	$9.70
Branford Spreading Basin Upgrade	549	500	1,049	2018	$4.00	$2.00
Total Estimated Yield	**25,782**	**25,950**	**51,732**		**$251.90**	**$82.30**
Total Expenditure-to-date						$18.60
Total Expenditure Remaining						$63.70

1. This will allow increased collection of 4,000 AFY at Tujunga Spreading Grounds.
2. Includes 1/2 benefits from Big Tujunga Dam Rehabilitation Project.
3. No recharge occurs at the facility. All additional capture has been divided between Hansen & Tujunga Spreading Grounds.
4. Including benefits from Sheldon-Arleta Project and 1/2 benefits from Big Tujunga Dam Rehabilitation Project.
5. To be recharged at Sun Valley Park.

Sheldon-Arleta Methane Gas Collection Project. In 1998, a task force comprised of representatives from LADWP, other City departments (Bureau of Sanitation (BOS), Bureau of Engineering, and Environmental Affairs) and the Upper Los Angeles River Area Watermaster was formed to review the issues surrounding the recharge of groundwater through spreading at the Tujunga Spreading Grounds. The objective of this Task Force was to maximize water spreading at the Tujunga Spreading Grounds without causing off-site landfill gas migration. An outcome of the Task Force was the Sheldon-Arleta Methane Gas Collection Project. The project is designed to restore the original Tujunga Spreading Grounds capacity of 250 cubic feet per second (cfs) with the potential for future enhancement by bringing the Tujunga Spreading Basins closest to the Sheldon-Arleta landfill back online. The Tujunga Spreading Grounds are located adjacent to the closed Sheldon-Arleta Landfill. During spreading operations, water displaces air from the ground potentially increasing migration of methane gas generated by the landfill. In the past, elevated levels of methane gas have been detected in the surrounding communities. Therefore, restrictions were enacted curtailing spreading operations to 20 percent of their original capacity. This project is a joint effort between LADWP and BOS to replace the methane gas collection system within the landfill and thereby contain methane gas onsite. The project is being implemented by LADWP through LABOS's Proposition "O" Clean Water Bond program. Proposition "O" funded approximately $3 million of the $9 million cost. Construction began in 2007 and was completed in November 2009.

Big Tujunga Dam – San Fernando Groundwater Enhancement Project. LADWP and LACFCD approved Cooperative Agreement No. 47717 on September 18, 2007 for the Big Tujunga Dam –San Fernando Groundwater Enhancement Project. This Project will increase stormwater capture and provide other benefits including improvements in flood prevention and environmental enhancement through seismically retrofitting the dam and spillway. Annual stormwater capture will increase by 4,500 AFY for a total capture amount of 6,000 AFY. The project is integrated with the following projects in this section: Hansen Spreading Grounds Enhancement Project, Tujunga Spreading Grounds Enhancement Project, and the Sheldon-Arleta Methane Gas Collection Project. Both the Greater Los Angeles County Integrated Regional Watershed Management Plan and the Tujunga/Pacoima Watershed Plan are being incorporated into the Project. LADWP is contributing $9 million of the $105 million project cost. Construction of the project is in progress with an anticipated completion date by July 2011.

Hansen Spreading Grounds Enhancement Project. The Hansen Spreading Grounds is a 120 acre parcel located adjacent to the Tujunga Wash Channel downstream from the Hansen Dam. Under Cooperative Agreement No. 47739, the LACFCD and LADWP propose to modernize the facility to increase intake and storage capacity thereby improving groundwater recharge, flood protection and water quality while providing recreational benefits and native habitat improvements. To accomplish the goals of the project, a phased approach is being proposed. Phase 1A will deepen and reconfigure the existing basins; Phase 1B will improve the intake capacity by replacing a radial gate with a new rubber dam and telemetry system; and Phase 2 will develop other compatible uses such as recreational trails and native habitat for the community. Estimated recharge is 17,284 AFY, and estimated cost of this project is $10 million of which LADWP will fund $5 million. The Phase 1A reconstruction of the spreading grounds was completed in December 2009 and the Phase 1B intake structure will be completed in December 2011.

Tujunga Spreading Grounds Enhancement Project. The Tujunga Spreading Grounds Enhancement Project is designed to increase average annual stormwater capture by 8,000 AFY through relocating and automating the current intake structure on the Tujunga Wash, installation of an automated intake structure on the Pacoima Wash, and reconfiguration of the Tujunga Spreading Basins. Other multiple benefits include habitat improvements, passive recreation, educational opportunities, flood protection, and water quality improvements. Owned by LADWP, the Tujunga Spreading Grounds are operated by LACFCD in conjunction with other facilities along the Tujunga and Pacoima Wash Channels. Construction is expected to begin in 2012.

Valley Generating Station Stormwater Capture Project. LADWP is leading efforts to capture and infiltrate stormwater from the Valley Generating Station, from adjacent streets, and from the Tujunga Wash Channel. Phase 1 will capture and infiltrate all stormwater from the Valley Generating Station. Phase 2 will divert water mainly from the Hansen

Spreading Grounds for infiltration at the abandoned gravel pit at the generating station. Total stormwater capture is estimated at 700 AFY. Project designs are expected to be completed at the end of 2013.

Pacoima Spreading Grounds Enhancement Project. LADWP in conjunction with LACFCD is proposing to upgrade the Pacoima Spreading Grounds by improving the intake and stormwater storage capacity. Annual average stormwater capture is expected to increase by approximately 2,000 AFY with completion of the project. Other project benefits include flood protection, water quality improvements, and passive recreation. The final concept report and design has an expected completion date by the end of 2012.

Lopez Spreading Grounds Enhancement Project. The Lopez Spreading Grounds Enhancement Project involves deepening the existing Lopez Spreading Grounds and improving the intake and delivery system. LACFCD is the lead agency for the project. Additional groundwater recharge to the SFB of approximately 750 AFY is expected from the project. Project designs are anticipated to begin in 2013.

Strathern Wetlands Park Project. The Strathern Wetlands Park Project involves the conversion of a 45-acre gravel pit into a multipurpose facility for flood protection, stormwater retention, treatment, groundwater recharge, habitat restoration, and recreation. Estimated stormwater capture is approximately 900 AFY. Proposition "O" funding of $17.8 million has been approved for acquisition of the site. LACFCD purchased the land and project planning is underway. Designs are expected in 2012, and construction is expected to occur in two phases from 2013 to 2016.

Hansen Dam Water Conservation Project. In 1999 the U.S. Army Corps of Engineers completed a feasibility study to examine operational changes and facility improvements at the Hansen Dam as part of a cost-shared study with LACFCD.

Pacoima Dam Reservoir Sediment Removal Project. The Pacoima Dam Reservoir Sediment Removal Project involves removing sediment from behind Pacoima Dam to increase storage volume. The sediment build-up behind the dam has decreased the capacity to about 3,300 acre-feet. In the fall of 2009 approximately 80 percent of the Pacoima Dam watershed was burned. This damage will likely increase sediment flow into the reservoir above the estimates provided based on 2005 topography. The project will involve excavating 5 million cubic yards of sediment and increasing the storage volume by 3,000 acre-feet. Increased storage would decrease the number of reservoir spill events and increase the available recharge flow for the Pacoima and Lopez Spreading Grounds. The excavation will extend over 7,000 feet upstream of the existing dam. The project will produce an additional annual water recharge benefit of 670 AFY.

Branford Spreading Basin Upgrade. The Branford Spreading Basin Project will remove fine silts from the basin and install new pumps to drain the basin. These pumps could be used to drain the existing facility into the Tujunga Spreading Grounds. The expected additional recharge for this project is approximately 500 AFY.

7.6 Distributed Stormwater Capture

Throughout the City there are opportunities to capture localized dry and wet weather runoff for local reuse. However, Los Angeles' storm drain systems have historically been designed to protect life and property from flood impacts by quickly redirecting rainfall and runoff from impervious surfaces into the City's storm drain system and ultimately the Pacific Ocean without regard to water quality impacts. The September 2, 2002 Municipal Stormwater National Pollutant Discharge Elimination System Permit

(NPDES Permit No. CAS004001) for the Los Angeles region requires all new development or redevelopment projects to develop and comply with a Standard Urban Stormwater Mitigation Plan (SUSMP) to reduce runoff leaving the project site and to improve the project's water quality impacts.

Recently the City has taken initial steps towards promoting distributed capture and infiltration of runoff through development of a suite of distributed runoff demonstration projects. Distributed stormwater capture (also known as decentralized stormwater capture) is defined as any groundwater recharge system capturing less then 500 AF or any direct stormwater capture system capturing less then 10 AF. In addition, the City is close to adopting a Low Impact Development (LID) ordinance requiring retention of stormwater onsite for new and redevelopment projects which extends beyond SUSMP regulations. The Watershed Management Group is working with the Los Angeles and San Gabriel Rivers Watershed Council (LASGRWC), TreePeople, BOS, Department of Building and Safety, Los Angeles County Department of Public Works (LACDPW), The River Project and others to evaluate and study the impacts of localized stormwater capture and source control within the City.

LADWP is providing various resources for projects that would enhance the City's ability to capture additional dry and wet weather runoff for beneficial use. Both dry and wet weather runoff can be beneficially used. Dry weather runoff occurs in the absence of rainfall while wet weather runoff occurs as a direct result of rainfall. Dry weather runoff is typically related to inefficient irrigation systems, overwatering, and other wasteful outdoor water use practices. Wet weather runoff represents a significantly larger volume of water than dry weather runoff. Exhibit 7G summarizes the potential water yield and average unit cost of the different resources available to increase localized capture and infiltration of runoff.

7.6.1 Watershed Council – Water Augmentation Study

The Los Angeles Basin Water Augmentation Study is a long-term research project, initiated in 2000, created to determine the benefits of implementing a broad-based approach to stormwater infiltration within the Los Angeles Region. The study was led by the Los Angeles & San Gabriel Rivers Watershed Council in partnership with local, state, and federal agencies and organizations, with major support from the U.S. Bureau of Reclamation. LADWP assisted in the funding and creation of the study report as part of the Technical Advisory Committee.

While centralized strategies such as spreading basins and dams are reliable and effective methods to capture stormwater, increased urbanization, high land costs, and scarcity of imported water for recharge signal the need to pursue additional stormwater capture methods. Furthermore, centralized stormwater infiltration is unable to capture the entire watershed which leaves a large quantity of additional stormwater to be tapped into. The Los Angeles Basin Water Augmentation Study research has concluded that decentralized strategies (distributed stormwater capture such as rainbarrels & cisterns) would provide a local and reliable supply of water that would not negatively impact groundwater quality. Distributed stormwater capture and infiltration system techniques provide a viable means of augmenting groundwater recharge and reducing the overall cost of treating urban runoff. Based on the findings of this study, the Los Angeles Basin Water Augmentation Study partnership moved forward on a demonstration project in a single family residential home neighborhood in northeast San Fernando Valley to validate the study findings.

CASE STUDY:
Elmer Avenue Neighborhood Retrofit Project

The Background

Initiated in 2000, the Los Angeles Basin Water Augmentation Study (WAS) is a long-term research project led by the Los Angeles & San Gabriel Rivers Watershed Council in partnership with eight local, state, and federal agencies of which LADWP is an active partner. The study is evaluating the practical potential to improve surface water quality and increase local groundwater supplies through infiltration of urban stormwater runoff.

Based on positive findings of the study, the WAS partnership moved forward with a demonstration project to display an integrated and comprehensive approach to water management by retrofitting a neighborhood with strategies to address water conservation, pollution reduction and treatment, flooding, and habitat restoration. The Elmer Avenue Neighborhood Retrofit Project was chosen after an extensive selection process that evaluated neighborhoods based on more than 80 criteria.

The Project

The Elmer Avenue Neighborhood Retrofit Project commenced in July 2009 and was completed in June 2010 and cost approximately $2.5 million. Elmer Avenue receives stormwater runoff from approximately 40 acres of upstream residential area causing flooding in most storms. To address this runoff, the project encompasses improvements to both the public right-of-way as well as the private residences. As such, the project required active interaction and cooperation between the WAS partnership and the residents to work together and come up with a solution for the neighborhood.

Public Right-of-Way Improvements:

Infiltration Gallery-

A large infiltration gallery was installed underneath the street right-of-way which is estimated to infiltrate 16 acre-feet annually. The gallery is a sub-surface groundwater collection system, shallow in depth, constructed with perforated pipes into which runoff water flows and is then allowed to infiltrate into the ground to recharge the local groundwater basin.

Bioswale-

The newly installed sidewalks include bio-swales in the parkways to capture and treat stormwater runoff from the local sub-watershed mostly from residential land use. The bioswales are open shallow channels with gently sloped sides and bottoms filled with vegetation and rip rap where stormwater runoff is collected. Bioswales help reduce the flow velocity and treat stormwater runoff by filtering it through the vegetation in the channel, through the subsoil matrix, and/or into the underlying soils. In addition, bioswales trap particulate pollutants (suspended solids and trace metals), promote infiltration and serve as part of the whole stormwater drainage system installed for this project.

Private Residence Improvements:

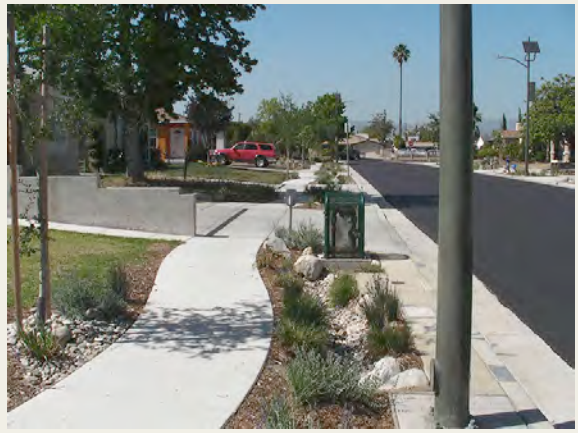
Numerous improvements were offered to residents who chose to participate to help reduce runoff as well as exercise better outdoor water conservation such as porous pavers, rain gardens, rain barrels, and drought-tolerant and native landscaping.

<u>The Benefits</u>

The finished project incorporates a mixture of strategies to produce multiple levels of benefits (to the neighborhood but also to the local, regional, and national community whom can take this work as an encouraging model):

- Capture stormwater and dry-weather runoff to prevent flooding and decrease pollution of local rivers and oceans
- Reduce impermeable surfaces and increase groundwater recharge
- Improve neighborhood aesthetics through increased green space and public right-of-way improvements
- Increase community awareness of watershed issues
- Encourage community awareness of water and associated environmental issues.

As a result of the success and positive feedback from citizens for the Elmer Avenue Neighborhood Retrofit Project, a second phase is currently underway at Elmer Avenue to retrofit its alleyway. Such small projects aim to spark large change by showing citizens and other communities that they also can make changes and improve their neighborhoods to be more water-efficient and environmentally friendly.



"By turning our yards into rain gardens and our streets into water recharge facilities, we can ensure clean water for the future. In contrast to a typical urban street, Elmer Avenue now reduces flooding and water pollution, improves water quality, replenishes groundwater supplies, and increases native habitat."

Nancy Steele, Executive Director
Los Angeles and San Gabriel Rivers Watershed Council

"This project is a prime example of how homeowners and the city can work together on a project that demonstrates smart watershed management through stormwater capture and water conservation measures that are beautiful and effective"

Edward Belden, Water Programs Manager
Los Angeles and San Gabriel Rivers Watershed Council

7.6.2 Integrated Water Resources Plan Analysis

As part of the City's Integrated Water Resources Plan, further described in Chapter 10, the City investigated the beneficial reuse of urban runoff for both dry and wet weather conditions.

7.6.2.1 Dry Weather Runoff Options

The beneficial use option for dry weather runoff consists of runoff capture, treatment, and reuse. For dry weather flow, most of the runoff could potentially be diverted directly for beneficial use, particularly during the summer months when demands for non-potable water are high (due to the higher irrigation demands in the summertime). The level of treatment of the runoff before beneficial use would be determined by the ultimate use of the water.

A computer modeling analysis was performed during development of the Integrated Water Resources Plan based on the recycled water demands in Los Angeles and the available dry weather runoff. Based on the data, the model determined which of the recycled water demands could be realistically met through treated runoff. The dry weather runoff available for reuse throughout the City is estimated at 97 mgd (approximately 26,000 million gallons per year). Exhibit 7D identifies the amount of this runoff that could, after treatment, be used to meet the recycled water demands.

7.6.2.2 Wet Weather Runoff Options

Rain Barrels

Rain barrels are distributed stormwater capture devices used to store rainwater collected from roofs via roof rain gutter systems. Harvested water can be used for outdoor irrigation at a later time. Rain barrels vary in size with a typical rain barrel holding approximately 55 gallons that can be readily installed under any residential roof gutter downspout. Installation of rain barrels at residences

Exhibit 7D
Potential Non-Potable Water Demands Met with Dry Weather Treated Runoff

Service Area	Total Demand Served	
	(AF per year)	(million gallon per year)
Aliso Wash	1,400	460
Canoga	3,250	1,050
Reseda	2,900	950
Tujunga / Burbank	9,050	2,950
LA River Reach 3	1,100	360
Dominguez Channel	8,500	2,770
Compton Creek	1,450	470
Ballona	10,850	3,530
Verdugo Wash	100	30
LA River/Arroyo	9,600	3,130
Total	48,200	15,700

Source: City of Los Angeles Integrated Resources Plan, Facilities Plan, Volume 3: Runoff Management

CASE STUDY:
Ballona Creek Watershed Rainwater Harvesting Pilot Program

Funded by the Safe Neighborhood Parks, Clean Water, Clean Air and Coastal Protection Bond Act of 2000 (Prop 12), a partnership between the Santa Monica Bay Restoration Commission and the California Coastal Conservancy, the City of Los Angeles, Department of Public Works, Bureau of Sanitation, Watershed Protection Division (Stormwater Program) began the City's first free Rainwater Harvesting pilot program in July 2009. The goal of this program is to engage as many property owners as possible by installing one downspout and rainbarrel retrofit per property thereby allowing the maximum number of residences engaged.

Liz Herron, Land Use Chair of Mt. Washington Association, supports rainwater harvesting systems: "Rain barrel systems serve environmental purposes by allowing homeowners to collect the rainwater for personal irrigational purposes. It also reduces the amount of rainwater entering into the streets and ocean. These residential systems are successful programs that save water and prevent pollution."

Designed to conserve potable water and reduce the amount of polluted rainwater that runs untreated into the ocean, the $1-million pilot plan has enough funds to install 490 residential rain barrels, provide consultation on rain gardens, and provide one custom-made commercial planter box for each of ten businesses. It is estimated to save 584,100 gallons of water each year. The City estimates there are roughly 18 rain events in Los Angeles each year filling each barrel at least once each time.

In a typical year, about 9,600 gallons of water is generated on an average 1,000-square foot residential City roof top. If each of the 400,000 residential parcels in the City were to install a single rain barrel, the City estimates that about 400 million gallons of water would be saved, thereby reducing the demand for water. An evaluation of the program is scheduled for completion in Spring 2011.

The 55-gallon capacity rain barrel was chosen because the weight of 200 pounds is relatively manageable. The rain barrels are also made from food-grade plastic, repurposed from containers in case the harvested rainwater is used to grow food. They are equipped with mesh netting to keep out debris and mosquitoes and connected to the downspouts by a trained rain barrel installation specialist.

Planter boxes that businesses are eligible for will be custom-made to fit the layout and dimensions of the property. The City will be working with each business to make sure they are content with the presentation of the planter box.

The program addresses the City's broad problems of water scarcity and stormwater pollution. Currently outdoor water usage accounts for 1/3 of the average family's overall water consumption. The Rainwater Harvesting program helps to meet the City's water conservation goals by reducing the amount of potable water used for irrigation and other outdoor purposes.

throughout Los Angeles could potentially capture 2,400 AFY assuming 400,000 residences, an annual average rainfall of 15.6 inches, one 55-gallon rain barrel installed per residence, and an average roof area of 500 square feet. If overflow infiltration is provided, and/or greater roof area is utilized, annual rainfall volume captured can be significantly greater.

Cisterns

Cisterns are larger than rain barrels and can range from 100 to 10,000 or more gallons. They store diverted runoff from roof areas and other impervious surfaces. This stored runoff can provide a source of untreated water for gardens and compost, free of most sediment and dissolved salts. Because residential irrigation can account for up to 40 percent of domestic water consumption, water conservation measures such as cisterns can be utilized to reduce demands, especially during hot summer months.

An analysis of the effect of installing cisterns in all single family and multi-family residences in the City was conducted as part of the Integrated Water Resources Plan, which was based on projected household demands, irrigation needs, and historical rainfall data. The results showed that during a storm event of 0.45 inches, the result of installing 1,000-gallon cisterns at all single-family and multi-family residences in the City would be a maximum capture of approximately 440 million gallons. This provides a substantial amount of water conservation and reduction in potable water demands within the City.

The primary beneficial use of dry and wet weather runoff is to meet irrigation demands. These demands are typically non-existent during rain events and low throughout the rainy season. Therefore, the wet weather runoff would need to be stored until the demand exists. This can be done through a regional and/or a localized approach. A regional approach to seasonal storage could include the use of out-of-service reservoirs for seasonal storage. A localized approach would be to construct distributed underground storage facilities in open spaces, parks, schools, etc. throughout the City.

Exhibit 7E demonstrates a modular storage media that holds the runoff in a honeycomb-like box under the ground.

Exhibit 7E
Construction of Underground Cistern for Stormwater Capture
(Photo courtesy of TreePeople)

Exhibit 7F Underground Storage Potential throughout the City

Land Use	Acres (acres)	Potential Storage Volume[1] (million gallons)
Open space	6,000	15,000
Schools (assume only ~ 25 percent suitable land)	1,500	4,000
Alleys	900 count	Unknown
Total	7,500	19,000

Note: 1. Maximum storage potential shown assumes 4.22 million gallons of storage per acre of land. Actual usable volume may be less.

Source: City of Los Angeles Integrated Resources Plan, Facilities Plan, Volume 3: Runoff Management

The storage media has approximately 95 percent voids, so almost all of the storage volume would be filled with water. The maximum depth is 8 feet, which translates to approximately 2.44 million gallons per acre of water storage potential. The containers can also be constructed to be impermeable to prohibit infiltration.

According to studies conducted during the development of the Los Angeles Integrated Water Resources Plan, the City currently has an estimated open space area of 6,000 acres, which includes parks, open space, and vacant lots. School sites are also a potential option for installing modular storage media under playgrounds and athletic fields. The total school area in the City is approximately 6,000 acres. Assuming that only 25 percent of this area has no buildings or other structures, this equals approximately 1,500 acres of potentially suitable land. Additionally, there are approximately 900 abandoned or no longer maintained alleys of various unknown dimensions that could potentially be converted to underground storage facilities. Exhibit 7F summarizes the approximate underground storage potential throughout the City.

The City has the potential to store a considerable volume of wet weather runoff in order to meet the potential future surface water quality regulations if the underground storage options were utilized. This stored water could then be drawn down and beneficially used during the dry weather months.

Rain Gardens

Rain gardens are another simple form of relatively small scale rainwater harvesting. As gardens or depressions, usually constructed sub-grade, they act as small retention/percolations basins for rainwater collection. Not only do they provide for an attractive landscape, but they are effective in treating and infiltrating stormwater for local groundwater recharge.

While extremely functional, these are basically regular gardens and can be designed to fit well into the surrounding landscape. Many cities and states across the country have extensive rain garden programs, and years of research have gone into their design and performance. Acting as a bio-retention systems, rain gardens treat runoff naturally as it seeps underground. In the case of lowered percolation rates or in hillside developments, rain gardens are typically installed with impermeable liners and supplied with under drains.

Unit cost of rain gardens are similar to that of rain barrels, as the mechanism for collecting water is the same. Cost is dependent upon the form and extent of construction and on the type and quantity landscape used, as well as the associated maintenance. Installation of rain gardens at residences throughout Los Angeles, assuming 400,000 residences, could potentially capture 6,400 AFY assuming an annual average rainfall of 15.6 inches, and an average roof area of 500 square feet. Under these conditions, assuming a 10-15 year lifespan, the cost of rain gardens varies from $308-$5,000 / AF.

Neighborhood Recharge

Neighborhood recharge involves installing recharge facilities in portions of vacant urban lots, abandoned alleys, and City parklands, where the soil is highly permeable. This option involves installing underground storage (such as a honeycomb shaped device shown in Exhibit 7F, but without the lining to allow infiltration). This would allow the runoff to be stored underground, while still maintaining a safe area above ground for human activity. The runoff would be pumped or would flow by gravity to the site where it would be collected temporarily until it is able to infiltrate.

The amount of runoff that could be managed by neighborhood recharge was determined as part of the Los Angeles Integrated Water Resources Plan by assuming that only the east San Fernando Valley area has predominantly permeable soils appropriate for infiltration (though there may be other areas within the City that could be usable for recharge with smaller-scale projects). Based on an analysis by the City's Geographical Information System, the maximum total area available for neighborhood recharge facilities is approximately 831 acres, which includes vacant urban lots, abandoned alleys, and 25 percent of City parklands. Assuming an infiltration rate of 2 feet per day, the maximum runoff that could potentially be managed by recharge facilities would be 550 million gallons per day (mgd).

7.6.3 Distributed Stormwater Capture Projects

As an outgrowth of the Los Angeles Integrated Water Resources Plan, neighborhood recharge concept efforts are moving from the conceptual stage visualized in the Los Angeles Integrated Water Resources Plan to actual identified projects in the City which infiltrate wet weather runoff as close as possible to the point of origin. A few of the identified projects are highlighted here.

Whitnall Highway Power Line Easement Stormwater Capture Project. This project involves the capture, treatment, and infiltration of stormwater from streets in the eastern San Fernando Valley using LADWP's Whitnall Power Line Easement in the lower Sun Valley Watershed. Average annual recharge is estimated at 110 AFY. Additional uses of the project site may include open space and recreational enhancements. Designs are anticipated for completion by the end of 2011.

Elmer Avenue Neighborhood Retrofit Project. In December of 2008, the City of Los Angeles partnered with TreePeople and the LASGRWC to retrofit an existing neighborhood in the Sun Valley portion of Los Angeles that is prone to flooding during wet weather events. A combination of Best Management Practices such as vegetated swales, infiltration trenches, rain gardens, rain barrels, native and climate appropriate landscaping, roof gutters, street tree plantings, and aligning driveways to drain to vegetated swales are incorporated into this project. This project was designed to capture and infiltrate the equivalent of a 2-year storm in order to increase groundwater recharge. Project funding was provided by the US Bureau of Reclamation, DWR, LACDPW, MWD, Water Replenishment District of Southern California and LADWP. Construction was completed in June 2010.

Woodman Avenue Multi-Beneficial Stormwater Capture Project. LADWP in partnership with the BOS Watershed Protection Division and The River Project, a non-profit organization, are developing the Woodman Avenue Median Retrofit Demonstration Project to capture, treat, and infiltrate stormwater runoff along a portion of Woodman Avenue. The Project will replace the existing median with pre-treatment devices, a vegetated swale, and an underground retention system. Project benefits include reductions in localized flooding, open space enhancements, groundwater recharge, and native habitat enhancement. The CalFed Watershed Program awarded the project a $1.6 million grant. Construction is expected to be completed by the end of 2012.

North Hollywood Alley Retrofit BMP Demonstration Project. The project's goal is to demonstrate the ability to infiltrate stormwater near the point of origin while increasing groundwater recharge, reducing flooding, and improving water quality. Four segments of alleyways in the San Fernando Valley are proposed to be retrofitted with pervious surfaces and diversion of flows from intersecting streets into these alleyways. Construction began in early 2011.

Laurel Canyon Parkway Infiltration Swale Project. Construction of the Laurel Canyon Parkway Infiltration Swale Project will involve construction of an infiltration trench and parkway swale between the street curb and sidewalk near the Tujunga Spreading Grounds in the San Fernando Valley. Stormwater will be collected and infiltrated into the groundwater from the local residential neighborhood. The project is currently in the conceptual stage.

7.6.4 Low Impact Development and Best Management Practices

LADWP, in conjunction with other City departments, is developing programs to highlight water conservation through Low Impact Development (LID) and installation of BMPs. LID is a stormwater management strategy that has been adopted by many localities across the country over the past several years. It is a stormwater management approach that is designed to reduce runoff of water and pollutants from the site(s) at which they are generated.

The past few decades of stormwater management have resulted in the current convention of control-and-treatment strategies. They are largely engineered, end-of-pipe practices that have been focused on controlling peak flow rate and suspended solids concentrations. Conventional practices, however, fail to address the widespread and cumulative hydrologic modifications within the watershed that increase stormwater volumes and runoff rates and cause excessive erosion and stream channel degradation.

In general, implementing integrated LID practices into new development and retrofit of existing facilities can result in enhanced environmental performance while at the same time reducing development costs when compared to traditional stormwater management approaches.

According to the U.S. Environmental Protection Agency, infrastructure costs associated with LID practices as compared to traditional stormwater treatment practices result in significant cost savings ranging between 15 percent and 80 percent less than traditional practices. BMPs consist of practices designed to infiltrate runoff for groundwater recharge, reduce runoff volume, and capture rainwater for reuse. Programs under development include pilot projects, retrofitting of existing facilities, new development standards, and assistance in ordinance development.

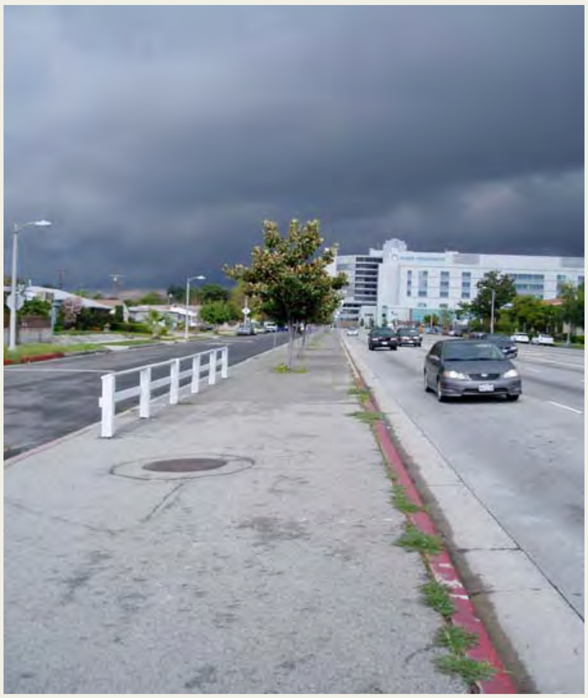
Retrofit of LADWP Facilities to Meet LID Standards

LADWP is assessing its existing facilities for potential retrofits using LID BMPs. LID BMPs under consideration include pervious pavement, stormwater capture, curb cuts, bioretention cells, and amended soils. Expected benefits include:

- Increased groundwater recharge.
- Decreased outdoor water use.
- Increased compliance with stormwater regulations.

CASE STUDY:
Woodman Avenue Multi-Beneficial Stormwater Capture Project

Originally proposed by the local Panorama City Neighborhood Council for the Tujunga-Pacoima Watershed Plan, the Woodman Avenue project represents an innovative example of stormwater capture, which includes extensive benefits for the environment, the City's groundwater basin, and the surrounding community. The Woodman Avenue median is located along the west side of Woodman Avenue from Lanark Street to Saticoy Street in Panorama City.



The project's construction will be relatively simple but effective. The project will capture surface runoff from approximately 130 acres that currently flows along street gutters to storm drains, through the Tujunga Wash and ultimately down the Los Angeles River and into the Pacific Ocean. Instead flows will now be directed through pre-treatment devices into a vegetated swale and an underground retention system for groundwater basin infiltration. The vegetated swale and underground retention/infiltration system will replace an existing 16-foot wide, 3,500-foot long concrete median. After construction of the project, participants will conduct active monitoring of water flows, water quality, and vegetation for approximately three years. This data should provide valuable information to facilitate the development of future projects, and optimize system processes.

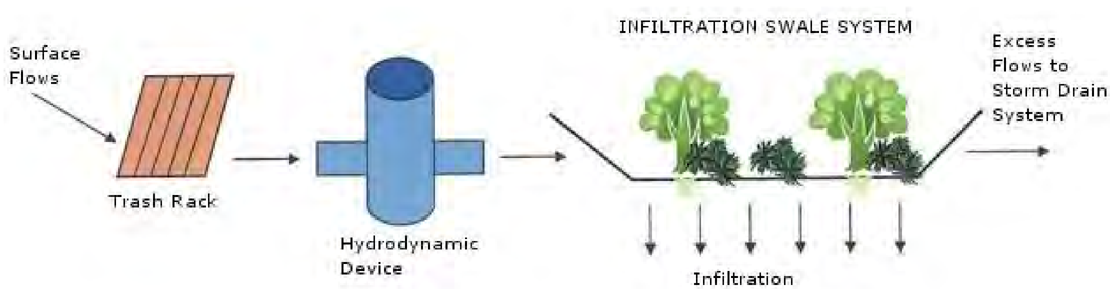
The direct water resource related benefits from this project are three fold. First, the additional water captured will recharge the San Fernando Groundwater Basin with approximately 80 AF per year. This replenishes the City's local groundwater supply, and helps protect pumping rights for City, which ultimately guarantees a more reliable water supply. Secondly, diverted flow alleviates local flooding, particularly during sizable rain events. Finally, the infiltration prevents contaminant carrying runoff and debris from entering local waterways and ultimately coastal areas.

Also recognized are the Community benefits associated with this project. These include creation of open space enhancements such as improved aesthetics and pedestrian access near schools, a walking path, benches, and native vegetation. The River Project will be running an active education program with the local community, including workshops with nearby business owners/residents and the introduction of a curriculum for students at the local elementary school. The organization's goal is to get the students involved in monitoring and maintenance of the project as part of their service learning requirements. Establishing knowledge of sustainable water supplies with the City's youth is an investment in constituent water use practices for generations to come.

Project participants include the Panorama City Neighborhood Council, Council District 6, the Los Angeles Bureau of Sanitation, the Los Angeles Bureau of Street Services, the State of California Water Resources Control Board (SCWRCB), The River Project, and LADWP. This cooperative partnership is anticipating the project's construction to begin in 2012.

State funding used for the project is provided through Proposition 50. SCWRCB has dedicated $1.6 million through the CALFED Watershed Grant Program, which covers roughly half of the overall project cost.

Melanie Winter from The River Project speaks positively of this stormwater capture project: "The community's involvement in the watershed planning process helped them identify a prime opportunity site that maximizes all the potential benefits. It helps reduce our dependence on imported supplies, addresses peak flows, improves water quality, and re-establishes habitat. It's gratifying to receive State funding to work in a well-rounded partnership to implement this integrated watershed project conceived at the grassroots level."



- Improved environmental conditions for employees and the public.
- Improved public image.
- Increased awareness of LID and provide examples for residents.
- Compliance with Model Water Efficient Landscape Ordinance.

New LADWP Facility Development Using LID Standards

LADWP's Watershed Management Group is developing a framework for implementation of LIDs and BMPs during the new facility development process. Within the framework, LID and BMPs are taken into consideration during the planning, design, implementation, and maintenance processes associated with new LADWP facilities. Benefits include:

- Reductions in costs associated with stormwater infrastructure and landscape maintenance.
- Reduced costs for grading by using natural drainage.
- Reduced sidewalk costs by using narrower sidewalks.
- Increased groundwater recharge.
- Reduced runoff volume and pollutant loading.
- Reductions in long-term maintenance and operation costs by using climate appropriate landscaping.
- Reduction in life cycle costs of replacing or rehabilitating pipe and below ground infrastructure.

Assistance in Ordinance Development

LADWP is represented on the City of Los Angeles Landscape & Stream Protection Ordinances Joint Meeting Committee through the Watershed Management Group. Other committee members include the Department of Recreation and Parks, the Department of Public Works, the Department of Environmental Affairs, the City Planning Department, and the Department of Building and Safety. The committee is tasked with developing ordinances for city-wide implementation that will reduce water use and improve groundwater recharge among other multiple benefits. Ordinances under review include the:

- Green Building Ordinance using the US Green Building Council's Leadership in Energy and Environmental Design (LEED) Green Building Rating System.
- LID Ordinance to incorporate improvements in stormwater management at the point of origin.
- Stream Protection Ordinance to incorporate methodologies for improving surface and groundwater quality.
- Hillside Ordinance revisions to include modifications in policies regarding front yards, side yards, height, fire protection, street access, lot coverage, off-street parking requirements, and exceptions in relation to the ordinances above.

7.6.5 Future Distributed Stormwater Programs

LADWP continues to investigate the potential for implementation of future distributed stormwater programs. Through its Watershed Management Group, LADWP will continue to develop partnerships and programs to improve utilization of stormwater runoff for outdoor water use and groundwater recharge. Potential programs that could be considered in the future include rain barrel/cistern/rain garden rebates and retrofit incentives for installation of LID BMPs.

7.7 Integrated Regional Water Management Plan (IRWMP) Program

LADWP is a participating agency in the IRWMP which encompasses 92 cities in the Greater Los Angeles County Region. The IRWMP aims to address the water quality, resource, and supply issues of the region. A final plan was adopted on December 16, 2006.

Highlights of the plan that pertain to watershed issues include:

- Short and long term objectives to comply with water quality regulations (including TMDLs) by improving the quality of urban runoff, stormwater, and wastewater.
- Optimize local water resources to reduce the region's reliance on imported water.
- Long term priority to protect groundwater supplies through stormwater recharge.
- Target goal to reduce and reuse 150,000 AFY (40%) of dry weather urban runoff and capture and treat an additional 170,000 AFY (50%) for a total target of 90%.
- Target goal to reduce and reuse 220,000 AFY (40%) of stormwater runoff from developed areas and capture and treat an additional 270,000 AFY (50%) for a total of 90%.

For more detailed information on the IRWMP, please refer to Chapter 10.

Exhibit 7G Cost Analysis

Water Source	Water Yield (AFY)	Average Unit Cost ($/AF)
Centralized Stormwater Capture[1]	25,950	$60 - $300
Distributed Stormwater Capture		
Urban Runoff Plants[2]	5,000	$4,044
Rain Barrels[3]	2,400	$278 - $2,778
Cisterns[4]	8,000	$2,426
Rain Gardens[5]	5,960	$149 - $1,781
Neighborhood Recharge[6]	12,000	$3,351

Notes:
1. Water Yield and cost are based on LADWP's current planned centralized stormwater capture projects. Additional centralized stormwater capture potential will be identified once the Stormwater Capture Master Plan is complete. Cost assumes 50 year project life.

2. Source: City of Los Angeles Integrated Resources Plan (2004); updated from 2004 to 2009 dollars using annual CPI index for LA-Riverside-Orange County MSA .

3. Source: TreePeople. Assumes 30 year life, one 55 gallon barrel per residence, 15.6 in annual rainfall (LA average) with 18 rain events per year (> ¼ in), and a collection roof area of 500 square feet. Minimum case assumes only material cost of $75 barrel and infiltration of 50 percent of barrel overflow into a permeable area such as a rain garden. Maximum case assumes $250 per barrel with installation cost included, and zero infiltration of overflow (worst case). Water yield assumes median between min/max range with 400,000 residences; 2010 dollars

4. Source: City of Los Angeles Integrated Resources Plan (2004); updated from 2004 to 2009 dollars using annual CPI index for LA-Riverside-Orange County MSA; capturing and reusing stormwater on-site for schools and government only.

5. Source: TreePeople. Assumes 30 year life, 15.6 in annual rainfall, an average roof collection area of 500 square feet, $2.50 - $25.66 / ft^2 (min/max) for rain garden construction, and 26.6- 31.0 ft^2 (min/max) rain garden size with 5.3% - 6.2% of contributing roof area respectively. Yield is based on 400,000 residences; 2010 dollars

6. Source: City of Los Angeles Integrated Resources Plan (2004); updated from 2004 to 2009 dollars using annual CPI index for LA-Riverside-Orange County MSMSA.

7.8 Cost Analysis

Exhibit 7G compares side by side the various watershed management opportunities LADWP is pursuing and/or investigating to add to its water portfolio.

It is important to note that the centralized stormwater capture values are based on the planned projects listed in Section 7.5. LADWP is currently compiling a Stormwater Capture Master Plan (see Section 7.3) which will investigate the maximum potential for stormwater capture within the City (for both centralized and distributed capture). Nevertheless, even with this fraction of the potential, it is clear that centralized stormwater capture is a very cost effective, plentiful water supply asset to be pursued. Recognizing its great potential, LADWP will proceed with its efforts on the centralized stormwater capture projects listed in Section 7.5, and closely monitor findings of the Stormwater Capture Master Plan to determine future potential centralized stormwater capture projects.

Distributed stormwater capture values are based on the maximum potential achievable by the City. While the cost listed is high, distributed stormwater capture options are highly variable based on a variety of factors such as the magnitude of the overall program, project locations, etc. Furthermore, distributed stormwater capture projects yield additional benefits to the public outside of water supply generation such as flood control, restored native habitat, community beautification, public right of way improvements, water conservation, as well as private residence safety and aesthetic improvements. LADWP will continue to investigate these options to evaluate the best approach to establish a cost effective program that will help add to LADWP's water portfolio.

7.9 Summary

There is a significant potential for increased stormwater capture in the City to create new water supplies. While stormwater capture occurs to replenish the SFB, the majority of stormwater runoff is not captured. Increased urbanization has decreased natural infiltration, thereby contributing to declines in local groundwater levels. Given the significant potential increased stormwater capture can play in a local, reliable water supply, LADWP is developing a Stormwater Capture Master Plan to determine overall stormwater capture targets and strategies to achieve those targets over the next twenty years.

City departments, other governmental agencies, non-profit organizations and numerous stakeholders recognize the necessity for public agencies to coordinate their activities toward improving stormwater capture. Increased stormwater capture can be used to augment local water supplies, improve water quality, restore natural waterways, and enhance neighborhoods.

For water supply benefits, stormwater can be captured in rain barrels or cisterns for reuse; or infiltrated through spreading basins, rain gardens, underground infiltration galleries, permeable surfaces or other green infrastructure and low impact development Best Management Practices.

Increased Groundwater Production due to Stormwater Infiltration

The UWMP projects that by 2035 there will be a minimum of 15,000 AFY of increased groundwater pumping in the SFB due to water supply augmentation through stormwater infiltration. In order to increase groundwater production, it must be determined that not only have groundwater levels recovered to sustain existing safe yield pumping amounts, but documented additional infiltration is occurring that could potentially increase the safe yield. Increasing the safe yield will require concurrence by the Watermaster and the courts to amend the basin judgment. Amending the judgment would be a lengthy process involving all basin pumpers.

Existing managed infiltration by the LACFCD results in an average of 25,782 AFY of recharge (see Exhibit 7A). LADWP has planned projects to double this amount (see Exhibit 7C). However, at this time there is not enough information to determine the quantity of additional stormwater infiltration required to restore groundwater levels required to sustain safe yield pumping, or to justify an increase in the safe yield. More studies must be conducted to determine how much more infiltration must be developed to increase the safe yield and groundwater production. The Stormwater Capture Master Plan will identify the potential acre-feet per year quantities available for recharge, and develop an implementation plan to augment the groundwater basin through centralized and decentralized infiltration projects and programs.

In addition to the proposed LADWP stormwater infiltration projects identified in Exhibit 7C, initiatives such as the proposed City of Los Angeles Low Impact Development Ordinance will augment stormwater infiltration by requiring stormwater capture for new development.

Capture and Reuse

By 2035, the UWMP projects 10,000 AFY of additional water conservation through rain barrels and cisterns. There have been some limited programs to distribute rain barrels, but much more remains to be done to achieve these projected stormwater capture amounts. The LADWP Stormwater Capture Master Plan will help identify how to achieve this goal.

Exhibit 7H summarizes existing and projected increased annual average stormwater capture and infiltration capability.

Exhibit 7H
Stormwater Capture Summary

Existing and Planned Annual Average Centralized Stormwater Capture	
Estimated existing annual average centralized stormwater infiltration	25,017 AFY
Planned increase in annual average centralized stormwater infiltration	25,950 AFY
Total Existing and Planned Annual Average Stormwater Infiltration	50,967 AFY

Projected Total Increase in Water Supplies from Stormwater Capture	
Projected 2035 increased annual groundwater production	15,000 AFY
Projected 2035 distributed stormwater capture and reuse	10,000 AFY
Total Projected 2035 Increased Water Supplies	25,000 AFY

Chapter Eight
Metropolitan Water District Supplies

8.0 Overview

As a member agency, the City of Los Angeles purchases water from the Metropolitan Water District of Southern California (MWD) to supplement its supplies from local groundwater, Los Angeles Aqueduct (LAA) deliveries, and recycled water. LADWP has historically purchased MWD water to make up the deficit between demand and other City supplies. As a percentage of the City's total water supply, MWD water varies from 4 percent in Fiscal Year (FY) 1983/84 to 71 percent in FY 2008/09 with the 5-year average of 52 percent between FY 2005/06 and FY 2009/10. Exhibit 1F in Chapter 1 illustrates the City's reliance on MWD water during dry years and increasingly in recent years as LAA supply as been cut back for environmental enhancement projects. Although the City plans to reduce its reliance on MWD supply, it has made significant investments in MWD and will continue to rely on the wholesaler to meet its current and future supplemental water needs.

MWD is the largest water wholesaler for domestic and municipal uses in California providing nearly 19 million people with on average 1.7 billion gallons of water per day to a service area of approximately 5,200 square miles. MWD was formed by the MWD Act and exists pursuant to this statute which was enacted by the California Legislature in 1927. MWD's adopted purpose is to develop, store, and distribute water to Southern California residents. In 1928, MWD was incorporated as a public agency following a vote by residents in 13 cities in Southern California. Operating solely as a wholesaler, MWD owns and operates the Colorado River Aqueduct (CRA), is a contractor for water from the California State Water Project (SWP), manages and owns in-basin surface storage facilities, stores groundwater within the basin via contracts, engages in groundwater storage outside the basin, and conducts water transfers to provide additional supplies for its member agencies. Today, MWD has 26 member agencies consisting of 11 water districts, one county water authority, and 14 cities, including the City of Los Angeles.

This Urban Water Management Plan projects LADWP's reliance on MWD water supplies will be reduced by half from the current five-year average of 52 percent of total demand to 24 percent by FY 2034/35 under average weather conditions.

8.0.1 History

Initially formed to import water into the Southern California region, MWD's first project was to build the CRA to import water from the Colorado River. The City of Los Angeles provided the capital dollars to initiate and complete land surveys of all proposed alignments for the Aqueduct. Construction was financed through $220 million in bond sales during the Great Depression. Ten years after initiating construction, Colorado River water reached Southern California in 1941. To meet further water demands in the southern California region, MWD contracted with the SWP in 1960 for almost half of the SWP's water supplies which are delivered from the San Francisco Bay-Delta region into Southern California via the California Aqueduct. After completion of the California Aqueduct, deliveries of SWP water were first received in 1972.

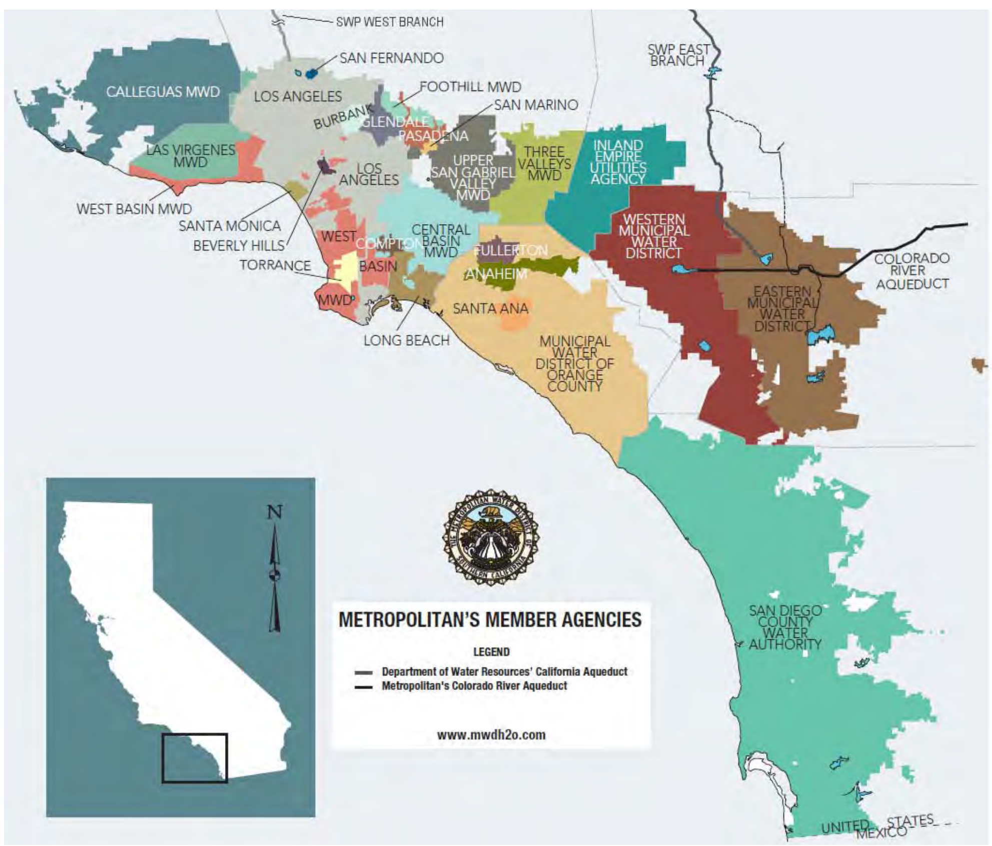
8.0.2 Governance

MWD is governed by a Board of Directors composed of 37 individuals with a minimum of one representative from each of MWD's 26 member agencies. The allocation of the directors and voting rights are determined by each agency's assessed valuation. The City of Los Angeles has four Directors on MWD's Board and controls 19.44 percent of the vote. MWD's Administrative Code defines various tasks which the Board has delegated to MWD staff. A General Manager oversees MWD staff. The General Manager, General Auditor, General Counsel, and Ethics Officer serve under direction and authority given directly by the Board.

8.0.3 Service Area

Originally serving an area of 675 square miles in 1928, MWD's service area has grown to approximately 5,200 square miles serving 19 million people via its 26 member agencies. MWD's service area covers portions of Los Angeles, Ventura, Orange, Riverside, San Bernardino, and

Exhibit 8A
MWD Service Area



Courtesy of The Metropolitan Water District of Southern California

San Diego counties as depicted in Exhibit 8A. MWD member agencies serve 152 cities and 89 unincorporated areas. Member agencies provide wholesale, retail, or a combination of wholesale/retail water sales in their individual service territories.

8.0.4 Major Infrastructure

MWD delivers approximately 6,000 AF per day of treated and untreated water to its member agencies through its vast infrastructure network. Major facilities include the CRA, pumping plants, pipelines, treatment plants, reservoirs, and hydroelectric recovery power plants. A summary of the major facilities and capacities are provided in Exhibit 8B and Exhibit 8C illustrates the geographic locations of the facilities.

Exhibit 8B Major MWD Facilities Summary

Facility	Units	Capacity
Colorado River Aqueduct		
Aqueduct	242 miles	1.3 million AFY
Pumping Plants	5 plants	1,617 feet of total lift
Pipelines	819 miles	
Water Treatment Plants		
Joseph Jensen		750 mgd
Robert A. Skinner		630 mgd
F.E. Weymouth		520 mgd
Robert B. Diemer		520 mgd
Henry J. Mills		220 mgd
Total Treatment Capacity		2,640 mgd
Reservoirs		
Diamond Valley Lake		810,000 AF
Lake Matthews		182,000 AF
Lake Skinner		44,000 AF
Copper Basin		24,200 AF
Gene Wash		6,300 AF
Live Oak		2,500 AF
Garvey		1,600 AF
Palos Verdes		1,100 AF
Orange County		212 AF
Total Reservoir Capacity		1,071,912 AF
Hydroelectric Recovery Plants	16 plants	122 megawatts

Exhibit 8C Major MWD Facilities

Courtesy of The Metropolitan Water District of Southern California

8.1 Supply Sources

Colorado River supplies, State Water Project supplies, In-Basin Storage, Outside-Basin Storage, and Water Transfers together comprise MWD's total system water supply sources. These sources provide supplemental water to meet the demands in Ventura, Los Angeles, Riverside, Orange, San Bernardino and San Diego Counties.

8.1.1 Colorado River

The Colorado River forms California's border with Arizona to the east. The drainage area in California that contributes water to the Colorado River is relatively small and has an arid climate. Accordingly, California has no major tributaries contributing water to the Colorado River.

The Colorado River Board of California is the California state agency given authority to protect the interests and rights of the state and its citizens in matters pertaining to the Colorado River. The Board is comprised of 10 gubernatorial appointees representing the LADWP, MWD, San Diego County Water Authority, Palo Verde Irrigation District, Coachella Valley Water District, Imperial Irrigation District, Department of Water Resources, Department of Fish and Game, and two public members.

8.1.1.1 The Law of the River

The Secretary of the Interior is vested with the responsibility to manage the mainstream waters of the Colorado River pursuant to applicable federal law. This responsibility is carried out consistent with a body of documents referred to as the Law of the River. Water rights to Colorado River water are governed by a complex collection of federal laws, state laws, a treaty with Mexico, other agreements with Mexico, Supreme Court decrees, contracts with the Secretary, interstate compacts, state, and administrative actions at the federal and state levels. Collectively, these documents and associated interpretations are commonly referred to as the "Law of the River" and govern water rights and operations on the Colorado River.

The following are particularly notable among these documents:

1. The Colorado River Compact of 1922, which apportioned beneficial consumptive use of water between the Colorado River Upper Basin and Lower Basin, and defined the term "States of the Lower Division" to mean the States of Arizona, California, and Nevada. Serving as the basis of the "Law of the River," the Compact apportioned water to each basin in anticipation of a dam on the Colorado River. The Upper Basin is the portion of the Basin upstream of Lee Ferry, Arizona, while the Lower Basin is downstream of this point. Each basin was apportioned 7.5 million acre-feet (MAF) annually, and the Lower Basin received the option to an additional 1 MAF annually based on excess flows. California is within the Lower Basin along with Arizona and Nevada.

2. The Boulder Canyon Project Act (Act) of 1928, enacted by Congress to authorize construction of Hoover Dam and the All-American Canal. The Act required that water users in the Lower Basin have a contract with the Secretary, and established the responsibilities of the Secretary to direct, manage, and coordinate the operation of Colorado River dams and related works in the Lower Basin. The Act stipulated conditions, one of which required California to limit Colorado River water use to 4.4 MAF annually plus one-half of the excess water unapportioned by the Colorado River Compact. To satisfy the condition, the California Legislature enacted the Limitation Act in 1929 limiting its use of Colorado River water to the basic apportionment of 4.4 MAF.

3. The California Seven Party Agreement of 1931. Developed in response to the Limitation Act and through regulations adopted by the Secretary, which established the relative priorities of rights among major users of Colorado River water in California. The Seven Party Agreement apportioned California's share of Colorado River water to California contractors. Within the agreement, priorities were established for each of the four agencies holding contracts for Colorado River water with the U.S. Bureau of Reclamation. These priorities are shown in Exhibit D. Seven priorities were established with the first four priorities satisfying California's allocation of 4.4 MAF annually and the fifth and sixth priorities relating to California's share of excess Colorado River flows. MWD holds the fourth and fifth priorities. The fourth priority allocates 550 thousand acre-feet (TAF) of California's apportionment to MWD and the fifth priority allocates 662 TAF of California's share of excess flows to MWD.

4. The 1944 Treaty (and subsequent minutes of the International Boundary and Water Commission) related to the quantity and quality of Colorado River water delivered to Mexico. The Treaty guaranteed an annual quantity of 1.5 MAF to be delivered in accordance with the provisions of the Treaty.

5. The 1963 United States Supreme Court Decision in Arizona v. California, which confirmed the Lower Basin mainstream apportionments of:

   2.8 million acre-feet per year (AFY) for use in Arizona,

   4.4 million AFY for use in California, and

   0.3 million AFY for use in Nevada provided water for Indian reservations and other federal reservations in Arizona, California, and Nevada; and confirmed the significant role of the Secretary in managing the mainstream Colorado River within the Lower Basin.

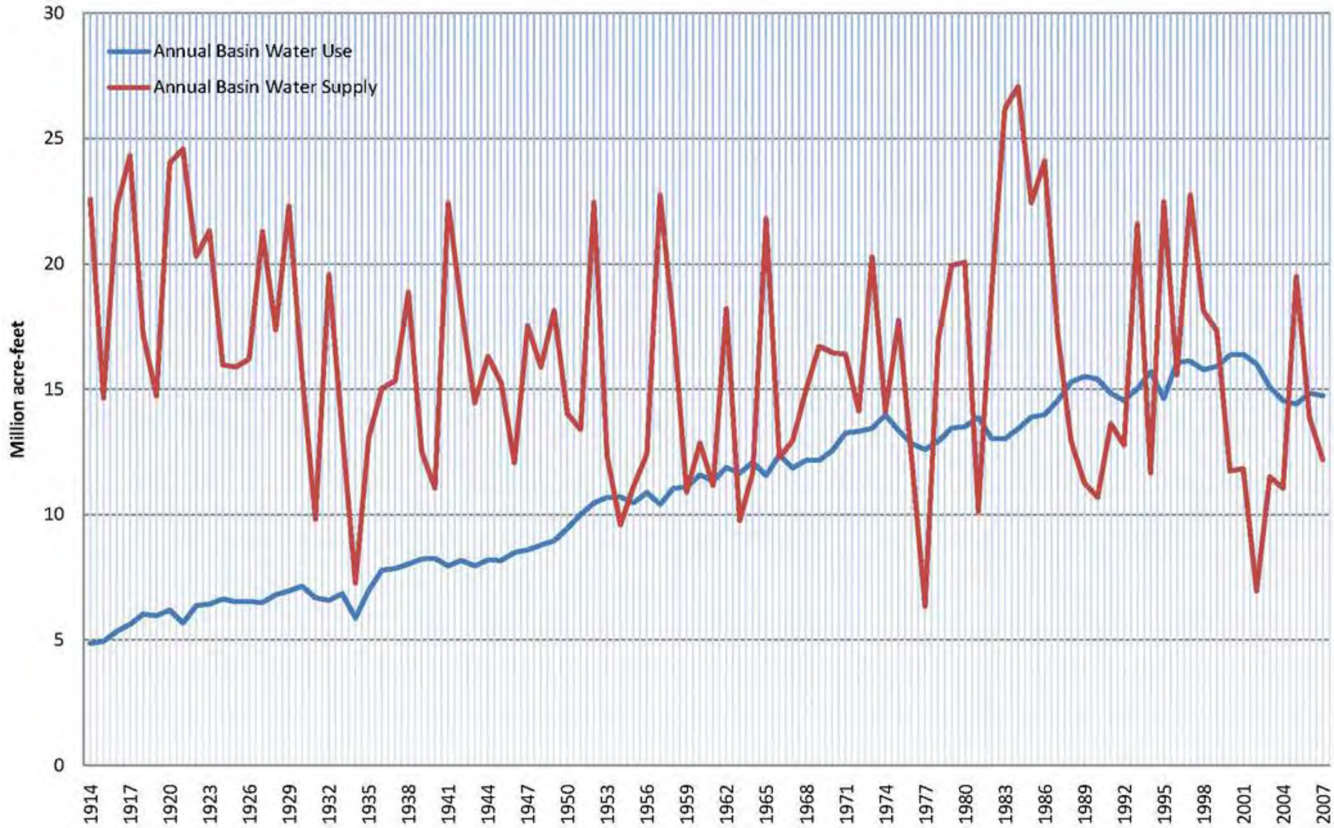
6. The 1964 United States Supreme Court Decree (Decree) in *Arizona v. California* which implemented the Supreme Court's 1963 decision; allocated 50 percent of the surplus water available for use in California; and allowed the Secretary to release water apportioned to but unused in one state for use in the other two states. The Decree was supplemented over time after its adoption and the Supreme Court entered a Consolidated Decree in 2006 which incorporates all applicable provisions of the earlier-issued Decrees.

7. The Colorado River Basin Project Act of 1968, which authorized construction of a number of water development projects including the Central Arizona Project (CAP); provided existing California, Arizona, and Nevada water contractors a priority over the CAP and other users of the same character in Arizona and Nevada whenever less than 7.5 million AFY is available; and required the Secretary to develop the Long Range Operating Criteria and issue an Annual Operating Plan for mainstream reservoirs.

Exhibit 8D
Listing of Priorities - Seven Party Agreement

Priority Number	Agency and Description of Service Area	Beneficial Consumptive Use (Acre-feet/year)
1	Palo Verde Irrigation District - 104,500 acres	3,850,000
2	Yuma Project, California Portion, not exceeding 25,000 acres	
3(a)	Imperial Irrigation District	
3(b)	Palo Verde Irrigation District - 16,000 acres	
4	Metropolitan Water District, City of Los Angeles and/or others on the coastal plain	550,000
5	Metropolitan Water District, City of Los Angeles and/or others on the coastal plain	662,000
6(a)	Imperial Irrigation District	300,000
6(b)	Palo Verde Irrigation District - 16,000 acres of adjoining mesa	
	Total	**5,362,000**

Exhibit 8E
Historical Annual Colorado River Supply and Use

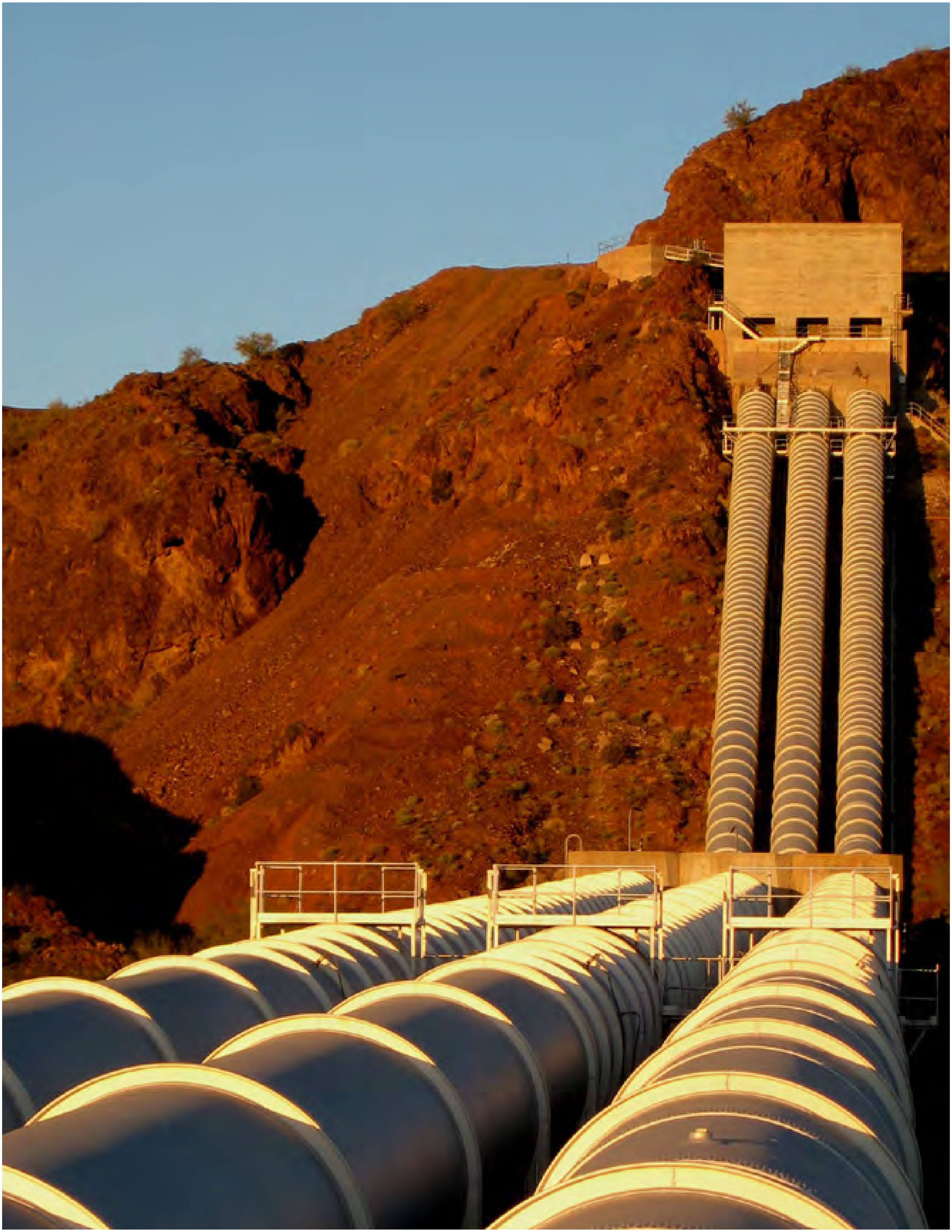


8.1.1.2 Colorado Supply Reliability

Exhibit 8E illustrates the historical annual Colorado River Basin supply and demand beginning 1914 through 2007. The steady increase of demand has caught up with the supply.

Reliability of CRA water for MWD has decreased overtime as a consequence of multiple events. Historically, California had used up to 5.4 million AFY as Arizona and Nevada were not using their normal apportionments of Colorado River water and surplus water was made available by the Secretary. The 1964 Decree and the 2006 Consolidated Decree of the US Supreme Court in *Arizona v. California* confirmed California's allocation was limited to 4.4 MAF annually. As a result, MWD can now only rely on its fourth priority allocation of 550 TAF annually. Prior to this, MWD was able to satisfy its fifth priority allocation with Nevada and Arizona's unused water. However, in 1985 Arizona began increasing deliveries to its Central Arizona Project reducing the availability of unused apportionment to fill MWD's fifth priority.

Because of dry years on the Colorado River system and Arizona and Nevada using their full apportionment, the U.S. Secretary of Interior asserted that California must come up with a plan to live within its 4.4 MAF apportionment. Therefore, users from California have developed California's Colorado River Water Use Plan (California Plan). The users included: MWD, Palo Verde Irrigation District (PVID), Imperial Irrigation District (IID), and Coachella Valley Water District (CVWD). This plan identifies actions that California will take to operate within its 4.4 million acre-foot entitlement. Exhibit 8F and Exhibit 8G illustrate the historical total Colorado River Basin storage and the historical Lake Mead elevation, which show a protracted dry period beginning around 1999.



California currently consumes its normal apportionment of 4.4 million AFY. The order of priority is as follows:

1. PVID - gross area of 104,500 acres of land in the Palo Verde Valley.

2. Yuma Project-Reservation Division - not exceeding a gross area of 25,000 acres in California.

3(a). IID - lands in the Imperial Valley served by the All-American Canal. Export out of basin, primarily agricultural usage. Also, second 63,000 AF in priority 6(a) and balance of any remaining priority 6(a) and 7 water available.

3(b). CVWD - lands in the Coachella Valley served by the Coachella Branch of the All-American Canal. Export out of basin, agricultural usage. Also third 119,000 AF in priority 6(a) and balance of any remaining priority 6(a) and 7 water available.

3(c). PVID - 16,000 acres of land on the Lower Palo Verde Mesa, also priority 6(b).

4. MWD – 550,000 AF, also 662,000 AF in priority 5, and first 38,000 AF in 6(a)

A component of the California Plan was completion of the Quantification Settlement Agreement (QSA) in 2003, which established baseline water use for each California party with Colorado River water rights. Key to the agreement is the quantification of IID at 3.1 MAF and CVWD at 330 TAF. Completion of the QSA facilitates the transfer of water from agricultural agencies to urban water suppliers by allowing water conserved on farm land to be made available for urban use. As a result of litigation, the QSA and eleven other agreements were ruled invalid on February 11, 2010. MWD in conjunction with CVWD and the SDCWA have appealed the court's decision. Ultimately, the total impact of the court's decisions on MWD's Colorado River supplies cannot be determined at this time pending the outcome of the appeal. However, MWD's existing conservation, land fallowing, and transfer programs for Colorado River supplies are independent of the QSA and will not be impacted by the QSA lawsuit.

Along with MWD's apportionment, MWD has developed a number of water supply programs to improve reliability of Colorado River supplies, such as agricultural water transfers and storage programs, and has multiple programs under development as listed in Exhibit 8G. Developed programs in conjunction

Exhibit 8F
Historical Total Colorado River Basin Storage

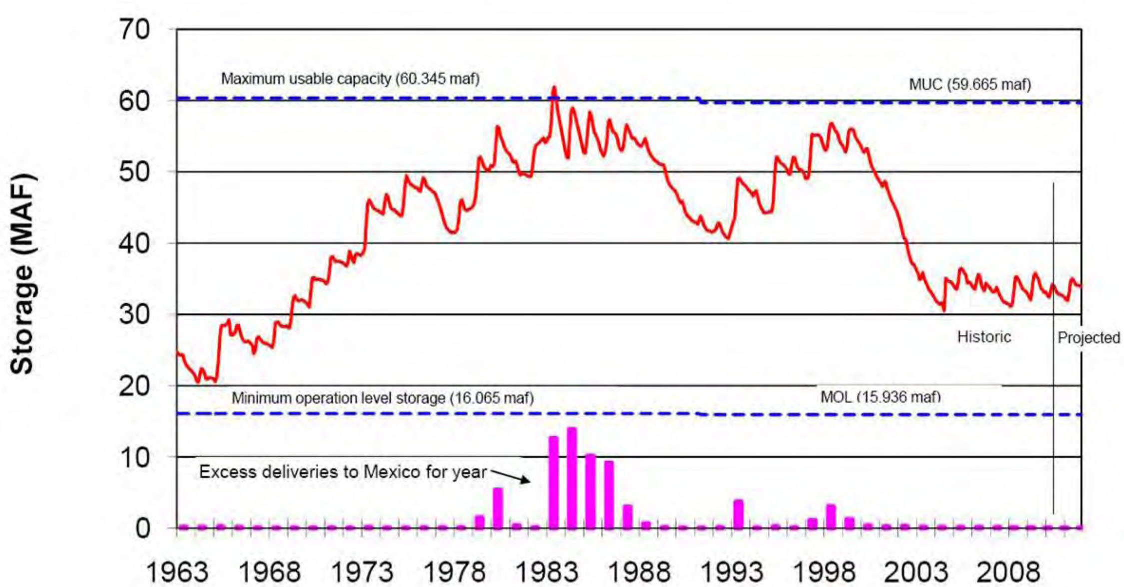
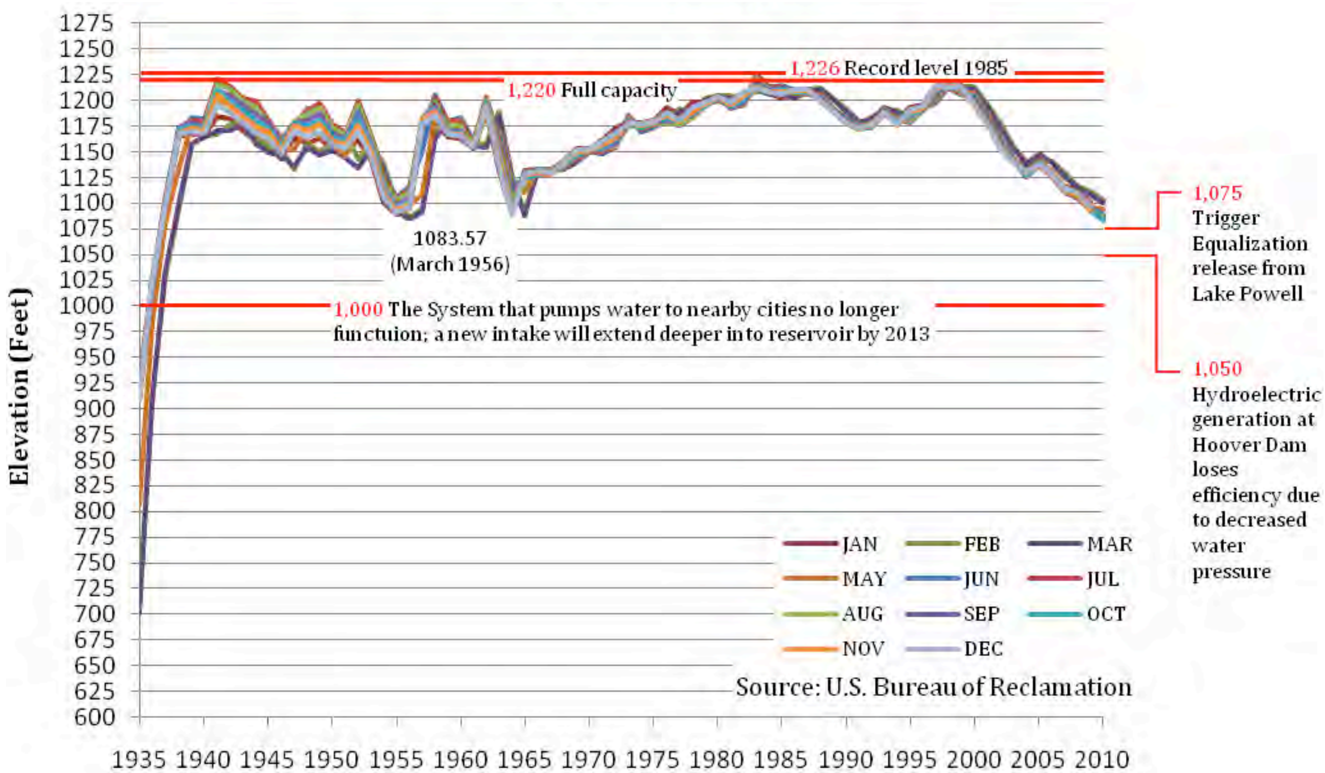


Exhibit 8G
Historical Lake Mead Elevation



The bathtub ring at Lake Mead, August 2010, lake elevation 1,087 feet.

Exhibit 8H
MWD's CRA Forecast Supplies in 2035, Average Year (1922 - 2004 Hydrology)

Program	Supply (Thousands of AF)/ Year
Current	
Basic Apportionment - Priority 4	550
Imperial Irrigation District/MWD Conservation Program	85
Priority 5 Apportionment (Surplus)	13
Palo Verde Irrigation District Land Management Crop Rotation and Water Supply Program	133
Lower Colorado Water Supply Project	5
Lake Mead Storage Program	400
Quechan Settlement Agreement Supply	7
Forbearance for Present Perfected Rights	-47
Coachella Valley Water District State Water Project/QSA Transfer Obligation	-35
Desert Water Agency and Coachella Valley Water District SWP Table A Obligation	-155
Desert Water Agency and Coachella Valley Water District SWP Table A Transfer Call-back	82
Desert Water Agency and Coachella Valley Water District Advance Delivery Account	73
Drop 2 Reservoir Funding	25
Southern Nevada Water Authority Agreement	0
Subtotal of Current Programs	**1,136**
Programs Under Development	
Additional Palo Verde Irrigation District Transfers	62
Arizona Programs - Central Arizona Project	50
California Indians/Other Agriculture	10
ICS Exchange	25
Agreements with Coachella Valley Water District	35
Hayfield Groundwater Extraction Project	0
Subtotal of Proposed Programs	**182**
Additional Non-MWD CRA Supplies	
San Diego County Water Authority/ Imperial Irrigation District Transfer	200
Coachella and All-American Canal Lining	
To San Diego County Water Authority	80
To San Luis Rey Settlement Parties[1]	16
Subtotal of Non-MWD CRA Supplies	**296**
Maximum CRA Supply Capability[2]	**1,614**
Minus Supply CRA Capacity Constraint of 1.25 MAF Annually	**-364**
Maximum Forecast CRA Deliveries	**1,250**
Minus Non-MWD Supplies[3]	**-296**
Maximum MWD Supply Capability[4]	**954**

1. Subject to satisfaction of conditions specified in agreement among MWD, the US, and the San Luis Rey Settlement Parties
2. Total amount of supplies available without taking into consideration of CRA capacity constraint of 1.25 MAF annually.
3. Exchange obligation for San Diego County Water Authority - Imperial Irrigation District transfer and the Coachella and All-American Canal Lining Projects.
4. The amount of CRA water available to MWD after meeting exchange obligations.

Source: 2010 Regional Urban Water Management Plan, Metropolitan Water District of Southern California

with MWD's apportionment will provide MWD with approximately 1.14 MAF in 2035 under an average year (1922 – 2004 hydrology). Proposed programs under development could add another 182 TAF per year. Non-MWD supplies conveyed through the CRA are forecast at 296 TAF for a total CRA supply capability of 1.61 MAF. However, the CRA has a supply capacity constraint of 1.25 MAF. After subtracting MWD's conveyance obligation of non-MWD supplies, MWD's supplies for 2035 under average year, single-dry year (1977 hydrology), and multi-dry year (1990 – 1992 hydrology) scenarios are all forecast at 954 TAF. Exhibit 8H summarizes the CRA supply forecast for 2035 under an average year.

8.1.1.3 Water Quality Issues

Water quality issues for Colorado River supplies cover high salinity levels, perchlorate, nutrients, uranium, chromium VI, N-nitrosodimethlamine (NDMA), and pharmaceuticals and personal care products (PPCPs). High salinity levels present the most significant issue and the only foreseeable water quality constraint for the Colorado River supply. MWD expects its source control programs for the CRA to adequately address the other water quality issues. MWD has also bolstered its water security measures across all of its operations since 2001, including an increase in water quality tests. Details of MWD's water quality initiatives are available in MWD's 2010 Regional Urban Water Management Plan (RUWMP).

Salinity

Water obtained from the Colorado River has the highest salinity levels of all MWD supply sources averaging 630 mg/L since 1976. Salts are eroded from saline sediments deposited in prehistoric marine environments in the Colorado River Basin (Basin), dissolved by precipitation, and conveyed into the Basin's water courses. Salinity issues have been recognized in the Basin for over 30 years. The seven basin states formed the Colorado River Basin Salinity Control Forum (Forum) to mutually cooperate on salinity issues in the Basin. The Forum recommended the U.S. Environmental Protection Agency (USEPA) to act upon the Forum's proposal and in response the USEPA approved water quality standards and established numeric criteria for controlling salinity increases. Each Basin State adopted the water quality standards, which are designed to limit the flow-weighted average annual salinity level to 1972 levels or below. An outgrowth of the Forum was the Colorado River Basin Control Program. At the core of the program is the reduction in salts entering the river system by intercepting and controlling non-point sources, wastewater, and saline hot springs. Salinity reduction projects have reduced salinity concentration of Colorado River water by over 100mg/L, which equates to approximately $264 million per year in avoided damages (2005 dollars).

MWD adopted a Salinity Management Policy in 1999 with the goal of achieving salinity concentrations of less than 500 mg/L at delivery. To reduce salinity levels, Colorado River supplies are blended with SWP water supplies to achieve the salinity target. In some years, the target is not possible to achieve as a result of hydrologic conditions that increase salinity on the Colorado River and decrease SWP water available for blending. Additionally, to maximize the use of recycled water for agriculture, MWD attempts to import lower salinity imported water during the spring/summer months to reduce salinity levels in recycled water supplies.

Perchlorate

In 1997 perchlorate was first detected in the Colorado River. It was attributed to an industrial site upstream of the Las Vegas Wash in Nevada which drains to the river. Subsequently, an additional perchlorate plume was found to be migrating from an additional industrial site, but had not reached the Las Vegas Wash. Since the initial discovery of contamination, remediation efforts have significantly reduced perchlorate loading from the Las Vegas Wash. At Lake Havasu, downstream of the convergence of the Las Vegas Wash and Colorado River, perchlorate levels have decreased from 9 μg/L at their peak in 1998 to less than 6 μg/L in October 2002. Since June 2006, typical levels have been less than 2 μg/L.

Nutrients

Excessive nutrient levels in water can stimulate algal and aquatic weed growth leading to taste and odor concerns. Nutrients include both phosphorous and nitrogen compounds. Other impacts of algal and aquatic weed growth include reductions in operating efficiencies and potentially provide an additional food source for invasive aquatic species, such as quagga and zebra mussels.

Naturally, the Colorado River system has relatively low concentrations of phosphorous. Additional loading to the system as upstream urbanization increases has the ability to increase phosphorous concentrations and impact MWD's ability to blend low nutrient concentration CRA water with high nutrient concentration SWP water. MWD continues to work with agencies located along the lower Colorado River to improve wastewater management in order to reduce phosphorous loading.

Uranium

Near Moab, Utah, a 16-million ton pile of uranium tailings located approximately 750 feet from the Colorado River is a potential source of uranium loading to the river. In 1999, the US Department of Energy began remediating the site by removing tailings and treating contaminated groundwater. Complete removal of the pile is expected by 2025 or 2019 if additional funding is secured. MWD is tracking clean-up progress and continues to support rapid clean-up of the site.

To address recent uranium mining claims in the vicinity of the Colorado River and the Grand Canyon Area, MWD has sent letters to the Secretary of Interior to highlight MWD's concern of source water protection and recommended close federal oversight. In 1999, the Department of Interior placed a two-year hold on mining claims for 1 million acres adjacent to the Grand Canyon area to conduct additional analyses and H.R. 644, Grand Canyon Watersheds Protection Act, was introduced in 2009. H.R. 644, if approved, would prohibit new mining activities around the Grand Canyon area.

Chromium VI

Chromium VI has been detected in a groundwater aquifer in the vicinity of the Colorado River near Topock, Arizona. The source of the contamination is a natural gas compression site operated by Pacific Gas and Electric (PG&E) that previously used chromium VI in its operations. Monitoring upstream and downstream of the site range from non-detect (0.03 μg/L) to 0.06 μg/L which are considered within the background range for the river. MWD is actively involved in the corrective action process through its participation in stakeholder workgroups and partnerships with State and federal regulators, Indian tribes, and other stakeholders. The Final Environmental Impact Report (EIR) for the Topock Chromium VI remediation project is complete and has been certified by California Department of Toxic Substances Control. U.S. Department of Interior has issued a Federal Record of Decision which states that PG&E holds sole responsibility for the substantial threat of the release of Chromium VI near Topock, Arizona. A time-critical removal action is authorized and PG&E's clean-up operations are under the direction and oversight of the Department of Toxic Substances Control.

NDMA and Pharmaceuticals and Personal Care Products

N-nitrosodimenthylamine is a by-product formed by secondary disinfection of some natural waters with chloramines. MWD is

involved with projects to understand the potential sources of NDMA precursors in its source watersheds and to develop treatment strategies to minimize NDMA formation at its water treatment facilities. In 2007, MWD initiated monitoring efforts to measure PPCPs in its source supplies. PPCPs have been detected at very low levels (low ng/L level; parts per trillion) consistent with monitoring results from other utilities. MWD is involved with programs to improve analytical testing methods, characterize PPCP in drinking water sources in California, and effects of PPCPs on groundwater recharge and recycled water use.

8.1.2 State Water Project

MWD began receiving water from the SWP in 1972. MWD is the largest of 29 contractors for water from the SWP, holding a contract for 1.912 MAF per year, or 46 percent of the total contracted amount of the 4.173 MAF ultimate delivery capacity of the project. Variable hydrology, environmental issues, and regulatory restrictions in the San Francisco Bay/ Sacramento-San Joaquin River Delta (Bay-Delta) have periodically reduced the quantity of water that the SWP delivers to MWD.

Exhibit 81
State Water Project Major Facilities

Courtesy of the State of California Department of Water Resources

8.1.2.1 Major State Water Project Facilities

The SWP is owned by the State of California and operated by the Department of Water Resources (DWR) delivering water to two-thirds of the population of California and 750,000 acres of farmland. The SWP system consists of 701 miles of aqueduct, 34 storage facilities totaling 5.8 MAF of storage, five hydro-electric power plants, four pumping-generating plants, 17 pumping plants, and three pump stations. Exhibit 8I illustrates the location of major SWP facilities. SWP facilities originate in Northern California at Lake Oroville on the Feather River. Water released from Lake Oroville flows into the Feather River, goes downstream to its confluence with the Sacramento River, and then travels into the Bay-Delta. Water is pumped from the Bay-Delta region to contractors in areas north and south of the San Francisco Bay and south of the Bay-Delta. SWP deliveries consist solely of untreated water. In addition to delivering water to its contractors, the SWP is operated to improve water quality in the Bay-Delta region, control flood waters, and provide recreation, power generation, and environmental enhancement.

MWD receives SWP water at three locations: Castaic Lake in Los Angeles County, Devil Canyon Afterbay in San Bernardino County, and Box Spring Turnout at Lake Perris in Riverside County. In addition, MWD has flexible storage rights of 65 TAF at Lake Perris at the terminus of the East Branch of the SWP and 153.95 TAF at Castaic Lake at the terminus of the West Branch.

8.1.2.2 Contract Allocations

Contract allocations, also known as entitlements, for SWP contractors are provided by DWR in a table commonly referred to as Table A and shown in Exhibit 8J. Allocations are based on the original projected SWP maximum yield of 4.173 MAF. Table A is a tool used by DWR to allocate fixed and variable SWP costs and yearly water entitlements to the contractors. Table A contract amounts do not reflect actual deliveries a contractor should expect to receive. MWD has a Table A contract amount of 1.912 MAF. MWD's full Table A contract amount was made available to MWD for the first time in 2006.

DWR annually approves the amount of contract allocations SWP contractors will receive. The contract allocation amount received by contractors varies based on contractor demands and projected available water supplies. Variables impacting projected water supplies include snowpack in the Sierra Nevada, capacity available in reservoirs, operational constraints, and demands of other water users. Operational constraints include pumping restrictions related to fish species listed as either threatened or endangered under the federal or state Endangered Species Acts. Contractors' requests for portions of their entitlements cannot always be met. In some years there are shortages and in other years surpluses. In 2008 and 2009, SWP contractors received only 35 percent and 40 percent, respectively, of their SWP contract allocations.

DWR bi-annually prepares the State Water Project Delivery Reliability Report to provide contractors with current and projected water supply availability for SWP. The 2009 draft released in January 2010 indicates expected deliveries for multiple-dry year periods will vary from 32 to 38 percent of maximum Table A amounts and for multiple-year wet periods, 72 to 94 percent of maximum Table A amounts. Overall the report shows increased reductions in water deliveries on average when compared to the previous 2007 report. Factors impacting deliveries include environmental constraints and hydrologic changes as a result of climate change.

Exhibit 8J Table A Maximum Annual SWP Amounts (acre-feet)

Contractor Maximum SWP Table A

North Bay	
Napa County Flood Control and Water Conservation District	29,025
Solano County Water Agency	47,756
Subtotal	**76,781**
South Bay	
Alameda County Flood Control and Water Conservation District, Zone 7	80,619
Alameda County Water District	42,000
Santa Clara Valley Water District	100,000
Subtotal	**222,619**
San Joaquin Valley	
Oak Flat Water District	5,700
Kings County	9,305
Dudley Ridge Water District	57,343
Empire West Side Irrigation District	3,000
Kern County Water Agency	998,730
Tulare Lake Basin Water Storage District	95,922
Subtotal	**1,170,000**
Central Coastal	
San Luis Obispo County Flood Control and Water Conservation District	25,000
Santa Barbara County Flood Control and Water Conservation District	45,486
Subtotal	**70,486**
Southern California	
Antelope Valley-East Kern Water Agency	141,400
Castaic Lake Water Agency	95,200
Coachella Valley Water District	121,100
Crestline-Lake Arrowhead Water Agency	5,800
Desert Water Agency	50,000
Littlerock Creek Irrigation District	2,300
Mojave Water Agency	75,800
Metropolitan Water District of Southern California	1,911,500
Palmdale Water District	21,300
San Bernardino Valley MWD	102,600
San Gabriel Valley MWD	28,800
San Gorgonio Pass Water Agency	17,300
Ventura County Flood Control District	20,000
Subtotal	**2,593,100**
Delta Delivery Total	**4,132,986**
Feather River	
Butte County	27,500
Plumas County Flood Control and Water Conservation District	2,700
Yuba City	9,600
Subtotal	**39,800**
Total	**4,172,786**

In addition to MWD's Table A amount, MWD has long term agreements in place to obtain additional SWP supplies through five other programs:

- Article 21
- Turnback Pool
- Yuba River Accord
- San Luis Carryover Storage
- Desert Water Agency and Coachella Valley Water District Table A Transfer

Article 21 is in reference to a provision in the SWP contract with DWR that allows SWP contractors, such as MWD, to take additional water deliveries in addition to Table A amounts. Article 21 water is only available under certain conditions as outlined in Article 21. SWP Article 21 of the contracts permits delivery of water excess to delivery of SWP Table A and some other water types to those contractors requesting it. SWP Article 21 water is apportioned to those contractors requesting it in the same proportion as their SWP Table A.

Turnback Pool (Pool) water allows a contractor that has been allocated Table A annual entitlement that the contractor will not use to sell that water to other SWP contractors through the Pool. If there are more requests from contractors to purchase water from the Pool than the amount in the Pool, the water in the Pool is allocated among those contractors requesting water in proportion to their Table A entitlements. If requests to purchase water from the Pool total are less than the amount of water in the Pool, the sale of water is allocated to the selling contractors in proportion to their respective amounts of water in the Pool.

In 2007, MWD and DWR signed an agreement allowing MWD to participate in the Yuba Dry Year Water Purchase Program. Under this program, transfers are available from the Yuba County Water Agency during dry years up to 2025. MWD completed purchases of 26.4 TAF and 42.9 TAF in 2008 and 2009, respectively.

As part of the Monterey Amendment, which modified the contractors' long term contracts with DWR, the use of carryover storage by contractors was permitted in the San Luis Reservoir for use during dry years. Carryover storage is curtailed if it impedes with the storage of SWP water for project needs.

MWD entered into a transfer agreement with the DWA and CVWD for their Table A contract amounts in exchange for an equal amount of water from the CRA. Both DWA and CVWD are SWP contractors, but have no physical connections to obtain SWP water. MWD is able to transfer CRA water to both agencies as a result of their locations adjacent to CRA facilities. DWA and CVWD have a combined Table A amount of 1.912 MAF per year. MWD additionally can provide DWA and CVWD with deliveries of MWD's other SWP water supplies and non-SWP supplies utilizing SWP facilities, thus allowing MWD additional flexibility in managing its water supply portfolio.

MWD also engages in short-term transfer agreements using SWP facilities to bolster supplies as opportunities become available as discussed in the Groundwater Storage and Transfers sub-section. Historically, MWD has obtained transfers through the Governor's Water Bank, Dry-Year Purchase Programs, and the State Water Contractors Water Transfer Program.

MWD expects to receive 2.046 MAF through its SWP supplies in 2035 under average conditions (1922 – 2004 hydrology). Exhibit 8K summarizes MWD's SWP supplies by program. Current programs are expected to result in 1.441 MAF and programs under development are expected to add an additional 605 TAF. Under multi-year dry conditions (1990 – 1992 hydrology), MWD expects to receive only 956 TAF and 1,003 TAF under a single-dry year (1977 hydrology).

8.1.2.3 Water Quality Issues

Water quality issues for SWP supplies include total organic carbon (TOC), bromide, arsenic, nutrients, NDMA, and PPCPs. TOC and bromide in SWP water present the greatest water quality issues and have restricted MWD's ability to use SWP water at various times as the contaminants form disinfection byproducts during water treatment processes. MWD has initiated a process to upgrade its treatment processes to ozone disinfection to reduce formation of disinfection byproducts and lift potential restrictions on SWP water usage. MWD requires low salinity levels of SWP water to meet blending requirements for CRA water, and therefore, any increase in salinity levels in SWP supplies is a concern to MWD.

MWD supported DWR in the establishment of a policy regarding water quality of non-SWP water transported through the SWP system and in the expansion of Municipal Water Quality Investigations Programs to include additional monitoring and advanced warnings to contractors that may impact water treatment processes.

MWD is utilizing its water supply portfolio options to conduct water quality exchanges to reduce TOC and bromide. MWD has stored SWP water during periods of high water quality in groundwater storage basins for later use when SWP is at a lower water quality. These storage programs were initially designed to provide water during dry SWP conditions, but a few of these programs are now operated for dual-purposes.

TOC and bromide in high concentrations lead to the formation of disinfection byproducts when source water is treated with disinfectants, such as chlorine. Agricultural drainage to the Bay-Delta and seawater comingling with Bay-Delta supplies increases these contaminants. The Bay Delta Conservation Plan (BDCP) has outlined multiple options to improve the water supply reliability and habitat protection, which is being prepared through a collaboration of state, federal, and local water agencies, state and

Exhibit 8K
MWD Forecast Supplies of SWP Water in 2035, Average Year (1922 – 2004 Hydrology)

Program	Supply (Thousands of AF)
Current	
MWD Table A	1,026
Desert Water Agency and Coachella Valley Water District SWP Table A Transfer	155
San Luis Carryover Storage[1]	208
Article 21 Supplies	52
Yuba River Accord Purchase	0
Subtotal of Current Programs[2]	**1,441**
Programs Under Development	
Delta Conveyance Improvements	605
Integrated Resources Plan SWP Target[3]	0
Subtotal of Proposed Programs[2]	**605**
Maximum SWP Supply Capability[2]	**2,046**

1. Includes carryover water from Desert Water Agency and Coachella Valley Water District.
2. Does not include transfers and water banking associated with SWP.
3. Remaining supply needed to meet Integrated Resources Plan target.

Source: 2010 Regional Urban Water Management Plan, Metropolitan Water District of Southern California

federal fish agencies, environmental organizations, and other interested parties. The overall goal of BDCP is identifying water flow and habitat restoration actions to both improve water supply reliability and recover endangered and sensitive species and their habitats Bay-Delta. MWD is in the process of computing upgrades to its water treatment plants to use ozone as the primary disinfectant. Ozone disinfection is very effective treatment for control of bromate formation and will allow MWD to treat higher quantities of SWP supplies without blending those supplies with CRA water.

Arsenic

SWP supplies not banked in MWD's SWP groundwater storage programs naturally contain low levels of arsenic ranging from non-detect to 4.0 µg/L and do not require additional treatment for arsenic removal. SWP supplies banked in at least one of these groundwater storage programs contain arsenic levels close to or at the regulatory threshold of 10 µg/L requiring additional treatment for arsenic removal. Historically, MWD has at times restricted flows from one groundwater storage program as a result of arsenic levels. One groundwater storage partner has initiated a pilot arsenic removal program, albeit raising the cost of the groundwater storage program. Arsenic can also be removed at water treatment plants by increasing coagulant doses. To handle arsenic removed during water treatment processes, MWD has had to invest in solids handling facilities.

Nutrients

Nutrient levels in SWP water are significantly higher than in Colorado River water. Both phosphorous and nitrogen compounds are a concern in SWP water, but similar to CRA supplies phosphorous is the limiting nutrient. Nutrient sources in SWP water include wastewater discharges, agricultural drainage, and sediments from nutrient rich soils in the Bay-Delta. MWD reservoirs have been temporarily bypassed at times as a result of taste and odor events related to nutrients leading to short-term supply impacts.

MWD is working with other water agencies also receiving SWP water from the Bay-Delta region to reduce the impact of nutrient loading from wastewater plants discharging to the Bay-Delta. To assist in managing its operations, MWD has implemented an algae monitoring and management program designed to provide warnings in advance of algae and taste and odor issues at its reservoirs allowing adjustments in other system operations.

NDMA and Pharmaceuticals and Personal Care Products

Similar to all of its water supply sources, NDMA and PPCPs are constituents of emerging concern. As described above for Colorado River supplies, MWD is involved with efforts to address both NDMA and PPCPs.

Salinity

Over the long term salinity concentrations in SWP water are significantly lower than in CRA water, but the timing of supply availability and total dissolved solids (TDS) concentrations can vary in response to hydrologic conditions. Additionally, salinity concentrations vary in the short term in response to seasonal and tidal flow patterns. MWD requires lower salinity SWP water to blend with CRA water to meet salinity requirements for its member agencies. MWD's blended salinity objective is 500 mg/L.

Environmental constraints also impact MWD's ability to meet its salinity objective. Since 2007, pumping operations in the Bay-Delta have been limited to prevent environmental harm (as discussed in the Bay-Delta Issues subsection below). MWD must rely on higher salinity CRA water resulting in an exceedance in MWD's salinity objective at times.

SWP salinity concentrations as specified in the SWP Water Service Contract have not been met. Article 19 of SWP Water Service Contract specifies ten-year average salinity concentrations of 220 mg/L and a monthly maximum of 440 mg/L. MWD is working with DWR and other agencies to reduce salinity in SWP Bay-Delta supplies through multiple programs. These programs include modifying agricultural drainages and completing basin plans on the San Joaquin River, modifying levees around flooded islands in the Bay-Delta, and installing gates to reduce transportation of salts from seawater.

8.1.2.4 Bay-Delta Issues

The Bay-Delta is a major waterway at the confluence of the Sacramento and San Joaquin rivers serving multiple and at times conflicting purposes exacerbated during dry years when water to meet the needs of both people and the environment is in short supply. Approximately two-thirds of Californians receive at least a portion of their water from the Bay-Delta. Almost all water delivered via the SWP to Southern California must pass through the Bay-Delta. Runoff from more than 40 percent of the state is also conveyed through the Bay-Delta forming the eastern edge of the San Francisco bay's estuary. A large portion of the Bay-Delta region lies below sea level and is protected by more than 1,100 miles of levees to prevent flooding. Deterioration of the Bay-Delta ecosystem coupled with infrastructure concerns, hydrologic variability, climate change, litigation, regulatory restrictions, and previously discussed water quality issues have resulted in supply reliability challenges for SWP contractors who depend upon the Bay-Delta for water supplies.

Environmental

As an estuarine environment, the Bay-Delta provides habitat for migratory and resident fish and birds, including those placed on the threatened or endangered species list under the federal or California Endangered Species Act (ESA). Five fish species residing in the Bay-Delta were listed as endangered under the ESA, and one additional species was listed as threatened in 2009 under the California ESA. As a result of a combination of lawsuits regarding the ESA listed species and biological opinions and incidental take permits (permits for inadvertently harming ESA listed species) from the U.S. Fish and Wildlife Service and National Marine Fisheries Service, SWP exports and pumping operations in the Bay-Delta have been significantly curtailed. However, DWR prepared a Water Allocation Analysis in 2010 indicating that MWD could receive 150 to 200 TAF less water than forecast for 2010 under average hydrologic conditions. Ongoing litigation, additional species listing, and regulations could further curtail pumping operations and have an additional adverse impact on MWD's supplies and reserves. MWD has filed a lawsuit in conjunction with other SWP contractors challenging one of the biological opinions. As discussed below under the Delta Plan, the Delta Vision process is designed to develop long term solutions to these issues.

Infrastructure

Bay-Delta channels are constrained by a levee system to protect below sea level islands in the Bay-Delta from flooding. Land in the Bay-Delta subsides mainly from ongoing oxidation of aerated peat soils. Some islands are presently twenty feet or more below sea level. Land subsidence is expected to continue which increases the risk of levee failure and island flooding. Many of the levees are old and do not meet modern engineering standards. A catastrophic earthquake could cause widespread levee failure shutting down SWP operations for an extended period of time. Following a levee failure, the flow of water onto an island can pull saline water from the San Francisco Bay into the central Bay-Delta area and, if coupled with pumping in the south Bay-Delta, draw saline water into the south Bay-Delta area. Therefore, pumping in the south Bay-Delta may need to be stopped or slowed down for an extended period, and additional flows may

Photo courtesy of The Metropolitan Water District of Southern California.

need to be released from Lake Oroville to flush saline water out of the Bay-Delta. Any salinity introduced into Bay-Delta may also impact Bay-Delta water quality for an extended period of time.

Recognizing the need for protecting these vulnerable Bay-Delta levees, the Bay-Delta Levees Program was formed to coordinate improvements to and maintenance of the Bay-Delta levees. Over the next few years, the DWR and other agencies will conduct a Comprehensive Program Evaluation. This program will supplement existing risk studies, develop a strategic plan, recommend priorities, and provide estimates for the Bay-Delta Levees Program.

8.1.2.5 Delta Plan

Former California Governor Arnold Schwarzenegger established the Delta Vision Process in 2006 to address ongoing Bay-Delta conflicts through long-term solutions. The independent Blue Ribbon Task Force completed their vision for sustainable management of the Bay-Delta in 2008. After delivery of the Delta Vision recommendations and goals, the State Legislature initiated the process to conduct information hearings and draft legislation. Ultimately, the Governor called the Seventh Extraordinary Session to address the Bay-Delta and water issues in the State. Resulting legislation included the approval of SB 1 X7 addressing Bay-Delta policy reforms and governance of the Bay-Delta.

A key concept of SB 1 X7 is the formation of a Delta Stewardship Council (Council). The Council is an independent State agency tasked to equally further the goals of Delta restoration and water supply reliability. One of the Council's first major tasks is to develop, adopt, and begin implementation of a Delta Plan by January 1, 2012. Key requirements of the plan as summarized in the MWD RUWMP are:

- Further the coequal goals of ecosystem restoration and water supply reliability.
- Attempt to reduce risks to people, property, and State interests.
- Promote Statewide water conservation, water use efficiency, and sustainable use of water to achieve the coequal goals.
- Improvements to water conveyance/storage and operations of such facilities to achieve the coequal goals.
- Consider including the Bay Delta Conservation Plan (BDCP) into the Delta Plan and allow the BDCP to be eligible for State funding if specific conditions are met.

The BDCP is a joint effort of State and federal fish agencies; State, Federal, and local water agencies; environmental organizations; and other parties with the goal of providing for both improvements in water reliability through securing long-term permits to operate the SWP and species/habitat protection in the Delta. MWD is a member of the Steering Committee. An outcome of the plan will be the identification of water flow and habitat restoration actions that assist in recovery of ESA listed and sensitive species and their associated habitats in the Bay-Delta. A range of options to accomplish the outcome will be carried forward to the environmental review phase.

Photo courtesy of The Metropolitan Water District of Southern California.

8.1.3 In-Basin Storage

In basin-storage facilities play a key role in maintaining MWD's reliability during droughts or other imported water curtailments and emergency outages. In-basin storage facilities consist of surface reservoirs and contracted groundwater basin storage. Conjunctive use of surface reservoirs and groundwater basins was first initiated by MWD in the 1950's. Long term storage goals for in-basin storage facilities were established in MWD's Water Surplus and Drought Management Plan (WSDM). The WSDM plan allows storage for hydrology variances, water quality, and SWP and CRA issues.

MWD has established emergency in-basin storage requirements based on a major earthquake that could potentially cutoff all supplies for six months from the all aqueducts serving the region, the CRA, both SWP branches, and LADWP's LAA. Under this scenario, MWD would maintain deliveries by suspending interruptible deliveries, implementing mandatory water use reductions of 25 percent of normal-year demands, water would be made available from surface reservoir and groundwater supplies stored as part of MWD's interruptible supply program, and full local groundwater production would occur. MWD's emergency storage requirement is a function of projected demands and varies with time.

8.1.3.1 Surface Reservoirs

MWD owns and operates seven in-basin surface storage reservoirs. Four of the reservoirs, Live Oak, Garvey, Palos Verdes, and Orange County, are used for regulatory purposes and do not provide drought or emergency storage. Additionally, MWD owns and operates two reservoirs, Copper Basin and Gene Wash, along the CRA outside of the basin for system regulation purposes. Outside its basin, MWD has 1.45 MAF storage rights in Lake Mead on the Colorado River pursuant to its intentionally created surplus agreement with the U.S. Bureau of Reclamation. MWD also has storage rights in DWR's SWP terminal reservoirs, Lake Perris and Castaic Lake, as previously discussed. The total capacity of all in-basin surface reservoirs, inclusive of the rights in the terminal reservoirs, is 1.26 MAF, as listed in Exhibit 8L.

MWD operates its three main storage reservoirs, Diamond Valley Lake, Lake Skinner and Lake Matthews, for dry-year, emergency, and seasonal storage. MWD has identified a dry-year storage capacity goal of 620 TAF by 2020. To date, this goal has been met and will be sustained with storage at Diamond Valley Lake and the two terminal reservoirs. Under an average year scenario for 2035 (1922-1994 hydrology), 576 TAF per year

Exhibit 8L
MWD's In-Basin Surface Reservoir Capacity

Reservoir	Capacity (AF)
Dry Year/Emergency/Seasonal Storage Purposes	
Diamond Valley Lake	810,000
Lake Matthews	182,000
Lake Skinner	44,000
Lake Perris (Storage Rights)[1]	65,000
Castaic Lake (Storage Rights)[1]	153,940
Subtotal	1,254,940
Regulatory Purposes	
Live Oak	2,500
Garvey	1,600
Palos Verdes	1,100
Orange County	212
Subtotal	5,412
Total Reservoir Capacity	**1,260,352**

1. MWD holds storage rights for flexible use in DWR terminal storage facilities, Lake Perris and Castaic Lake. In addition, MWD has emergency storage of 334 TAF in DWR's reservoirs.

of in-basin surface storage is projected to be available, exclusive of emergency supplies, as summarized in Exhibit 8M.

MWD reserves a portion of its in-basin surface reservoir storage capacity for emergencies. MWD's emergency surface reservoir storage portfolio is split between storage in its three main reservoirs and DWR reservoirs. MWD's emergency storage capacity, based on demands for 2030, is forecast to be approximately 610 TAF. Approximately 276 TAF is projected to be stored in MWD's facilities and the balance of 334 TAF in DWR's facilities. The balance of available storage capacity, 975 TAF, is for dry-year and seasonal storage.

Any additional reservoir capacity is used for seasonal storage and system operations. Seasonal storage is required to meet peak demands. MWD incorporates reserves of 5 percent into reservoir operations to account for imported water transmission infrastructure maintenance that would restrict or temporarily halt imported water flows.

8.1.3.2 Contracted Groundwater Basin Storage

To improve reliability, MWD engages in contracted groundwater basin storage within the basin area. By 2020, MWD aims to develop an annual dry supply of 300 TAF. To meet this goal, MWD has worked with local water agencies to increase groundwater storage. Groundwater storage occurs using the following methods:

- Direct delivery – Water is delivered directly by MWD to local groundwater storage facilities through the use of injection wells and spreading basins.

- In-lieu delivery – Water is delivered directly to a member agency's distribution system and the member agency uses the delivered water and forgoes pumping allowing water to remain in storage.

MWD engages in three main types of storage programs: replenishment,

Exhibit 8M
MWD Forecast Supplies of In-Basin Surface Storage Supplies in 2035, Average Year (1922 - 2004 Hydrology)

Program	Supply (Thousands of AF)/Year
In-Basin Surface Storage (Diamond Valley Lake, Lake Skinner, Lake Matthews)	444
Lake Perris and Castaic Lake MWD Storage Rights	132
Maximum MWD Supply Capability	**576**

Source: 2010 Regional Urban Water Management Plan, Metropolitan Water District of Southern California

cyclical, and conjunctive use. These programs are designed to deliver water to agencies prior to the actual need for the demands, allowing MWD to store supplies for use in dry years. Since 2007, MWD has used these programs to address SWP shortages. MWD provides financial incentives and funding to assist agencies to assist with developing storage programs.

Replenishment programs provide water to agencies at a discounted cost and can be withdrawn by the recipient after one year. Cyclic storage contracts allow surplus imported water to be delivered for recharge in advance of the actual water purchase. The delivered water is in excess of an agency's planned and budgeted deliveries. The agency purchases the water at a later time when it has a need for groundwater replenishment deliveries.

Conjunctive use contracts allow MWD to request an agency to withdraw previously stored MWD water from storage during dry periods or emergencies. Agencies must pay MWD the current water rate when they are requested to withdraw water from storage. Water withdrawn from storage allows MWD to temporarily curtail deliveries by an equal amount. MWD currently has ten conjunctive use programs with a combined storage capacity of 421.9 TAF and a dry-year yield of 117.3 TAF per year as summarized in Exhibit 8N.

MWD prepared a Groundwater Assessment Study in 2007 in conjunction with local agencies and groundwater basin managers. As indicated in the report, there is substantial groundwater storage available in the basin, but there are multiple challenges that must be met to utilize the identified storage. Challenges include infrastructure limitations, contamination, legal issues, and funding.

To further increase the availability of in-basin groundwater storage, MWD has identified nine potential storage programs in the basin and an additional two

Exhibit 8N In-Basin Conjunctive Use Programs

Program	Storage Capacity (Thousands of AF)	Dry-Year Yield (Thousands of AF/Year)	Balance 12/31/09 (Thousands of AF)
Los Angeles County			
Long Beach Conjunctive Use Project	13	4.3	6.4
Foothill Area GW Storage Project	9	3	0.6
Long Beach Conjunctive Use Project: Expansion in Lakewood	4	1.2	`
City of Compton Conjunctive Use Program	2	0.8	0
Upper Claremont Heights Conjunctive Use	3	1	0
Orange County			
Orange County GW Conjunctive Use Program	66	22	8.6
San Bernardino County			
Chino Basin Programs	100	33	23
Live Oak Basin Conjunctive Use Project	3	1	0.7
Riverside County			
Elsinore Groundwater Storage Program	12	4	0
Ventura County			
North Las Posas Groundwater Storage Program	210	47	43.5
Total	421.9	117.3	84.6

Source: 2010 Regional Urban Water Management Plan, Metropolitan Water District of Southern California

Exhibit 80
MWD Forecast Supplies of In-Basin Groundwater Storage in 2035, Average Year (1922 - 2004 Hydrology)

Program	Supply (Thousands of AF/Year)
Current	
Conjunctive Use	115
Cyclic Storage	139
LADWP Tujunga Well Field Groundwater Recovery Project	12
Subtotal of Current Programs	266
Programs Under Development	
Raymond Basin Conjunctive Use	22
Subtotal of Programs Under Development	22
Maximum MWD Supply Capability	**288**

Source: 2010 Regional Urban Water Management Plan, Metropolitan Water District of Southern California

programs are under development. The Raymond Basin Conjunctive Use Program and the LADWP Groundwater Recovery Project are expected to add an additional 34 TAF per year in 2035 under an average year (1922 – 2004 hydrology).

In 2009, a reconnaissance-level analysis was prepared for analyzing the potential for using recycled water as a supply source for a conjunctive use program. The study concluded up to 100 TAF of groundwater storage and production could be potentially developed in four major groundwater basins using Los Angeles County Department of Sanitation supplies. MWD initiated a formal study in 2010 to further study. This concept along with the potential to use City of Los Angeles recycled water supplies from the Hyperion Wastewater Treatment Plant as an additional source.

Exhibit 80 provides a summary of forecast groundwater storage supplies available in 2035 under an average year (1922 -2004 hydrology). Approximately 289 TAF per year are forecast to be available.

8.1.4 Groundwater Storage and Water Transfers

MWD engages in groundwater storage outside of the basin and water transfers to increase the reliability of SWP dry-year supplies. Groundwater storage and water transfers were initiated by MWD in response to concerns that MWD's supply reliability objectives could not be met by the SWP. Groundwater storage and transfer programs were developed to allow MWD to reach its SWP reliability goal. All groundwater storage and water transfer programs designed to bolster SWP reliability are located within the vicinity of the SWP or Central Valley Project (CVP) facilities to facilitate the ultimate deliver of water to MWD. Groundwater storage programs involve agreements allowing MWD to store its SWP contract Table A water in excess of MWD demands and to purchase water for storage. MWD calls for delivery of the stored water during dry years. Transfers involve purchases by MWD from willing sellers during dry years when necessary.

Exhibit 8P
MWD Forecast Supplies of Groundwater Storage and Transfers in 2035, Average Year (1922 - 2004 Hydrology)

Program	Supply (Thousands of AF/Year)
Current	
San Bernardino Valley MWD Minimum Purchase	20
San Bernardino Valley MWD Option Purchase	29
Central Valley Storage and Transfers	
Semitropic Water Banking and Exchange Program	69
Arvin-Edison Water Management Program	75
San Bernardino Valley MWD Program	50
Kern Delta Water Management Program	50
Subtotal of Current Programs	**293**
Programs Under Development	
Mojave Groundwater Storage Program	43
North of Delta/In-Delta Transfers	33
San Bernardino Valley MWD Central Feeder	5
Shasta Return	18
Semitropic Agricultural Water Reuse	11
Subtotal of Proposed Programs	**110**
Maximum Supply Capability	**403**

Source: 2010 Regional Urban Water Management Plan, Metropolitan Water District of Southern California

Exhibit 8P summarizes MWD's out of basin groundwater storage and transfer programs supplies in 2035, under an average year (1922 – 2004 hydrology). Current programs are expected to deliver 293 TAF in 2035. Five programs under development are forecasted to deliver an additional 110 TAF for a total of 403 TAF in 2035.

8.1.4.1 Groundwater Storage

MWD has four Central Valley groundwater storage programs with a fifth program under development as described below.

The Semitropic Water Banking and Exchange Program is a partnership formed in 1994 between Semitropic Water Storage District (SWSD), MWD, and five other banking partners. The bank has a total storage capacity of 650 TAF, of which MWD has 350 TAF of storage volume. During years of excess SWP deliveries, beyond MWD's demands, a portion of MWD's SWP entitlement water is stored for withdrawal during dry years. Deliveries for storage are transferred via SWP facilities for direct use by agricultural users that in turn forgo pumping an equal volume of water. In dry years, water is pumped from storage to SWP facilities for delivery to MWD or entitlements are exchanged. MWD's average annual supply capability for a dry year (1977 hydrology) is 125 TAF and for multiple dry years (1990 – 1992 hydrology) is 107 TAF. By the end of 2009, MWD had 45 TAF in storage.

Since 1997, MWD has had an agreement with Arvin-Edison Water Storage District to use 350 TAF of storage in its groundwater basins. The agreement was amended in 2008 to include the South Canal Improvement project to deliver higher quality water to MWD. During wet years, MWD delivers SWP water in excess of its demands for storage and receives return water in dry years in a similar manner as the Semitropic program, except a combination of SWP and CVP facilities are used to transfer the water and water can be stored by a combination of direct spreading or in lieu use by agricultural users. MWD's average supply capability is 75 TAF for either a single dry year (1977 hydrology) or multiple dry years (1990 – 1992 hydrology). In 2009, MWF had 95 TAF in storage.

The San Bernardino Municipal Water District Program (SBMWD) allows for the purchase and storage of SWP water on behalf of MWD. MWD has a minimum purchase agreement with SBMWD of 20 TAF per year of SBMWD's SWP Table A amount. Additionally, MWD has the option to purchase SBMWD's additional SWP allocation when available and the first right-of-refusal to purchase additional SWP supplies available to SBMWD beyond the minimum and option agreements. If MWD does not require the minimum purchase amount for operations, MWD can store up to 50 AF for future use in dry years within SBMWD's groundwater basins. Water is delivered to MWD via SWP facilities and groundwater pumping conveyed through local connections to MWD's service area. MWD's average annual supply capability for a dry year (1977 hydrology) is 70 TAF and for multiple dry years (1990 – 1992 hydrology) is 37 TAF. By the end of 2009, MWD had no water in storage and deliveries have been suspended upon a mutual agreement between MWD and SBMWD.

MWD entered into an agreement with the Kern Delta Water District (Kern-Delta) for the Kern-Delta Water Management Plan in 2001 to allow up to 250 TAF of groundwater storage. During wet years MWD delivers SWP water in excess of its demands for storage and receives return water in a similar manner as the Semitropic program, except the water can be stored by direct recharge or in lieu use by agricultural users. Per terms of the agreement, MWD can potentially store beyond 250 TAF. In dry years, water is pumped from storage to SWP facilities for delivery to MWD or entitlements are exchanged. When the project is completed 50 TAF per year of dry year supply can be withdrawn. At the close of 2009, MWD had 10 TAF in storage and expects to fully withdraw the amount in 2010.

The Mojave Groundwater Storage Program is currently a demonstration project between MWD and Mojave Water Agency. Similar to the other groundwater storage programs, MWD's excess SWP water will be stored during wet years for withdrawal during dry years. When fully operational, the program is expected to have a dry year yield of 35 TAF.

8.1.4.2 Transfers

MWD utilizes Central Valley water transfers to obtain additional supplies originally destined for agricultural users on an as needed basis. Past transfer agreements have used both spot markets and option contracts. Spot markets occur when there are willing sellers and buyers. Option contracts lock-in MWD's ability to have the option to purchase supplies if needed. Additionally, MWD has multiple long-term transfer programs under

Exhibit 8Q
MWD Historic Central Valley Water Transfers

Program	Purchases by MWD[1] (AF/Year)
1991 Governor's Water Bank	215,000
1992 Governor's Water Bank	10,000
1994 Governor's Water Bank	100
2001 Dry Year Purchase Program	80,000
2003 MWD Transfer Program	126,230
2005 State Water Contractors Water Transfer Program[2]	0
2008 State Water Contractors Water Transfer Program	26,621
2009 Governor's Water Bank	36,900

1. Transfers requiring use of Bay-Delta result in a water loss of 20 percent. Transfers requiring the California Aqueduct for delivery to MWD's service area result in a 3 percent water loss.
2. 127,275 in options were secured, but not needed.

Source: 2010 Regional Urban Water Management Plan, Metropolitan Water District of Southern California

development. MWD's ability to conduct transfers and the amount of water to be transferred using SWP facilities are a function of hydrologic conditions, market conditions, and pumping restrictions in the Bay-Delta region. Transfers may require the use of the Bay-Delta for conveyance dependent upon the origin of the water. Historic transfers, as listed in Exhibit 8Q, indicate MWD is capable of negotiating contracts with agricultural districts and the State's Drought Water Bank to obtain transfers. MWD also has demonstrated it can work with DWR and the U.S. Bureau of Reclamation (USBR). Cooperation of both agencies is required as transfers use a combination of DWR's SWP and USBR's CVP facilities. Transfers from north of the Bay-Delta result in the loss of 20 percent of the water during conveyance while transfers via the California Aqueduct to MWD's service area result in the loss of 3 percent water during conveyance. During dry years and when pumping capacity in the Bay-Delta is available, MWD expects to be able to transfer 125 TAF through SWP facilities.

Exhibit 8R
MWD System Forecast Supplies and Demands, Average Year (1922 - 2004 Hydrology)

Forecast year	**Supply (Thousands of AF per Year)**				
	2015	**2020**	**2025**	**2030**	**2035**
Current Programs					
In-Basin Surface Reservoir and Groundwater Storage	685	931	1,076	964	830
State Water Project[1]	1,550	1,629	1,763	1,733	1,734
Colorado River Aqueduct					
Colorado River Aqueduct Supply[2]	1,507	1,529	1,472	1,432	1,429
Aqueduct Capacity Limit[3]	1,250	1,250	1,250	1,250	1,250
Colorado Aqueduct Capability	1,250	1,250	1,250	1,250	1,250
Capability of Current Programs	**3,485**	**3,810**	**4,089**	**3,947**	**3,814**
Demands					
Firm Demands on MWD	1,826	1,660	1,705	1,769	1,826
Imperial Irrigation District - San Diego County Water Authority Transfers and Canal Linings[4]	180	273	280	280	280
Total Demands on MWD	**2,006**	**1,933**	**1,985**	**2,049**	**2,106**
Surplus	**1,479**	**1,877**	**2,104**	**1,898**	**1,708**
Programs Under Development					
In-Basin Surface Reservoir and Groundwater Storage	206	306	336	336	336
State Water Project[1]	382	383	715	715	715
Colorado River Aqueduct					
Colorado River Aqueduct Supply	187	187	187	182	182
Aqueduct Capacity Limit[2]	0	0	0	0	0
Colorado Aqueduct Capability	0	0	0	0	0
Capability of Programs Under Development	**775**	**876**	**1,238**	**1,233**	**1,233**
Maximum MWD Supply Capability	**4,260**	**4,686**	**5,327**	**5,180**	**5,047**
Potential Surplus	**2,254**	**2,753**	**3,342**	**3,131**	**2,941**

1. Includes water transfers and groundwater banking associated with SWP.
2. Includes 296 TAF of non-MWD supplies conveyed in CRA for Imperial Irrigation District - San Diego County Water Authority Transfers and Canal Linings.
3. CRA has a capacity constraint of 1.25 MAF per year.
4. Does not include 16 TAF subject to satisfaction of conditions specified in agreement among MWD, the US, and the San Luis Rey Settlement

Source: 2010 Regional Urban Water Management Plan, Metropolitan Water District of Southern California

8.2 MWD Supply Reliability and Projected LADWP Purchases

MWD's 2010 Integrated Water Resources Plan (IRP) update serves as the foundation for supply forecasts discussed in the RUMWP and continues to ensure system reliability for its member agencies. The 2010 IRP update concluded that the resource targets identified in previous updates, taking into consideration changed conditions identified since that time, will continue to provide for 100 percent reliability through 2030. MWD's subsequent evaluation to extend the resource targets by an additional five years through their 2010 draft RUWMP also concluded the same full reliability during average (1922 – 2004 hydrology), single dry (1977 hydrology), and multiple dry years (1990 - 1992 hydrology). For each of the scenarios, there is a surplus in every forecast year. Exhibit 8R summarizes MWD's reliability in five year increments extending to 2035.

The City purchases MWD water to make up the deficit between demand and other City supplies. Whether LADWP can provide reliable water services to the residents of Los Angeles is highly dependent on MWD's assurance on supply reliability. However, the recent water supply shortage caused by dry weather and pumping restrictions in the Bay-Delta prompted the City to develop a more sustainable water supply portfolio with emphasis on local water supplies such as recycled water, groundwater cleanup, stormwater capture, and conservation. LADWP's reliance on MWD water supply is projected to be cut in half from the current five-year average of 52 percent of the total demand to 24 percent by 2034-35 under average weather conditions.

The reliability of MWD's water supply is more fully discussed in Chapter 10, Integrated Resources Planning. The projected LADWP water purchase is further discussed in Chapter 11, Water Service Reliability Assessment under various weather scenarios.

8.3 MWD Rate Structure and LADWP's Purchased Water Costs

8.3.1 MWD Rate Structure

MWD's rates are structured on a tier–based system with two tiers and a surplus category. Nine major elements determine the actual price a member agency will pay for deliveries. All of the elements are volumetric based except for two fixed rates, the Readiness-to Serve Charge and the Capacity Charge.

Tier 1 rates are reflective of actual costs of existing supplies and are designed to recover most of the supply costs. Member agencies are allocated a specified volume of Tier 1 water that can be purchased within a given year. In 2011, LADWP's Tier 1 limit is 304,970 AF. Any purchases above this are charged at the Tier 2 rate. MWD has instituted a temporary Bay-Delta surcharge to recover costs associated with lower SWP deliveries related to pumping restrictions. The surcharge will remain in effect until SWP yields improve.

Tier 2 rates send a price signal associated with MWD's costs of developing additional long-term firm supply options. Member agencies with growing demands on MWD will have a higher proportion of deliveries within the Tier 2 range.

Surplus water is water in excess of consumptive municipal and industrial demands. Surplus water is available at two discounted levels dependent upon the end use. Replenishment Program water is discounted for replenishing local agency supplies. The program has been suspended as a result of dry conditions and uncertain future supplies. The Interim Agricultural Water Program (IAWP) provides discounted water for agricultural use. This program is being phased out and will terminate beginning in 2013.

Exhibit 8S
MWD Rates and Charges

Rates and Charges	Effective Rate January 1		
	2010	2011	2012
Tier 1 Supply Rate ($/AF)	101	104	106
Delta Supply Surcharge ($/AF)	69	51	58
Tier 2 Supply Rate ($/AF)	280	280	290
System Access Rate ($/AF)	154	204	217
Water Stewardship Rate ($/AF)	41	41	43
System Power Rate ($/AF)	119	127	136
Full Service Untreated Volumetric Cost ($/AF)			
Tier 1	484	527	560
Tier 2	594	652	686
Replenishment Water Untreated ($/AF)	366	409	442
Interim Agricultural Water Untreated ($/AF)	416	482	537
Treatment Surcharge ($/AF)	217	217	234
Full Service Treated Volumetric Cost ($/AF)			
Tier 1	701	744	794
Tier 2	811	869	920
Treated Replenishment Water ($/AF)	558	601	651
Treated Interim Agricultural Water Program ($/AF)	615	687	765
Readiness-to-Serve Charge ($/M)	114	125	146
Capacity Charge ($/cfs)	7,200	7,200	7,400

Source: 2010 Regional Urban Water Management Plan, Metropolitan Water District of Southern California

Exhibit 8S summarizes the rates and charges for member agencies effective on January 1 of 2010, 2011, and 2012.

8.3.2 LADWP's Purchased Water Costs

MWD's water rates vary from $484 per AF of tier 1 untreated water to $811 per AF of tier 2 treated water in 2010. The average unit cost of MWD water supply depends on the proportions of treated water and untreated water, tier 1 water, and tier 2 water purchased in a given period. From 2003 to 2009, LADWP purchased 88 percent tier 1 water and 12 percent tier 2 water, and 70 percent untreated water and 30 percent treated water on average. The tier 2 water purchase varied from no purchase in 2005 and 2006 to 29 percent in 2007 and 2008. The treated water purchase varied from 20 percent in 2007 to 46 percent in 2005. Exhibit 8T illustrates the various combinations.

The Readiness-to-Serve Charge and Capacity Charge are predetermined fixed charges for each member agency and not affected by the quantity of MWD water purchased. However, they add on to the unit cost of the City's MWD water purchase. The City's current share of the Readiness-to-Serve Charge is 15.12 percent or $17.24 million in 2010. The Capacity Charge is calculated based on the summer daily peak flow from the previous three years. The City's 2010 Capacity Charge is $5.9 million based on the daily peak flow of 822 cfs in 2008 summer. Both charges added an additional $110 per AF to the unit cost of LADWP's MWD water purchase in 2010.

Exhibit 8T
Percentage of LADWP's Purchased Water in Various MWD Rate Categories

MWD Deliveries	**Tier 1**		**Tier 2**		Total Tier 1	Total Tier 2	Total Untreated	Total Treated
Calender Year	**Untreated**	**Treated**	**Untreated**	**Treated**				
	%	%	%	%	%	%	%	%
2003	73	22	4	2	95	5	76	24
2004	71	25	3	1	96	4	74	26
2005	54	46	0	0	100	0	54	46
2006	58	42	0	0	100	0	58	42
2007	56	15	25	5	71	29	80	20
2008	48	23	23	6	71	29	71	29
2009	67	20	10	3	87	13	77	23
2010	62	38	0	0	100	0	62	38
Average	61	29	8	2	90	10	69	31

Chapter Nine

Other Water Supplies

9.0 Overview

LADWP continually investigates other feasible water supplies to ensure the sustainability of water supply for the City of Los Angeles. In recent years, LADWP has actively pursued and investigated various supply options including water transfers and banking and seawater desalination. Evaluating the viability of these and other water resource options is a key element to ensuring the City's future water supply reliability. Such options, with proper planning, can contribute toward fulfilling future demand under various conditions. Future water resource challenges, which include increased demand that must be met without increasing imported supply, warrant thoughtful consideration of these and other feasible water supply resources.

Following is a discussion of other water resource options as mentioned above, highlighting LADWP's progress in developing each alternative source of water. Factors that affect feasibility and influence potential implementation are also discussed, as well as advances that facilitate development of the resource option. Of the water supplies discussed in this chapter, LADWP is planning to pursue water transfers of up to 40,000 Acre-Feet (AF) by Fiscal Year 2014/15.

9.1 Water Transfers and Banking

Water transfers involve the lease or sale of water or water rights between consenting parties. Water Code Section 470 (The Costa-Isenberg Water Transfer Act of 1986) states that voluntary water transfers between water users can result in a more efficient use of water, benefiting both the buyer and the seller. The State Legislature further declared that transfers of surplus water on an intermittent basis can help alleviate water shortages, save capital outlay development costs, and conserve water and energy. This section of the Water Code also obligates the California Department of Water Resources (DWR) to facilitate voluntary exchanges and transfers of water.

DWR is required to establish an ongoing program to facilitate the voluntary exchange or transfer of water and implement the various State laws that pertain to water transfers. In response to this mandate, DWR established an internal office dedicated specifically to water transfers in June 2001 and has developed various definitions and policies for transfers. Of particular importance are the rules protecting existing water rights. Water rights cannot be lost when they are transferred to another user if the transferor has an underlying right to the transferred water. DWR also developed three fundamental rules specifically regarding water transfers:

- There can be no injury to any legal user of water.
- There can be no unreasonable effect on fish and wildlife.
- There can be no unreasonable economic effects to the economy in the county of origin.

Water banking, a form of conjunctive use, is the storage of water in groundwater basins for future use. Typically, during wet periods water is stored or banked within groundwater basins for potential extraction during dry periods. Water banking sets up accounts to track the volumes of water recharged and extracted per terms of contract agreements between water agencies. Water banking may occur outside of a water agency's service area. If the water agency's own conveyance facilities are not directly adjacent to the water bank, stored water can be extracted and transferred through wheeling and exchange via other conveyance and storage facilities. Such movements of water involve institutional transfer agreements among water users and agencies.

9.1.1 LADWP Opportunities

LADWP plans on acquiring water through transfers to replace a portion of LAA water used for environmental enhancements in the eastern Sierra Nevada. The City would purchase water when available and economically beneficial for storage or delivery to LADWP's transmission and distribution system. The City is seeking non-State Water Project (SWP) water to replace the reallocation of LAA water supply for environmental enhancements. MWD holds an exclusive contractual right to deliver SWP entitlement water into its service territory, which includes the City of Los Angeles. Purchasing only non-SWP supplies will ensure the City's compliance with MWD's SWP contract.

To facilitate water transfers, LADWP is constructing an interconnection between the LAA and the SWP's California Aqueduct, located where the two aqueducts intersect in the Antelope Valley (see photo below). This interconnection, the Neenach Pumping Station will allow for water transfers from the East Branch of the SWP to the LAA system, as well as provide operational flexibility in the event of a disruption of flows along the LAA System. Construction of the Neenach Pumping Station required a four-way agreement between DWR, MWD, LADWP, and the Antelope Valley-East Kern Water Agency (AVEK). When completed, the Neenach Pumping Station facility will be owned by DWR but will be designated as an AVEK interconnection. The Neenach Pumping Station will be operated on behalf of the LADWP. MWD is involved in the agreement to provide consent for the transferred water to enter its service territory.

LADWP's current goal is to transfer up to 40,000 AFY once the Neenach Pumping Station facilities are in place. This will provide LADWP with the ability to replace some LAA supplies that have been reallocated to environmental enhancement projects in the Mono Basin and Owens Valley. This will also provide increased operational flexibility and cost savings for LADWP customers.

A demonstration study will be performed during the Neenach Pumping Station's first two years of operations. This study will include an evaluation of the operational and water quality impacts of the Neenach Pumping Station.

To supplement water transfers, LADWP also investigated the feasibility of water banking. A request for proposal (RFP) was issued in 2008 and five proposals were received for evaluation to identify the most mutually beneficial water banking program. However, after this evaluation

Neenach Temporary Pumping Station, construction site, looking northerly, taken September 16, 2010, by Aqueduct Aerial Patrol.

process, LADWP decided to not pursue full scale water banking projects at this time.

The City supports statewide water transfer legislation that will ensure the efficient use of the State's limited water resources and provide safeguards for the environment, public facilities, water conservation efforts and local economies. LADWP will continue to develop a responsible water transfer program that can assist in replacing City supplies that have been reallocated to the environment in the Eastern Sierra Nevada.

9.1.2 MWD Opportunities

Regionally, MWD has been active with water transfers and banking, seeking and implementing agreements and cooperative arrangement opportunities to supplement Southern California's water supply. MWD's water transfer activities are classified as *spot transfers, option transfers, core transfers, storage transfers,* or *exchanges*. Each activity is described briefly below.

- *Spot transfers* make water available through a contract entered into the same year that the water is delivered.
- *Option transfers,* through multi-year or single-year contracts, allow MWD to obtain water on an "as-needed" basis.
- *Core transfers* make water available through multi-year contracts that convey specific water entitlement to MWD each year.

- *Storage transfers* allow MWD to store and later recover available water that can then be transported immediately to Southern California.

- *Exchange agreements* involve the transfer to MWD of another agency's entitlements in exchange for water entitled to MWD from another source.

MWD is in the process of developing and implementing transfer/storage projects in the Central Valley, and off-stream banking and dry year supplies of Colorado River water. Water transfers, including the programs highlighted below, are an important element of California's plan to live within its 4.4 million acre-feet per year entitlement to Colorado River water. These programs have also helped MWD adjust to regulatory restrictions on State Water Project pumping from the San Francisco Bay-Delta. Current and potential MWD transfer, storage, and exchange agreements/activities include:

- Semitropic Water Storage Program
- Kern Delta Water District Water Management Program
- Arvin-Edison Water Transfer and Storage Program, Kern County
- San Bernardino Valley Transfer and Storage Program
- Desert Water Agency/Coachella Valley Water District Exchange Program
- Palo Verde Land Management, Crop Rotation, and Water Supply Program
- Hayfield Groundwater Storage Project (under development)
- Southern Nevada Water Authority and Metropolitan Storage and Interstate Release Agreement
- Central Valley Water Transfers
- Yuba Accord Dry Year Purchase Program
- Lower Colorado Water Supply Project
- Lake Mead Water Storage Program
- Drop 2 Reservoir Funding
- Arizona Exchange (under development)
- Yuma Desalter Exchange (under development)
- California Indians Exchange (under development)
- Expansion of Southern Nevada Water Authority Agreement (under development)
- ICS Exchange Program (under development)
- Expansion of Palo Verde Land Management, Crop Rotation, and Water Supply Program (under development)
- Mojave Water Agency Exchange Demonstration Program (under development)
- North of Delta/In Delta Transfers (under development)
- North Kern/Desert Water Agency Exchange (under development)
- Shasta Return Project
- Semitropic Agricultural Water Reuse Demonstration Project (under development)
- San Bernardino Valley MWD Central Feeder Project (under development)
- Chuckwalla Groundwater Storage Program (under development)
- Coachella Valley Water District Agreement (under development)

MWD's water rate structure is designed to allow water transfers using MWD infrastructure by establishing a water wheeling rate, which is a combination of the System Access Rate, Water

Stewardship Rate, System Power Rate, and if treated water is delivered, a Treatment Surcharge. This wheeling rate applies to all water conveyed through MWD's infrastructure, regardless of the agency using the system. MWD's unbundled rate structure and its associated wheeling rate encourage development of water markets by providing for competition at the supply level; MWD's member agencies can purchase supplies from any source and pay MWD's wheeling rate to transmit the water. MWD's current water rate structure establishes charges for each component on a per acre-foot basis for all water moving through MWD's system. As of January 1, 2011, current wheeling rate charges are:

- System Access Rate: $204/AF
- Water Stewardship Rate: $41/AF
- System Power Rate: $127/AF
- Treatment Surcharge: $217/AF

The System Access Rate recovers costs associated with conveyance and distribution capacity to meet average annual demands. The Water Stewardship Rate recovers the cost associated with providing financial incentives for investments in local water resources, such as water conservation and recycled water programs. The System Power Rate recovers the cost of power required to move water through MWD's system. The Treatment Surcharge applies to all water that is treated at one of MWD's five treatment plants.

MWD's water rate structure also incorporates a tiered supply rate format. The first tier price applies to a fixed base quantity of water as defined by each MWD member agency's purchase order contract. The second tier price reflects the incremental cost for MWD to acquire additional supplies that are above the first tier contract base amount.

9.2 Seawater Desalination

Seawater desalination, the process of removing salts and other impurities from seawater, has reached an all-time high in terms of worldwide production capacity. According to the International Desalination Association, between 2007 and 2009, worldwide seawater desalination capacity increased by approximately thirty percent to a total capacity of 9.5 billion gallons per day. This is partly driven by the fact that the cost to desalinate water has decreased significantly due to technological and process advancements. Of the more than 14,000 seawater and groundwater desalination plants in operation worldwide, the majority are located in the Middle East, where energy costs are relatively low. The world's largest seawater desalination plant in Saudi Arabia produces 232 mgd of desalted water. In contrast, the largest facility in the United States, located in Tampa Bay, FL, produces 25 mgd.

LADWP's current water resource strategy does not include seawater desalination as a water supply. There are concerns with cost and the environmental impacts associated with the implementation of desalination. LADWP is primarily focused on enhancing recycling and conservation. While desalination may be explored further in the future, it currently represents only a supply alternative.

9.2.1 Desalination Technology

Technology to desalt seawater to produce potable water which meets or exceeds drinking water standards has been available for some time, but has not been widely implemented primarily due to its high cost. Although the cost to desalinate seawater is still more expensive than obtaining water from conventional sources, continued research and development, as well as large scale projects are being implemented in the United States and other parts of the world to improve technology and further drive costs down. Additionally, increasing costs associated with new water supplies and existing supplies is reducing the cost differential between desalinated water and other water sources improving the viability of desalinated water as a part of an overall water supply portfolio.

The two basic seawater desalination processes are: 1) use of the distillation process to evaporate water from salts; and 2) use of semi-permeable membranes to filter the water while straining out the salts. While distillation has been the dominant seawater desalination technology (primarily in the Middle East), current worldwide desalination development is rapidly migrating toward membrane technology. Facilities using distillation are still prevalent in the Middle East. However, new plant installations are increasingly taking advantage of technological advancements (higher yield and lower energy requirements) in membrane-based process technology. Today, membrane filtration accounts for over half of the world's desalting capacity.

9.2.2 DWR Desalination Efforts

Recognizing the potential of seawater as a water resource, the DWR through a legislative mandate, convened a California Water Desalination Task Force in 2002. The task force was responsible for making recommendations to the State Legislature on potential opportunities, impediments, and the State's role in furthering desalination technology.

The task force was effective in providing a forum in which stakeholders could convene and discuss critical issues related to desalination. Key seawater desalination issues that have been raised through the task force fall into six general categories: environmental, economic, permitting, engineering, planning, and coordination.

To assist in addressing these issues, the California Water Desalination Task Force has developed draft guidelines for developing environmentally and economically acceptable desalination projects. These include the following:

- Each project should be considered on its own merits.
- Sponsoring agencies should be determined early in the planning process.
- Public and permitting agencies should be engaged early in the planning process.
- Collaborative processes should be used to enhance support for project implementation.
- A feedback loop should be incorporated to allow for continuously revisiting and revising the project at each step of the planning process.
- Key decision points (e.g., costs, environmental acceptability) should be identified to test the general feasibility of the project as early in the planning process as possible.

After establishment of the task force, desalination was added to the California State Water Plan as an alternative for consideration in regional water supplies. Furthermore, in 2008, DWR published the *California Desalination Planning Handbook*, building upon the task force's efforts. The handbook provides guidance on determining appropriate conditions for desalination plants, addressing concerns, and building public trust.

Proposition 50, Chapter 6, has provided funding for desalination research, feasibility studies, pilot projects, and construction of new facilities. Over $45 million was distributed under this proposition in two rounds of funding for both seawater and groundwater desalination. Fund recipients included LADWP.

With increasing demand for water and limited new supply options, the future value of seawater desalination as a part of California's water supply portfolio has become apparent. Within Southern California, a range of 270,000 AFY to 422,000 AFY of desalinated seawater could be potentially produced based on current efforts (see Exhibit 9A). While this production represents less than five percent of the region's total water supplies, it is nonetheless considered by water planners as an important part of the region's water supply portfolio.

9.2.3 MWD Desalination Efforts

MWD first incorporated desalinated seawater as a potential new water supply source in its 2003 Integrated Resources Plan Update. Subsequently in 2009, MWD's Board of Directors created a special committee on Desalination and Recycling to study MWD's role in regional efforts to develop desalination facilities.

In response to a proposal solicitation in 2001, MWD received proposals by five member agencies to provide up to 142,000 AFY of potable water. To provide an incentive for the development of desalinated seawater, MWD is offering subsidies of up to $250 for each acre-foot (326,000 gallons) of desalinated seawater produced. LADWP, Long Beach Water Department (LBWD), West Basin Municipal Water District (WBMWD), Municipal Water District of Orange County, and San Diego County Water Authority (SDCWA) submitted detailed proposals that qualified for the MWD's Seawater Desalination Program. Exhibit 9A summarizes the status of the desalination efforts in MWD's service area, including projects not in the Seawater Desalination Program. Each of these agencies serves coastal areas, and is looking to desalination as a means to further diversify its water supply portfolio.

9.2.4 LADWP Seawater Desalination Efforts

Scattergood Generating Station Seawater Desalination Plant

LADWP initiated efforts in 2002 to evaluate seawater desalination as a potential water supply source with the goals of improving reliability and increasing diversity in its water supply portfolio. These efforts led to the selection of Scattergood Generating Station as a potential site for a seawater desalination plant. For the City, seawater desalination is a potential resource that could also offset supplies that had been committed from the LAA for environmental restoration in the eastern Sierra Nevada. As an identified project in MWD's Seawater Desalination Program, the proposed full-scale project would have qualified for MWD's grant of $250 per AF of water produced. However, in May 2008, LADWP decided to focus on water conservation and water recycling as the primary strategies in creating a sustainable water supply for the City.

While seawater desalination is not a potential water supply strategy at this time, studies performed to date have provided beneficial data that in the future can assist LADWP with any future evaluations of seawater desalination. Completed studies include the LADWP Proposed Seawater Desalination Plant Site Selection Fatal Flaw Analysis (2002), LADWP Seawater Desalination Facility Feasibility Study for the Scattergood Generating Station in Playa Del Rey (2004), Brine Dilution Study for the LADWP Desalination Project at Scattergood Generating Station (2005), and Scattergood Seawater Desalination Pilot Project Preliminary Evaluation Report (2008).

Exhibit 9A
Desalination Efforts in MWD Service Area

Project Name	Member Agency	Capacity (AFY)	Status
MWD Seawater Desalination Program			
Long Beach Seawater Desalination	Long Beach	10,000	Pilot Study[1]
Los Angeles Seawater Desalination	LADWP	28,000	On-hold
South Coast Coastal Ocean Desalination	Municipal Water District of Orange County	16,000 - 28,000	Pilot Study
Carlsbad Seawater Desalination	San Diego County Water Authority	56,000	Permitting Complete
West Basin Seawater Desalination	West Basin Municipal Water District	20,000	Pilot Study[1]
Subtotal		130,000 - 142,000	
Other Potential Projects in MWD Service Area			
Huntington Beach Seawater Desalination	Municipal Water District of Orange County	56,000	Initiating Permitting
Camp Pendleton Seawater Desalination	San Diego County Water Authority	56,000 - 168,000	Planning
Rosarito Beach Seawater Desalination	San Diego County Water Authority	28,000 - 56,000	Feasibility Study
Subtotal		140,000 - 280,000	
Total		270,000 - 422,000	

1. Full scale feasibility studies in progress.

Source: Annual Progress Report to the State Legislature, Achievements in Conservation, Recycling, and Groundwater Recharge, February 2010.

To determine the proper site location for a City desalination plant, LADWP conducted the LADWP Proposed Seawater Desalination Plant Site Selection Fatal Flaw Analysis evaluating three City-owned coastal power generating plants. Based on the findings from this analysis, LADWP initially decided to investigate development of a 12 to 25 mgd desalination facility at the Scattergood Generating Station.

Optimum capacity of a future desalting facility at the Scattergood Generating Station was evaluated in the LADWP Seawater Desalination Facility Feasibility Study. Results of the study indicated a 25 mgd facility would be the most economical. Estimated capital costs for a 25 mgd facility were approximately $148.5 million in 2004 dollars with an annual operations and maintenance cost of $28.9 million (2004 dollars) resulting in a total water cost of approximately $1,257 per AF. The study also identified the five-mile Hyperion Treatment Plant Outfall, which is adjacent to the Scattergood Generating Station, as the most environmentally advantageous method to dispose of the brine concentrate produced from the desalting process.

In an effort to develop an environmentally compatible project, LADWP evaluated the feasibility of discharging the desalted concentrate into Hyperion Wastewater Treatment Plant's 5-mile outfall. The Brine Dilution Study for the LADWP Desalination Project at Scattergood Generating Station performed by the Scripps Institute of Oceanography found that there are potential environmental benefits to the Santa Monica Bay's marine biology due to improved salt balance if the effluent discharged by the Hyperion Wastewater Treatment Plant were to include brine from a desalination facility.

In March 2008 the Preliminary Evaluation Report of the Scattergood Generation Station Seawater Desalination Pilot Project was completed. This was the first task of multiple tasks that was to ultimately result in the operation of a pilot plant. Co-funded by the US Bureau of Reclamation and DWR through Proposition 50 funding the overall goal was to further investigate the viability of seawater desalination for LADWP. Recommendations on site specific technologies and processes were provided for carry over to the pilot plant design stage. Items for further study included subsurface intake evaluation, cooling alternatives for warm water, second pass reverse osmosis, post treatment stabilization, and finished water blending strategy.

After completion of the first task, the other tasks were not initiated reflecting the City's new primary strategies of conservation and recycled water to create a sustainable water supply for the City. Studies completed to date and LADWPs other seawater desalination efforts discussed below have provided important data that could assist LADWP if the decision is made to move forward with seawater desalination in the future.

Other LADWP Seawater Desalination Efforts

LADWP historically engaged in multiple partnerships to advance seawater desalination in Southern California. Seawater desalination is hindered by multiple challenges including, but not limited to, capital costs, operating costs, environmental considerations, water quality, and public acceptance. To overcome these challenges, LADWP has supported efforts to lower the capital and operating costs of producing desalinated ocean water. LADWP also participated with California stakeholders through multiple venues, such as the MWD and the California Water Desalination Task Force to develop desalination study projects within Southern California.

LADWP, LBWD, and the United States Bureau of Reclamation partnered in the construction of a 300,000 gpd prototype seawater desalination facility to complete testing of LBWD's proprietary two-stage nanofiltration process (using membranes that require lower operating pressures and thus, the potential for lower operating costs). LBWD successfully performed a 9,000-gpd bench-scale testing of this technology and began testing on a larger scale in October 2006 at LADWP's Haynes Generating Station in Long Beach. In March 2010, LBWD completed its testing and subsequently prepared the final report.

LADWP also partnered with the WBMWD and other agencies in the American Water Works Association Research Foundation Tailored Collaboration project, "Water Quality Implications for Large-Scale Applications of MF/RO Treatment for Seawater Desalination." A 30,000-gpd pilot facility operating off the coast of El Segundo, California, from 2002 to 2008, was tested for membrane performance, water quality, and operational cost.

In a joint study by LADWP, LBWD, and WBMWD, preliminary sampling of raw seawater quality was initiated at three potential seawater desalination sites - Scattergood Generating Station in Playa Del Rey, Haynes Generating Station in Long Beach, and El Segundo Power Generating Station. Water quality analysis on the seawater was performed at various times of the year to analyze seawater quality variations during storm events when city surface runoffs drain into the ocean. The next step would be to collaborate with the California Department of Health Services on developing guidelines to ensure that product water from future desalting facilities will meet all State and Federal water quality regulations.

9.3 Other Water Supplies Yield and Cost

The range of water supplies, the unit cost, risks, and other benefits besides reductions in water demands for water transfer and seawater desalination are presented in Exhibit 9B. LADWP recognizes the value of these water supplies in offsetting unanticipated changes to supply or demand. Strategic water planning necessarily includes continuous monitoring of existing and future alternative water resources.

Exhibit 9B
Other Water Supplies

Other Water Supplies				
Water Supply Alternatives	**Potential Water Yield (AFY)**	**Average Unit Cost ($/AF)**	**Implementation Risks**	**Additional Benefits**
Seawater Desalination [1]	25,000	$1,300-$2,000	Environmental permitting may be difficult.	Replaces water committed to the environment. Hedges against climate change.
Water Transfer	40,000	$440-$540[2]	Wheeling and other institutional issues must be addressed.	Replaces water committed to the environment.

For Comparison Purposes:
Local Groundwater Pumping Unit Cost = $230/AF
MWD Treated Tier 2 Water Supply Unit Cost = $811/AF

Notes:

1. Source: Metropolitan Water District of Southern California Integrated Water Resources Plan 2010 Update – Report No. 1373. While the ocean is a virtually unlimited supply, yield shown here is the maximum given available land, outfall capacity, and other constraints.
2. Cost includes cost of water and wheeling fees. Treatment costs not included.

Chapter Ten

Intergrated Resources Planning

10.0 Overview

Integrated resources planning is a process used by many water and wastewater providers to meet their future needs in the most effective way possible, and with the greatest public support. The integrated planning process incorporates:

- Public stakeholders in an open, participatory process.
- Multiple objectives such as reliability, cost, water quality, environmental stewardship, and quality of life.
- Risk and uncertainty.
- Partnerships with other agencies, institutions, and non-governmental organizations.

LADWP has been actively involved in integrated resources planning since 1993, when the Metropolitan Water District of Southern California (MWD) initiated the region's first Integrated Resources Plan (IRP). LADWP was an active member of the technical workgroup that oversaw the development of alternatives and recommendations from MWD's IRP. In 1999, the City embarked on its first IRP for wastewater, stormwater and water supply. LADWP was a partner in this effort, working with the City's Bureau of Sanitation (BOS). In 2006, the Greater Los Angeles County IRWMP was approved. LADWP is a member of the IRWMP Leadership Committee and serves as the chair of the of the Upper Los Angeles River Watersheds sub-region for the IRWMP region.

10.1 City of Los Angeles Integrated Water Resources Plan

10.1.1 Description and Purpose

The City's Integrated Water Resources Plan (IRP) is a unique approach of technical integration and community involvement to guide policy decisions and water resources facilities planning. As part of the IRP development, an Environmental Impact Report (EIR) was prepared identifying the recommended alternatives for implementing the City's wastewater, runoff, and recycled water programs to meet its 2020 needs. On November 14, 2006, the City Council unanimously adopted the IRP recommendations and implementation strategy and certified the final EIR. The IRP development was a seven year stakeholder-driven process and was an innovative approach to guide the City's policy decisions and facilities planning. The IRP recognizes the interrelationship of water, wastewater, and runoff management in forming a future vision for the City's water resources activities and functions. In the past, the City traditionally utilized single-purpose planning efforts for each agency, such as one plan for wastewater and a separate plan for water supply. With the IRP, the City can meet its 2020 needs in a more cost-effective and sustainable way by addressing and integrating all its water resources. Additionally, the IRP was designed to meet multiple objectives, including evaluation of innovative supply opportunities that were once thought of as being too expensive. The City's LADWP and BOS are partners in this effort, joined by public stakeholders and other agencies.

The objectives for the IRP were developed by the City and public stakeholders, and represent the major reasons why the plan was developed. These objectives are:

- Protect public health and safety
- Effectively manage system capacity
- Protect the environment
- Enhance cost efficiency
- Protect quality of life
- Promote education

The IRP was developed in three phases. The first phase set policy guidelines for managing the City's water resources for the next 20 years. The second phase had three main deliverables: (1) detailed facility plans for wastewater, stormwater, and recycled water; (2) comprehensive financial plans for wastewater and stormwater; and (3) a certified Environmental Impact Report (EIR). The third phase of the IRP, which is now underway, represents implementation of the facility plans and more detailed studies to support implementation.

10.1.2 Integrated Watershed Approach

By taking an integrated watershed approach, the IRP identified opportunities that would normally not have been identified if water, wastewater, and stormwater were planned separately. The IRP recognized that all of the City's water resources are linked from a technical, social, and institutional aspect.

The City's IRP has also assisted in identifying partnerships between City agencies for project implementation potentially leading to increases in outside funding from grants and low-interest loans.

An example is the potential three-way partnership between the City's Department of Recreation and Parks, BOS, and LADWP. Land reclamation of blighted industrial and warehouse uses allows the City to create more parks and recreational areas while simultaneously allowing for underground storage of wet weather runoff for subsequent beneficial reuse. With this integrated approach, the City can potentially obtain more parkland, assist BOS in reducing wet weather runoff to improve water quality, and assist LADWP in increasing water supplies. The integrated approach also allows the City to better position itself for grants and loans that typically prioritize projects that demonstrate multiple benefits (e.g., water quality, water supply and recreation).

10.1.3 Stakeholder Involvement

A key element of the IRP was involvement of stakeholders throughout the entire IRP process. Stakeholders represented a wide range of the City's interests including, but not limited to, community, business, and environmental organizations. Stakeholders were instrumental in development of the guiding principles and identification of innovative water resource opportunities.

During Phase 2, stakeholders participated in a Steering Group. Steering Group members regularly attended scheduled workshops and provided on going input on the technical, environmental, and financial development of the IRP. Members provided necessary feedback to keep the facilities planning efforts aligned with the decision-making process. The Steering Group also considered key project issues in regards to the development of alternatives, such as facilities siting, implementation risks, and acceptability of costs associated with projects.

10.1.4 IRP Alternatives

The IRP evaluated a broad range of integrated alternatives. Each alternative represented different combinations of wastewater treatment options, wastewater collection system options, recycled water options, conservation options, and dry and wet weather urban runoff management options.

Twenty-one (21) preliminary alternatives were created with different focuses, allowing stakeholders and decision-makers to see trade-offs in key planning objectives. Based on the evaluation of the preliminary alternatives, nine (9) hybrid alternatives were created that incorporated the best elements from the preliminary alternatives in order to improve overall performance. City staff recommended the top-scoring four (4) hybrid alternatives to be carried through to the EIR process. Public stakeholders concurred with staff recommendations.

In November 2006, City Council approved the staff-recommended alternative, which consists of "Go-Projects", "Go-If-Triggered Projects" and "Go-Policy Directions". "Go-Projects" are projects recommended for immediate implementation because the flow and regulatory triggers have already been met. "Go-If-Triggered Projects" will only be implemented if or when additional information or circumstances, such as regulatory requirements, population growth, or increases in sewage flow, materialize. "Go-Policy Directions" are specific directions to City staff on further studies and evaluations necessary to progress on programmatic elements.

10.1.5 IRP Implementation Status

LADWP, in partnership with the City's Department of Public Works, has been working collaboratively along with other City departments on coordinating and implementing the various IRP recommendations. As part of the IRP implementation phase, the City has worked on keeping IRP stakeholders engaged through annual stakeholder meetings. Through these meetings, the City has provided updates on the IRP implementation and has obtained valuable input from stakeholders on IRP related issues. In addition, the Board of Water and Power Commissioners and the Board of Public Works have held three public joint meetings to review the IRP progress and provide directions on policy issues. Since the adoption of the IRP by the City Council in November 2006, a number of initiatives have been undertaken by the City which fulfill the IRP goals, including the Green Streets and Green Alleys Committee, the development of a Low Impact Development Ordinance, Conservation Initiatives (Chapter 3), the Recycled Water Master Plan (Chapter 4), and Watershed Management (Chapter 7). Projects and policies in the IRP implementation strategy are detailed below. Some projects are currently being implemented, while others continue to be monitored for triggers or policy direction:

Go Projects

- Construct wastewater storage facilities at Donald C. Tillman Water Reclamation Plant (DCT).
- Construct wastewater storage facilities at Los Angeles-Glendale Water Reclamation Plant (LAG).
- Construct recycled water storage facilities at LAG.
- Construct solids handling and truck loading facility at Hyperion Treatment Plant (HTP).
- Construct two new sewer lines, Glendale Burbank Interceptor Sewer and Northeast Interceptor Sewer Phase II.

Go-If-Triggered Projects

- Potential upgrades at DCT to advanced treatment at current capacity (if triggered by regulations and/or decision to reuse DCT effluent for groundwater replenishment).
- Potential expansion and upgrade of DCT to 100 mgd (if triggered by an increase in population, regulations, and/or groundwater replenishment decision). In the unlikely event that the overall framework for recycled water changes to disallow its use, then HTP would be potentially expanded to 500 mgd instead.
- Potential upgrades at LAG to advanced treatment at current capacity (if triggered by regulations and/or availability of downstream sewer capacity).
- Design and construction of additional secondary clarifiers at HTP to provide 450 mgd operational performance.
- Design and construction of up to 12 solids digesters at HTP (if triggered by increased biosolids production in the service area).
- Design and construction of Valley Spring Interceptor Sewer.

Of the "Go-Policy Directions" which provide specific directions to City staff on further studies and evaluations necessary to progress on programmatic elements., those applicable to or with the potential to impact LADWP operations include:

Recycled Water – Non-Potable Uses

- Direct LADWP and the Department of Public Works to work together to maximize recycled water use and identify recycled water for non-potable uses in the TIWRP service area, west side, and LAG service areas. LADWP is to conduct additional Tier 1 and 2 customer analyses to verify potential demands and feasibility and develop a long-range marketing strategy for recycled water that includes a plan for recruiting and retaining new customers.
- Direct the Department of Building and Safety to evaluate and develop ordinances to require installation, where feasible, of dual plumbing for new multi-family, commercial and industrial development, schools, and government properties in the vicinity of existing or planned recycled water distribution systems in coordination with the Los Angeles River (LA River) Revitalization Master Plan. Proximity and demand will be considered when determining feasibility. The dual plumbing will consist of separate plumbing and piping systems, one for potable water and the second for recycled water for non-potable uses, such as irrigation and industrial use.
- Direct the Department of Public Works and LADWP to continue to coordinate, where feasible, the design/construction of recycled water distribution piping (purple pipe) with other major public works projects, including street widening, and LA River Revitalization Master Plan project areas. Also coordinate with other agencies, including the Metropolitan Transit Authority and Caltrans, on major transportation projects.

Recycled Water –Indirect Potable Uses (Groundwater Replenishment)

- Direct LADWP to develop a public outreach program to explore the feasibility of implementing groundwater replenishment with advanced treated recycled water.

Recycled Water – Environmental Uses

- Direct LADWP and the Department of Public Works to continue to provide water from DCT to Lake Balboa, Wildlife Lake, and the Japanese Garden at Sepulveda Basin, and the LA River to meet baseline needs for habitat.

Water Conservation

- Direct LADWP to continue conservation efforts, including programs to reduce outdoor water usage through the use of smart irrigation devices on City properties, schools, and large developments (those with 50 dwelling units or 50,000 gross square feet or larger), and to increase incentives to residential properties.

- Direct LADWP to work with the Department of Building and Safety in continued conservation efforts by evaluating and considering new water conservation technologies, including no-flush urinal technology.

- Direct LADWP to continue to work with the Department of Building and Safety on conservation efforts by evaluating and developing a policy that requires developers to implement individual water meters for all new apartment buildings.

- Direct LADWP to continue conservation awareness efforts, including increasing education programs on the benefits of using climate-appropriate plants with an emphasis on California friendly plants for landscaping or landscaped areas developed in coordination with the LA River Revitalization Master Plan, and to develop a program of incentives for implementation.

- Direct the City Planning Department to consider development of a City directive to require use of California friendly plants in all City projects where feasible and not in conflict with other facilities usage.

Runoff Management – Wet Weather Runoff

- Direct the Department of Public Works to review SUSMP (Standard Urban Stormwater Management Plan) requirements to determine ways to require, where feasible, on-site filtration and/or treatment/reuse, rather than treatment and discharge, including in-lieu fees for projects where infiltration is infeasible.

- Direct the Department of Building and Safety to evaluate and modify applicable codes to encourage the installation of all feasible Best Management Practices (BMPs), including the use of porous pavement to maximize on-site capture and retention and/or infiltration of stormwater instead of discharge to the street and storm drain.

- Direct the Department of Public Works and the City Planning Department to evaluate the possibility of requiring porous pavement in all new public facilities in coordination with the LA River Revitalization Master Plan, and developments larger than one acre. Program feasibility should consider slope and soil conditions.

- Direct the City Planning Department to evaluate ordinances that would need to be changed to reduce the area of on private properties that can be paved with non-permeable pavement.

- Direct the Department of Public Works to evaluate and implement integration of porous pavements into sidewalks and street programs where feasible.

- Direct the Department of Public Works, LADWP, and the Department of Recreation and Parks to prepare a concept report and determine the feasibility of developing a powerline easement demonstration project for greening, public access, stormwater management, and groundwater replenishment.

- Direct the Department of Public Works and LADWP to work with the Los Angeles Unified School District to determine the feasibility of developing projects for both new and retrofitted schools, as well as for government/ City-owned facilities, to implement stormwater management BMPs (cisterns to store runoff for irrigation, reduce paving and hardscapes, add infiltration basins).

- Direct the Department of Public Works, the General Services Department, and the Department of Recreation and Parks, to identify sites that can provide on-site percolation of wet-weather runoff in surplus properties, vacant lots, parks/ open spaces, abandoned alleys in the East Valley area, and along the LA River in the East San Fernando Valley where feasible. Program feasibility should consider slope and soil conditions.

- Direct the Department of Public Works, the General Services Department, and the Department of Transportation to maximize unpaved open space in City-owned properties and parking medians by using all feasible BMPs and by removing all unnecessary pavement.

- In the context of developing Total Maximum Daily Load (TMDL) implementation plans, direct the Department of Public Works to consider diversion of dry weather runoff from Ballona Creek to constructed wetlands, wastewater system, or urban runoff plants for treatment and/or beneficial use. For inland creeks and storm drains tributary to the LA River, direct the Department of Public Works to consider diversion of dry weather runoff to the wastewater system or constructed wetlands or treatment/retention/ infiltration basins.

- Direct the General Services Department, in coordination with the City Planning Department and the Department of Public Works, to evaluate feasibility of all City properties identified as surplus for potential development of multi-benefit projects to improve stormwater management, water quality, and groundwater recharge.

Los Angeles River

The IRP planning effort included the Los Angeles River (LA River). The LA River is a valuable resource to the City providing habitat as well as recreational and economic opportunities. Since the City's water reclamation plants were built, recycled water has been released to the LA River resulting in the development of significant environmental benefits from riparian habitat in the unlined portions of the LA River near Glendale, to regionally significant migratory shore bird habitat in Long Beach. As a result, many efforts have been developed to protect existing habitat and promote interest in habitat restoration and river revitalization.

The IRP established that treated wastewater is needed for the operation of Lake Balboa, the Japanese Gardens, and the Wildlife Lake in the Sepulveda Basin. Treated wastewater flows through these features and ultimately is released to the LA River from DCT. The remainder of the treated wastewater produced by the City's water reclamation plants is available for recycled water use and distribution to LADWP customers.

Shortly after work on the IRP began, the Los Angeles City Council's Ad Hoc Committee on the LA River (Ad Hoc Committee) was formed to address LA River revitalization. LADWP staff routinely attends Ad Hoc Committee meetings and functions and monitors LA River-related activities.

LADWP also funded the preparation of a Los Angeles River Revitalization Master

Plan which was approved in 2007. This plan addresses economic development opportunities, water quality, water resources, flood control, and recreation along the Los Angeles River. The plan also discusses opportunities to improve access to the Los Angeles River and increase community awareness.

In addition, LADWP staff also actively participates on the City's LA River Task Force, which was formed in response to instructions by the Ad Hoc Committee to:

- Inventory all current and future City department projects, studies, and programs along the LA River.
- Assess opportunities for future funding, projects, and studies.
- Coordinate LA River related activities of City departments and other agencies.
- Partner with the U.S. Army Corps of Engineers for a Habitat Restoration Project Study.

LADWP recognizes the importance of the Los Angeles River as a resource that provides multiple benefits to the City.

10.1.6 Agency Coordination

LADWP was a partner with BOS in developing the IRP along with public stakeholders and other agencies. As with any integrated plan that extends beyond traditional departmental boundaries and government jurisdictions, close coordination is required with multiple City, state, and federal agencies including but not limited to, the Cities of Burbank and Glendale, County of Los Angeles, Caltrans, U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and the City Department of Recreation and Parks. Since approval of the IRP, ongoing project implementation and "Go-Policy Directions" continue to require close coordination with City departments and with the agencies listed above.

10.1.7 IRP Implications for City's Urban Water Management Plan

One of the primary purposes for developing the IRP was to explicitly consider the relationship between wastewater facility planning and other water resources issues, such as water supply and urban runoff. Implementation of the IRP has and will continue to result in increased beneficial reuse of water, water conservation, and groundwater supplies. IRP alternatives examined ways to decrease potable water needs by expanding the City's recycled water program; increase water efficiency by installing smart irrigation and other water efficient devices that reduce irrigation and indoor water demands; and increase groundwater resources by using wet weather runoff to recharge the aquifer. All of these options will have to be tested from a technical, institutional, and public acceptance perspective. Ongoing work on programmatic elements identified in the "Go-Policy Directions" applicable to LADWP will continue to investigate means of increasing local water supplies, water conservation, and groundwater recharge opportunities in an integrated manner. The IRP has demonstrated that by integrating water resources planning for the City, more opportunities for water supply development can be identified.

10.2 Greater Los Angeles County Integrated Regional Water Management Plan (IRWMP)

10.2.1 Description and Purpose

The Los Angeles County Department of Public Works led efforts to develop an

Integrated Regional Water Management Plan for the Greater Los Angeles County Region. Water quality, resource, and supply issues within the region are complex and managed by a myriad of government agencies subjected to a plethora of regulations. Exponential growth over the last century has required water managers to develop creative solutions to meet growing demands. Previously, projects addressing water issues were designed to appease single-focused visions and solutions of organizations operating independently. At the core of the plan, a clear vision and direction for the sustainable management of water resources within the region for the next twenty years was formulated. Over 1,600 projects were collected and synthesized for inclusion in the plan bringing together hundreds of local government agencies to cooperatively develop cost-effective, sensible, and economically feasible solutions to address regional water issues. New partnerships were forged between potential funding partners from within and outside the region. An innovative partnership between agencies was formed to create a new model of integrated regional planning to address competing water demands, water supply reliability, and project financing.

An Interim Draft of the IRWMP was adopted by the Leadership Committee on June 28, 2006 with a final plan adopted on December 16, 2006. To date the IRWMP has received $25 million from the Department of Water Resources (DWR) under Proposition 50, Chapter 8, for implementation of fourteen priority projects identified in the plan and $1.5 million from DWR for development of the IRWMP. Since completion of the document a revised Memorandum of Understanding (MOU) was executed by each of the sixteen agencies serving on the Leadership Committee for the purpose of developing, administering, updating, and implementing the IRWMP.

Region

The IRWMP region encompasses 92 cities, portions of four counties, and hundreds of government agencies and districts spread over 2,058 square miles. Approximately 10.2 million residents, or equivalent to roughly 28 percent of the population of California, reside within the region. To facilitate input, variations in geographic and water management strategies, and effective planning the region was further subdivided into five sub-regions:

- Lower San Gabriel and Los Angeles River Watersheds
- North Santa Monica Bay Watersheds
- South Bay Watersheds
- Upper Los Angeles River Watersheds
- Upper San Gabriel River and Rio Hondo Watersheds

Mission and Purpose

A collaborative process resulted in the following mission statement of the IRWMP: "To address the water resources needs of the Region in an integrated and collaborative manner." The IRWMP recognizes that in order to meet future needs water supply planning must be integrated with other resource strategies. Additionally, in a region with significant urban challenges, including population growth, densification, traffic congestion, poor air quality, and quality of life issues, it is imperative to consider water resources management in conjunction with other urban planning issues. The IRWMP's purpose is to proactively:

- Improve water supplies
- Enhance water supply reliability
- Improve surface water quality
- Preserve flood protection
- Conserve habitat
- Expand recreational access

10.2.2 Stakeholder Involvement

Over 1,400 invitations to participate in the IRWMP process were sent out to cities, counties, agencies, districts, disadvantaged communities, and community organizations. Stakeholders participated in workshops, project identification, and development of the IRWMP. Stakeholders were involved in the development of the IRWMP through participation in regional workshops, subregional workshops, and the Leadership Committee. Stakeholders assisted in the following:

- Development of the IRWMP mission and objectives.
- Refinement of procedures for incorporation of projects into the IRWMP.
- Identification of implementation strategies.
- Recommendation of stakeholder workshop improvements.

10.2.3 Recommended Projects

Over 1,600 projects were submitted and analyzed for inclusion in the IRWMP. This list was narrowed down to fourteen priority projects that met the objectives and priorities established by the IRWMP process and assisted in meeting the targets established for the planning region. Objectives and priorities were established to guide the project selection process. The IRWMP is a living document and will be updated as needed. Projects can continuously be submitted as they are identified by stakeholders.

Objectives and Priorities

Six objectives and six long-term priorities were developed through the stakeholder process to guide project selection based on stakeholder input and previously completed documents, including UWMPs, MWD's IRP, Common Ground (San Gabriel & Los Angeles Rivers and Mountains Conservancy Plan), Santa Monica Bay Restoration Plan, and watershed plans for the major tributaries in the region.

The objectives of the IRWMP are to:

- Optimize local water resources to reduce the Region's reliance on imported water.
- Comply with water quality regulations (including TMDLs) by improving the quality of urban runoff, runoff, stormwater, and wastewater.
- Protect and improve groundwater and drinking water quality.
- Protect, restore, and enhance natural processes and habitats.
- Increase watershed friendly recreational space for all communities.
- Maintain and enhance public infrastructure related to flood protection, water resources, and water quality.
- Long term regional priorities are to:
- Maintain a regional and sub-regional structure to oversee plan implementation and ensure continued stakeholder input.
- Optimize use of recycled water, groundwater, desalination, and stormwater to enhance water supply reliability.
- Reduce demand on imported water sources.
- Protect groundwater supplies.

- Improve surface water quality to meet applicable water quality regulations, including TMDLs.

- Preserve open space, conserve and restore functional habitats, and protect special-status species.

Targets

Targets for the region were developed to assist in prioritizing projects. Targets include:

- Increase water supply reliability by providing 800,000 AFY of additional water supply and demand reduction through conservation, including infiltration or reuse of 130,000 AFY of reclaimed water.

- Reduce and reuse 150,000 AFY (40%) of dry weather urban runoff and capture and treat an additional 170,000 AFY (50%) for a total target of 90 percent.

- Reduce and reuse 220,000 AFY (40%) of stormwater runoff from developed areas and capture and treat an additional 270,000 AFY (50%) for a total of 90 percent.

- Treat 91,000 AFY of contaminated groundwater.

- Restore 100+ linear miles of functional riparian habitat and associated buffer habitat.

- Restore 1,400 acres of functional wetland habitat.

- Develop 30,000 acres of recreational open space focused in under-served communities.

- Repair/replace 40 percent of aging water resources infrastructure.

Projects

Fourteen priority projects were developed for the Greater Los Angeles County region. As a regional plan encompassing an area larger than LADWP's service area, many of the IRWMP projects do not directly benefit LADWP's service area, but rather provide benefits towards improving water resources in the region as a whole. However, LADWP can utilize the results of these projects and apply the knowledge to potentially develop similar programs within the service area. Brief descriptions of the priority projects are provided below.

Southeast Water Reliability Project

The Southeast Water Reliability Project consists of an 11.4 mile recycled water transmission pipeline from the City of Pico Rivera to the City of Vernon to complete Central Basin Municipal Water District's recycled water transmission system. Recycled water will be mainly provided by the County Sanitation Districts of Los Angeles County via the San Jose Creek Water Reclamation Plant.

Joint Water Pollution Control Plant Marshland Enhancement

The Joint Water Pollution Control Plant Marshland Enhancement Project is designed to improve and maintain plant and wildlife habitat at the seventeen acre freshwater marshland located at the Joint Water Pollution Control Plant (JWPCP) in Carson. As proposed, the project will serve as a mitigation measure for upgrading the JWPCP to full secondary wastewater treatment. The JWPCP is operated by the County Sanitation Districts of Los Angeles County.

Large Landscape Water Conservation, Runoff Reduction, and Educational Program (Central Basin)

The Large Landscape Water Conservation, Runoff Reduction, and Education Program is an end-use water management program to reduce runoff and address water/energy management associated with large landscapes, residential land uses, and street medians within the Central Basin Municipal Water District's service area. Weather-based irrigation controllers coupled with Geographic Information Systems (GIS) to monitor runoff and two-way communication technologies will provide necessary information to address emergency, drought, and end-use management challenges.

Large Landscape Water Conservation, Runoff Reduction, and Educational Program (West Basin)

West Basin Municipal Water District's (WBMWD) Large Landscape Water Conservation, Runoff Reduction, and Educational Program is a four-component project. The first component targets large landscape sites of 1 acre or more by providing centralized weather-based irrigation controllers with the goal of conserving 1 AFY per acre of land. The second component provides 1,350 rebates for the purchase of smart irrigation controllers for the top residential water users. A third component consists of developing and offering classes on residential landscaping for residences and businesses. The last component involves installing ten "Ocean Friendly" demonstration gardens throughout watersheds in the service area.

Las Virgenes Creek Restoration Project

The City of Calabasas is initiating the Las Virgenes Creek Restoration Project to restore 450 linear feet of a concrete-lined section of the creek to a natural function. Native vegetation will be planted in place of the concrete liner to establish connectivity between riparian habitat north and south of the existing liner.

Malibu Creek Watershed Urban Water Conservation and Runoff Reduction Project

As proposed, the Malibu Creek Watershed Urban Water Conservation and Runoff Reduction Project seeks to conserve water and reduce runoff in the City of Westlake Village and within the Las Virgenes Municipal Water District's (LVMWD) service area. Irrigation controllers on city-owned land in Westlake Village will be replaced with weather-based irrigation controllers. Within the LVWMD service area, indoor conservation will be addressed by continuing rebates for residential and multi-family customers to install water saving devices. This project will also continue existing efforts to reduce urban runoff and outdoor conservation in the LVMWD service area by targeting customers with persistent and substantial irrigation runoff in the vicinity of storm drains. These customers are offered water-efficient equipment rebates and free on-site assistance to upgrade irrigation systems to eliminate runoff.

Morris Dam Water Supply Enhancement Project

The Morris Dam Water Supply Enhancement Project would allow the capture of additional local runoff (5,720 AF) for groundwater recharge and extraction in the San Gabriel River watershed. This project would reduce the minimum pool required by the Los Angeles County Flood Control District (LACFCD) to prevent sediment damage to the outlet works of the dam by modifying the dam valves and control systems.

Pacoima Wash Greenway Project

The Pacoima Wash Greenway will treat storm runoff from neighborhoods adjacent to the wash in a series of parks incorporating stormwater treatment BMPs along the wash. Project development will be a joint effort between the City of San Fernando and the Mountains Recreation and Conservation Authority.

San Gabriel Valley Riparian Habitat Arundo Removal Project

Arundo donax, a non-native plant classified federally and by California as noxious weed, will be removed from approximately 30 acres of riparian habitat in the San Gabriel Watershed. Removal will increase surface water flows to the Rio Hondo percolation basins and improve native habitat.

Solstice Creek Restoration Project

The Solstice Creek Restoration Project will restore side drainages of Solstice Creek and areas negatively impacting riparian habitat through sediment and invasive species introduction. This project is part of an overall larger project to restore Solstice Creek.

South Los Angeles Wetlands Park

The South Los Angeles Wetlands Park project will involve purchasing a 9 acre parcel in Los Angeles on Avalon Boulevard for conversion to a wetlands park. As proposed, the wetlands park will treat urban runoff from a 520 acre area through installation of a series of BMPs. Park vegetation will consist of plants not requiring supplemental irrigation.

Whittier Narrows Water Reclamation Plant Ultraviolet (UV) Disinfection

The Whittier Narrows Water Reclamation Plant UV Disinfection project will convert current disinfection processes at the 15 mgd plant to a UV disinfection process. Currently, tertiary-treated water is disinfected to Title 22 recycled water standards using chloramination resulting in the production of NDMA byproducts.

Wilmington Drain Restoration Multiuse

As proposed, the Wilmington Drain Restoration Multiuse Project involves restoration of the Wilmington Drain. Restoration will involve creation of a public park, improved public access, native revegetation, stormwater treatment, and educational signage. The drain is within the City on an easement held by the LACFCD.

North Atwater Creek Restoration

As a component of the overall Los Angeles River Revitalization Plan, the North Atwater Creek Restoration Project will restore North Atwater Creek at North Atwater Park by providing stormwater runoff capture and treatment and the provision of habitat linkage to the Los Angeles River. Additionally, the project will provide an educational component and includes BMP implementation at adjacent horse stables and riding trails.

10.2.4 Implications of IRWMP for LADWP's Urban Water Management Plan

LADWP is a member of the IRWMP Leadership Committee and additionally serves as the chair of the of the Upper Los Angeles River Watersheds sub-region for the IRWMP region. As member of the Leadership Committee, LADWP is a signatory to the MOU for the IRWMP approved by the Board of Water and Power Commissioners on July 15, 2008.

Participating agencies in the IRWMP coordinate and share information concerning water resources management planning programs and projects, share grant funding information, and improve and maintain overall communication among the participants. Coordination and information sharing assists LADWP and other agencies in achieving their respective missions and contribute to overall IRWMP goals.

10.3 MWD's 2010 Integrated Resources Plan

Approved by the Board on October 12, 2010, the updated IRP is MWD's strategic plan for water reliability through the year 2035. The plan was developed through a collaborative process which incorporated input from water districts, local governments, stakeholder groups and the public. The earliest version of the IRP, which dates back to 1996, sets a regional reliability goal of meeting "full-service demands at the retail level under all foreseeable hydrologic conditions." The 2010 IRP maintains this reliability goal by seeking to stabilize MWD's traditional imported water supplies and establish water reserves to withstand California's inevitable dry cycles and growth in water demand.

The 2010 IRP update has three main objectives: (1) develop an Emergency Response Plan for hydrologic, regulatory, and other types of uncertainties in the Bay-Delta; (2) identify energy-efficient and cost-effective energy management initiatives; and (3) evaluate the reliability of the IRP Preferred Resource Mix through 2035, adjust targets as needed to reflect changed conditions, and extend resource targets through 2035.

The 2010 IRP manages regional resource needs utilizing three baseline components. It begins with baseline efforts – or core resource strategies – designed to maintain reliable water supplies. Its second component – the uncertainty buffer – activates buffer actions to mitigate short-term changes. If changed conditions become more pronounced, there is a final component – foundational actions – which are strategies for securing additional water resources.

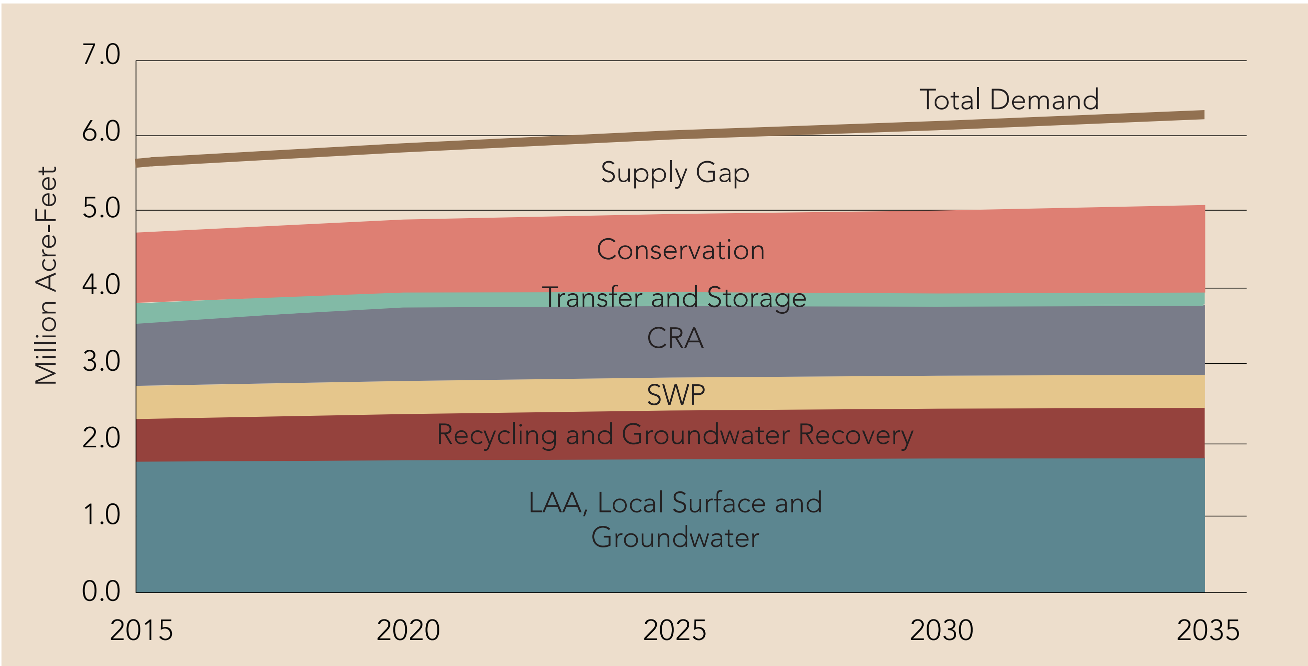
Additionally, the 2010 IRP takes additional steps to promote water use efficiency to further ensure reliability. It spells out a strategy to buffer the region from

Exhibit 10A
MWD's IRP Resource Targets

IRP Resource Targets	2004 IRP Update 2025	2010 IRP Update 2025	Change	2010 IRP Update 2035
Conservation	1,107,000	1,412,000	305,000	1,538,000
Local Projects*	750,000	905,000	155,000	928,000
Colorado River Aqueduct **	1,250,000	1,250,000	0	1,250,000
State Water Project	650,000	713,000	63,000	713,000
Groundwater Conjunctive Use	300,000	300,000	0	300,000
Central Valley/ State Water Project Storage and Transfers	550,000	1,070,000	520,000	1,092,000
MWD Surface Water Storage***	620,000	620,000	0	620,000

* Includes recycled water, brackish groundwater desalination, and seawater desalination
** Target for specific year types, the CRA is not intended to be full at all times
*** Represents the total amount that can be withdrawn from surface reservoirs
Source: MWD (2010)

Exhibit 10B
Meeting Regional Water Needs Through MWD's IRP



future changing circumstances through accelerated conservation and local supply development. And it advances long-term planning for potential future contingency resources, such as stormwater capture, large-scale seawater desalination, and local resource development through an adaptive management approach which will allow MWD, for the first time, to make direct equity investments and/or enter into partnerships for the development of local supply projects.

A summary of the 2004 IRP update and 2010 update targets are shown in Exhibit 10A.

Exhibit 10B shows regional water demands without conservation from 2015 to 2035 under dry weather. The graph also depicts the supply sources and water conservation identified in MWD's 2010 IRP update.

Exhibit 10B shows regional water demands without conservation from 2015 to 2035 under dry weather. The graph also depicts the supply sources and water conservation identified in MWD's 2010 IRP Update.

10.3.1 Stakeholder Participation

Like the preparation of previous IRPs, the crafting of the 2010 IRP was a collaborative effort. MWD sought input from its 26 public member agencies, retail water agencies, the public and other stakeholders including water and wastewater managers, environmental interests, and the business community. In preparation of MWD's IRP, all member agencies were closely involved, including LADWP. Additionally, LADWP was an active member of the technical workgroup.

To provide more direct involvement by MWD's Board in the 2010 IRP preparation, the IRP Steering Committee was created. This committee met on a regular basis to be briefed by MWD staff, review proposed resource strategies and provide recommended policy options. A Strategic Policy Review was conducted through a series of board workshops and managed public forums to help Metropolitan evaluate its future role for the region.

The managed public forums were regional assemblies held at critical milestones during the IRP development that provided a platform to collectively discuss strategic direction and regional water solutions. Participants in these assemblies included elected officials, board members, water agency managers, local retail water providers, groundwater basin managers, and public stakeholders from the business community, environmental groups, agricultural interests, and the general public.

10.3.2 Funding MWD's IRP

In accordance with the MWD Board's adoption of the IRP update, a revised Long-Range Finance Plan (LRP) was also developed and approved by the MWD Board. The LRP (2010) identifies MWD's planned capital improvement program (CIP) and operating expenses from 2015 to 2035.

The following summarizes MWD's CIP and operating expenses needed to implement the IRP:

- **Core Resources** (Fixed costs to maintain Bay-Delta habitat conservation and conveyance program, LRP contracts, CRA programs, and conservations funding) – costs for water supply will increase from the current $853/AF in 2015 to $1,484/AF in 2035.
- **Water Use Efficiency** – costs for water supply will increase from the current $892/AF in 2015 to $1,608/AF in 2035.
- **Capital Expenditures** – costs for water supply will increase from $919/AF in 2015 to $1,844/AF in 2035.
- **Demand Management & Local Projects** – costs from water supply will increase from $953/AF to $2,021/AF in 2035.

10.3.3 IRP Implications for City's Urban Water Management Plan

As LADWP evaluates its water supply options, it is important to understand the significance of a reliable and cost-effective water supply from MWD. The City's water supply reliability is directly linked to MWD's reliability, and LADWP's local supply development uses the cost of MWD water as one of the benchmarks for feasibility evaluation. Through its 2010 IRP update, MWD has shown that it will be able to meet the supplemental needs of all its member agencies reliably through 2035, even during prolonged drought events. MWD has also developed a plan to implement and finance the approved IRP targets.

Chapter Eleven
Water Supply Reliability and Financial Integrity

11.0 Overview

Providing a reliable water supply in a semiarid climate with high variability in weather is challenging. And because LADWP currently imports a substantial portion of its surface water from the Los Angeles Aqueduct (LAA) and Metropolitan Water District of Southern California (MWD), it is even more challenging. Imported surface supplies are highly variable due to climate and hydrology, and they are also subject to environmental restrictions. To diversify its water supply portfolio, LADWP has made and will continue to make significant investments in groundwater, recycled water, stormwater capture and water conservation. These local water supplies tend to be more reliable than imported water because they have less variability due to climate, weather, and environmental restrictions. And by investing in these local supplies, the City's urban environment is protected and enhanced.

11.1 Unit Cost and Funding of Supplies

11.1.1 Unit Cost Summary of Supplies

Unit costs play an important role in planning future water supply development and determining where supply investments provide the greatest benefits to LADWP. Unit costs of production vary dramatically by water supply source. Exhibit 11A summarizes the unit cost for each water supply source.

Among LA's existing and planned water supplies, costs per acre-foot ranged from a high of $1,500 for certain recycled water projects to a low of $215 for locally produced groundwater. LAA supply requires operation and maintenance costs regardless of water availability. Therefore, hydrology and increased water for environmental commitments in the Eastern Sierras result in LAA unit cost fluctuations from year to year. Local groundwater supply is the least expensive source. However, its production is limited by contamination. Unit costs for MWD purchased water vary based on tier allocations. MWD's water rates vary from $527 per AF of Tier 1 untreated water to $869 per AF of Tier 2 treated water in 2011. LADWP has a Tier 1 allocation of 304,970 AF. Any purchases above this amount will be at the Tier 2 rates. Conservation is relatively inexpensive and offsets water supplies that may otherwise be required to meet demand. Conservation unit costs are based on costs of conservation rebate and incentive programs and their potential water use reduction. Recycled water costs are project specific and vary widely depending on the infrastructure requirements of each project. Water transfers using a future connection between the LAA and the California Aqueduct are planned. Water transfer costs will include the purchase price of water and conveyance fees.

Unit costs for potential water supplies such as stormwater reuse and increased groundwater production from stormwater recharge are highly variable based on a variety of factors including the size of the overall program, project locations, etc. Centralized stormwater capture unit costs are based on LADWP's current planned centralized stormwater capture projects, and distributed stormwater capture unit costs are based on various sources as referenced in Chapter 7, Watershed Management. Stormwater projects are joint efforts among agencies, City departments, stakeholders and community groups and yield additional benefits beyond water supply.

Seawater desalination unit costs are based on estimates from MWD's 2010 IRP. Seawater desalination was a planned supply identified in the 2005 UWMP but is excluded from this 2010 UWMP. Its impacts to marine habitats and high energy consumption make seawater desalination less desirable compared to options such as recycled water, conservation, and stormwater capture.

Exhibit 11A Unit Costs of Supplies

Water Source	Chapter Reference	Average Unit Cost ($/AF)
Los Angeles Aqueduct[1]	**Chapter 5 - Los Angeles Aqueduct System**	$563
Groundwater[1]	**Chapter 6 - Local Groundwater**	$215
Metropolitan Water District[2]	**Chapter 8 - Metropolitan Water District Supplies**	$527 - $869
Conservation	**Chapter 3 - Conservation**	$75 - $900
Recycled Water	**Chapter 4 - Recycled Water**	$600 - $1,500
Water Transfer	**Chapter 9 - Other Potential Supplies**	$440 - $540
Stormwater Capture	**Chapter 7 - Watershed Management**	
- Centralized Stormwater Capture		$60 - $300
- Distributed Stormwater Capture		
Urban Runoff Plants		$4,044
Rain Barrels		$278 - $2,778
Cisterns		$2,426
Rain Gardens		$149 - $1,781
Neighborhood Recharge		$3,351
Seawater Desalination	**Chapter 9 - Other Potential Supplies**	**$1,300 - $2,000**

[1] Los Angeles Aqueduct supply and groundwater supply are based on FY2005/06 to FY2009/10 five-year average.
[2] MWD Water Rates effective on January 1, 2011.

11.1.2 Funding of Supplies

Funding for water resource programs and projects are primarily provided through LADWP water rates, with supplemental funding provided by the MWD, and state and federal grants. Funding for water conservation, water recycling, and stormwater capture projects has increased significantly in recent years. Currently, approximately $100 million is collected annually through water rates for the LADWP's water resource programs. The current level of annual expenditures is believed to be sufficient to achieve projected goals for conservation, water recycling, and stormwater capture. However, achieving the goals for contaminated groundwater treatment in the San Fernando Basin will require water rate increases. LADWP will also seek reimbursement from potential responsible parties to assist with groundwater treatment program costs.

The timeframe for achieving water resource goals as outlined in the 2008 document Securing L.A.'s Water Supply was based on the assumption that there would be additional increases in water rates to achieve the stated goals. With the exception of groundwater treatment, the 2010 UWMP assumes existing amounts of revenue.

Water Resource Project Funding

- Water Rates – An existing component of water rates currently provides approximately $100 million annually for water conservation, water recycling, and stormwater capture programs.

- MWD – Currently provides funding up to $250 per AF for water recycling through their Local Resources Program. MWD also provides some water conservation incentive funding through rebates equal to $195 per AF of water saved or half the product cost whichever is less.

- State Funds – Funds for recycling, conservation, and stormwater capture have been available on a competitive basis though voter approved initiatives, such as Propositions 50 and 84. The proposed 2012 Water Bond also includes potential funding for groundwater cleanup. Occasionally low or zero-interest loans are also available though State Revolving Fund programs.

- Federal Funds – Federal funding for recycling is available through the U.S. Army Corps of Engineers, via periodic Water Resource Development Act legislation, and the U.S. Bureau of Reclaimation's Title XVI program.

- Potentially Responsible Parties – LADWP may be able to recover some costs for groundwater cleanup from potentially responsible parties.

Receipt of state or federal funding will allow water resource goals to be achieved sooner than projected, or allow for increased local supply development.

11.2 Reliability Assessment Under Different Hydrologic Conditions

11.2.1 Los Angeles Aqueducts

Water supply from the LAA can vary substantially from year to year due to hydrology. In very wet years, LAA supply can exceed 500,000 AFY. During average year weather conditions (50-year average hydrology from Fiscal Year 1956/57 to 2005/06) LAA supply is projected to gradually decrease from 254,000 AFY to 244,000 AFY by 2035 due to climate change impact. Critical dry year (defined as a repeat of a 1990/91 drought) supplies can be as low as 48,520 AFY.

In the last decade environmental considerations have required the City to reallocate approximately one-half of the LAA water supply to environmental mitigation and enhancement projects. Reducing water deliveries to the City from the LAA has resulted in less water independence, and therefore, increased dependence on imported water supply from MWD.

11.2.2 Groundwater

Groundwater is also affected by local hydrology. However, with conjunctive use management of groundwater—storing imported water in the groundwater basins during wet and average years - groundwater production can actually be increased during dry years. During average weather conditions, LADWP projects it will pump approximately between 40,500 AFY and 111,500 AFY of groundwater during the projection period to Fiscal Year (FY) 2034/35. These projections are based on LADWP's planned Groundwater Treatment Facilities being operational in FY 2020/21 and groundwater storage credits of 5,000 AFY being used to maximize production thereafter. Although in dry years LADWP can pump larger quantities of groundwater, a more conservative approach was adopted by assuming the same level of projected groundwater production for both single dry year and multi-dry year analysis.

Groundwater is vulnerable to contamination. The clean-up of the contamination in San Fernando Basin will facilitate the plan of storing additional recycled water and stormwater for future extraction and is critical to ensuring the reliability of the City's groundwater supplies. The Groundwater Treatment Facilities will address this issue and restore LADWP's ability to fully utilize its local groundwater entitlements and will facilitate additional storage and extraction programs.

11.2.3 Conservation

LADWP has developed conservation goals to decrease water use in the City and to comply with the new State 20 percent by 2020 requirements. Multiple actions will be taken to increase water conservation including public education, targeting the CII sector, reducing outdoor water use, and continuing participation in MWD's rebate programs. LADWP is planning to increase water conservation levels by over 60,000 AFY between 2010 and 2035, assuming average weather conditions.

Conservation can be seen as both a demand control measure and/or a source of supply. Of the local supplies being pursued, additional planned conservation is the biggest contributor toward reducing MWD purchases and increasing local supply reliability through 2035 and is therefore a crucial supply asset for LADWP.

11.2.4 Recycled Water

Recycled water is based on wastewater effluent flows, which do not vary significantly due to hydrology. Therefore, recycled water use is mainly limited by system capacities and demands. These facts make recycled water a more reliable supply than imported water. As outlined in Chapter 4 on Recycled Water, LADWP is planning extensive expansion of its recycled water system not only to include expansion of irrigation and industrial uses, but also to include groundwater replenishment. Under average weather conditions, recycled water supply for irrigation and industrial purposes is projected to increase from 20,000 AFY in 2015 to 29,000 AFY in 2035. Groundwater replenishment with recycled water is projected to be 30,000 AFY in 2035. For a critical dry year available recycled water supplies would not change.

11.2.5 Water Transfers

Water transfers are being developed to replace a portion of the City's Los Angeles Aqueduct water that has been dedicated for environmental enhancement uses in the Eastern Sierra Nevada. Water acquired through transfers helps increase water supply reliability for the City. The Los Angeles Aqueduct and California Aqueduct interconnection is under construction and estimated to be completed after May 2013. LADWP is expected to enter into agreements to obtain 40,000 AF per year under average weather conditions beginning in FY 2014/15 and continuing through 2035.

11.2.6 MWD Imported Supplies

LADWP has historically purchased MWD water to make up the deficit between in-City demand and local supplies. The City relies on MWD water to a greater extent in dry years and has been increasing its dependence in recent years as LAA supplies have been reduced due to increased environmental mitigation and enhancement demands.

Historically, water from MWD (like supplies from the LAA) has been subject to severe variability due to water shortages (i.e., 1976/77, 1987-1992, and 2007-2010). This is a result of MWD's core sources of water supply being the Colorado River and SWP, both of which are highly affected by hydrology. More recently, restrictions to protect threatened fish species have further decreased pumping from the Bay-Delta, and limited SWP supplies available to MWD. After the 1987-1992 water shortage, MWD started to diversify its water supply portfolio. Partnering with its member agencies, MWD launched its first Integrated Resource Plan (IRP) in 1993 and most recently updated it in 2010. As a result of the resource targets in the IRP, MWD implemented a variety of projects and programs designed to reduce its dependency on imported water during water shortages and environmental triggering of SWP pumping restrictions. Efforts have included: (1) providing financial incentives for local projects and conservation; (2) increasing surface storage via Diamond Valley Lake, Lake Mead, and the use of SWP terminal reservoirs; (3) groundwater storage programs in the Central Valley, Imperial Valley, and Coachella Valley; (4) short- and long-term water transfers; and (5) contracted groundwater storage programs with participating member agencies.

In the 2010 IRP Update, MWD developed a three-part adaptive resource strategy that includes: (1) meeting demands by building on existing core resources to provide reliability under foreseen conditions; (2) implementing a supply buffer of 10 percent of retail demand through multiple actions to adapt to short-term uncertainty; and (3) implementing adaptive management through low-regret foundation actions, monitoring key vulnerabilities and bringing adaptive resources online, if required, and (4) using a comprehensive approach to meet specific needs and degrees of shortages. The 2010 IRP adaptive management concept seeks to mitigate against supply uncertainty to further increase reliability.

MWD's 2010 IRP Update concluded that the resource targets identified in previous IRP updates, taking into consideration changed conditions identified since that time, will continue to provide for 100 percent reliability through 2035 for all its member agencies. MWD's 2010 Regional Urban Water Management Plan also concluded the same full reliability through 2035 during average (1922 – 2004 hydrology), single dry (1977 hydrology), and multiple dry years (1990 - 1992 hydrology). For each of these scenarios there is a projected surplus of supply in every forecast year (see Exhibit 11B). The projected surpluses are based on the capability of current supplies and range from 1 percent to 106 percent. When

Exhibit 11B
MWD Supply Capability and Projected Demands (in AFY)

Single Dry-Year MWD Supply Capability and Projected Demands					
Fiscal Year	2015	2020	2025	2030	2035
Capability of Current Supplies	2,457,000	2,782,000	2,977,000	2,823,000	2,690,000
Projected Demands	2,171,000	2,162,000	2,201,000	2,254,000	2,319,000
Projected Surplus	286,000	620,000	776,000	569,000	371,000
Projected Surplus % (Proj. Surplus/Proj. Demands)	13%	29%	35%	25%	16%
Supplies under Development	762,000	862,000	1,036,000	1,036,000	1,036,000
Potential Surplus	1,048,000	1,482,000	1,812,000	1,605,000	1,407,000
Potential Surplus % (Potential Surplus/ Proj. Demands)	48%	69%	82%	71%	61%
Multiple Dry-Year MWD Supply Capability and Projected Demands					
Fiscal Year	2015	2020	2025	2030	2035
Capability of Current Supplies	2,248,000	2,417,000	2,520,000	2,459,000	2,415,000
Projected Demands	2,236,000	2,188,000	2,283,000	2,339,000	2,399,000
Projected Surplus	12,000	229,000	237,000	120,000	16,000
Projected Surplus % (Proj. Surplus/Proj. Demands)	1%	10%	10%	5%	1%
Supplies under Development	404,000	553,000	733,000	755,000	755,000
Potential Surplus	416,000	782,000	970,000	875,000	771,000
Potential Surplus % (Potential Surplus/ Proj. Demands)	19%	36%	42%	37%	32%
Average Year MWD Supply Capability and Projected Demands					
Fiscal Year	2015	2020	2025	2030	2035
Capability of Current Supplies	3,485,000	3,810,000	4,089,000	3,947,000	3,814,000
Projected Demands	2,006,000	1,933,000	1,985,000	2,049,000	2,106,000
Projected Surplus	1,479,000	1,877,000	2,104,000	1,898,000	1,708,000
Projected Surplus % (Proj. Surplus/Proj. Demands)	74%	97%	106%	93%	81%
Supplies under Development	588,000	689,000	1,051,000	1,051,000	1,051,000
Potential Surplus	2,067,000	2,566,000	3,155,000	2,949,000	2,759,000
Potential Surplus % (Potential Surplus/ Proj. Demands)	103%	133%	159%	144%	131%

Source: MWD 2010 Regional Urban Water Management Plan Tables 2-9 to 2-11.

including supplies under development, the potential surplus increases to between 19 percent and 159 percent of projected demand.

As part of the implementation of MWD's IRP, MWD and its member agencies worked together to develop MWD's Water Surplus and Drought Management Plan (WSDM Plan) in 1999. The WSDM Plan established broad water resource management strategies to ensure MWD's ability to meet full service demands at all times and provides principles for supply allocation if the need should ever arise. The WSDM Plan splits MWD's resource actions into two major categories: Surplus Actions and Shortage Actions. The Shortage Actions of the WSDM Plan are split into three sub-categories: Shortage, Severe Shortage, and Extreme Shortage. Under Shortage conditions, MWD will make withdrawals from storage and interrupt long-term groundwater basin replenishment deliveries. Under Severe Shortage conditions, MWD will call for extraordinary drought conservation in the form of voluntary savings from retail customers, interrupt 30 percent of deliveries to Agricultural Water Program users, call on its option transfer water, and purchase water on the spot market. The overall objective of MWD's IRP and WSDM Plan is to ensure that shortage allocations of MWD water supplies are not required.

Under Extreme Shortage conditions, MWD allocates supplies to its member agencies in accordance with its Water Supply Allocation Plan (WSAP). If shortage allocations are required, MWD will rely on the calculations established in its WSAP adopted in 2008. The plan equitably allocates shortages among its member agencies based on need with adjustments for growth, local investments, changes in supply conditions, demand hardening, and water conservation programs.

11.2.7 Potential Supplies

Other planned and potential water supplies that LADWP is exploring include capturing stormwater for reuse and infiltration leading to increased groundwater production (see Chapter 7). The beneficial reuse of stormwater presents significant opportunity and the development of these supplies will offset the need to import additional supplemental supplies from MWD. The City must also reduce pollutants in impaired receiving waters (rivers, creeks, and beaches in the Santa Monica and Los Angeles watersheds) as required by the Clean Water Act. By managing urban runoff during dry and wet periods, this pollution will be reduced.

Traditional ways of managing urban runoff would be to divert the runoff into existing wastewater treatment plants and/or build satellite treatment plants specifically designed to treat urban runoff. During the City's IRP process, stakeholders expressed the desire to examine other ways to manage runoff that would reduce pollution and provide for other benefits such as water supply and open space. These methods involve local and regional storage of wet weather runoff for groundwater infiltration, on-site storage and recovery of wet weather runoff for irrigation using cisterns and other devices, and reuse of treated dry weather effluent for irrigation (much like recycled water). As an outgrowth of the City's IRP, neighborhood recharge concept efforts are moving from the conceptual stage visualized in the IRP to actual projects in the City to infiltrate wet weather runoff as close as possible to the point of origin with multiple projects either complete, under construction, or in final design.

Under average weather conditions LADWP is projecting stormwater capture and reuse in 2015 could reach 2,000 AFY and increase to 10,000 AFY by 2035. Additionally, increased groundwater production from stormwater infiltration will potentially be 15,000 AFY in 2035. This increased groundwater production potential is contingent on modifying the court judgment which governs extractions from the San Fernando Groundwater Basin. If these resources reach fruition, LADWP will be able to reduce imported supplies purchased from MWD by 25,000 AFY in 2035 under average weather conditions.

11.2.8 Service Area Reliability Assessment

To determine the overall service area reliability, LADWP defined three hydrologic conditions: average year (50-year average hydrology from FY 1956/57 to 2005/06); single dry year (such as a repeat of the FY 1990/91 drought); and multi-dry year period (such as a repeat of FY1988/89 to FY1992/93). The average

Exhibit 11C
LADWP Supply Reliability FYE 2006-2010 Average

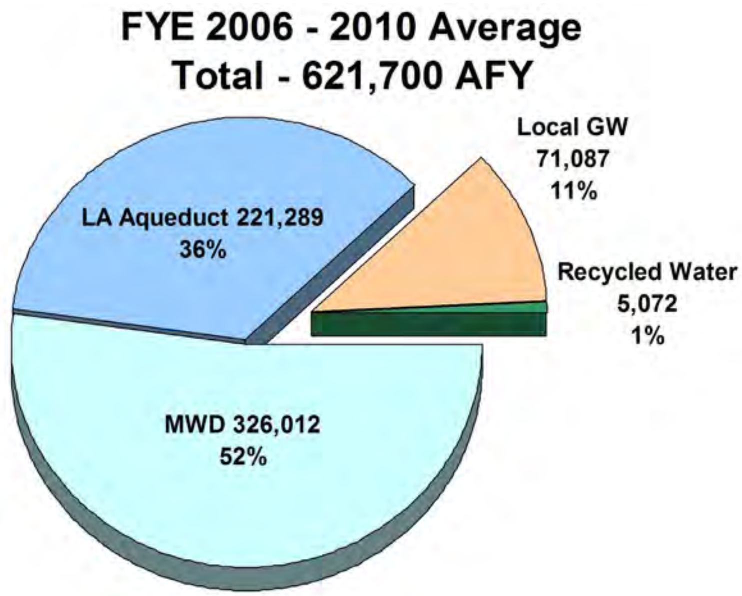
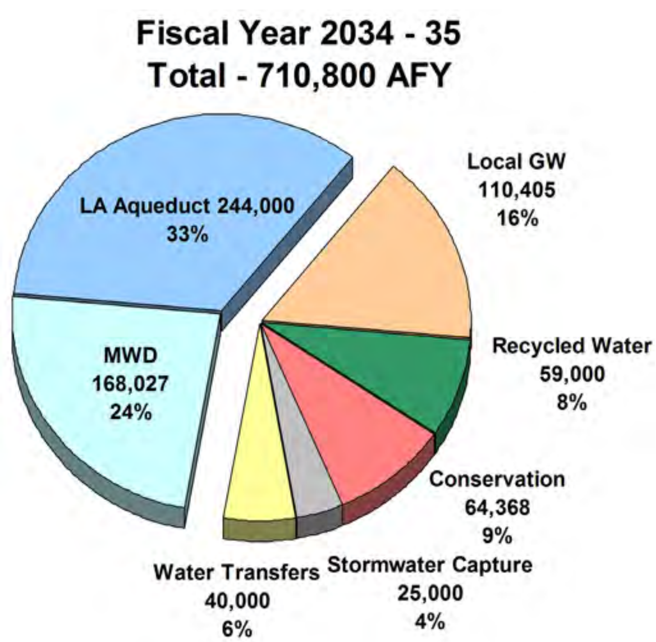


Exhibit 11D
LADWP Supply Reliability Under Average Weather Conditions in Fiscal Year 2034-35



Note: Charts do not reflect approximately 100,000 AF of existing conservation

year demand is based on the forecasted median demand as shown in Exhibit 2J. Weather patterns and water demands were further studied to determine single dry year demand and multi-dry year demands. The single dry year demand is estimated to be 6 percent higher than the forecasted median demand. The multi-dry year demands are increased above the forecasted median demands by the following percentages: 1st year – 4 percent, 2nd year – 5 percent, 3rd year – 6 percent, 4th year – 0 percent, and 5th year – 2 percent.

The water supply reliability summaries are shown in Exhibit 11C for the 5-year average from FY 2005/06 to FY 2009/10 and in Exhibit 11 D for FY 2034/35 under average weather conditions, with new water conservation shown as a supply source. The exhibits show that the City's reliance on MWD supply will decrease from 52 percent to 24 percent by FY 2034/35 while the combined imported supplies of LAA and MWD water will decrease from 88 percent to 57 percent by FY 2034/35. The locally-developed supplies will increase from 12 percent to 43 percent by FY 2034/35.

Exhibits 11E and 11F tabulate the service reliability assessment for normal and single dry year conditions, respectively. Exhibits 11G through 11K show reliability assessments in five year increments from 2010 to 2035 with each five year period assuming that a multiple dry year condition occurs. For these reliability tables, existing water conservation has been already subtracted from projected demands, but new water conservation is included as a supply source. Demands are met by the available supplies under all scenarios.

Exhibit 11E
Service Area Reliability Assessment for Average Weather Year

Demand and Supply Projections (in acre-feet)	FY2009-10 Actual	Average Weather Conditions (FY 1956/57 to 2005/06) Fiscal Year Ending on June 30				
		2015	2020	2025	2030	2035
Total Demand	**555,477**	**614,800**	**652,000**	**675,600**	**701,200**	**710,800**
Existing / Planned Supplies						
Los Angeles Aqueduct[1]	199,739	252,000	250,000	248,000	246,000	244,000
Groundwater[2]	76,982	40,500	96,300	111,500	111,500	110,405
Conservation	8,178	14,180	27,260	40,340	53,419	64,368
Recycled Water						
- Irrigation and Industrial Use	6,703	20,000	20,400	27,000	29,000	29,000
- Groundwater Replenishment	0	0	0	15,000	22,500	30,000
Water Transfers	0	40,000	40,000	40,000	40,000	40,000
Subtotal	291,602	366,680	433,960	481,840	502,419	517,773
MWD Water Purchases With Existing/Planned Supplies	263,875	248,120	218,040	193,760	198,781	193,027
Total Supplies	**555,477**	**614,800**	**652,000**	**675,600**	**701,200**	**710,800**
Potential Supplies						
Stormwater Capture						
- Capture and Reuse (Harvesting)	0	2,000	4,000	6,000	8,000	10,000
- Increased Groundwater Production (Recharge)	0	0	2,000	4,000	8,000	15,000
Subtotal	0	2,000	6,000	10,000	16,000	25,000
MWD Water Purchases With Existing/Planned/Potential Supplies	263,875	246,120	212,040	183,760	182,781	168,027
Total Supplies	**555,477**	**614,800**	**652,000**	**675,600**	**701,200**	**710,800**

[1] Los Angeles Aqueduct supply is estimated to decrease 0.1652% per year due to climate change impacts.
[2] North Hollywood/Rinaldi-Toluca Treatment Complex is expected to be in operation in FY 2019-20. Tujunga Groundwater Treatment Plant is expected to be in operation in 2020-21. Storage credit of 5,000 afy will be used to maximize the pumping in FY 2020-21 and thereafter. Sylmar Basin production was increased to 4,500 AFY from FY 2014-15 to FY 2029-30 to avoid the expiration of stored water credits, then go back to its entitlement of 3,405 AFY in FY 2030-31.

Exhibit 11F
Service Area Reliability Assessment for Single Dry Year

Demand and Supply Projections (in acre-feet)	FY2009-10 Actual	Single Dry Year (FY1990-91) Fiscal Year Ending on June 30				
		2015	2020	2025	2030	2035
Total Demand	**555,477**	**651,700**	**691,100**	**716,100**	**743,200**	**753,400**
Existing / Planned Supplies						
Los Angeles Aqueduct[1]	199,739	48,520	48,120	47,720	47,330	46,940
Groundwater[2]	76,982	40,500	96,300	111,500	111,500	110,405
Conservation	8,178	14,180	27,260	40,340	53,419	64,368
Recycled Water						
- Irrigation and Industrial Use	6,703	20,000	20,400	27,000	29,000	29,000
- Groundwater Replenishment	0	0	0	15,000	22,500	30,000
Water Transfers	0	40,000	40,000	40,000	40,000	40,000
Subtotal	291,602	163,200	232,080	281,560	303,749	320,713
MWD Water Purchases With Existing/Planned Supplies	263,875	488,500	459,020	434,540	439,451	432,687
Total Supplies	**555,477**	**651,700**	**691,100**	**716,100**	**743,200**	**753,400**
Potential Supplies						
Stormwater Capture						
- Capture and Reuse (Harvesting)	0	2,000	4,000	6,000	8,000	10,000
- Increased Groundwater Production (Recharge)	0	0	2,000	4,000	8,000	15,000
Subtotal	0	2,000	6,000	10,000	16,000	25,000
MWD Water Purchases With Existing/Planned/Potential Supplies	263,875	486,500	453,020	424,540	423,451	407,687
Total Supplies	**555,477**	**651,700**	**691,100**	**716,100**	**743,200**	**753,400**

[1] Los Angeles Aqueduct supply is estimated to decrease 0.1652% per year due to climate change impacts.
[2] North Hollywood/Rinaldi-Toluca Treatment Complex is expected to be in operation in FY 2019-20. Tujunga Groundwater Treatment Plant is expected to be in operation in 2020-21. Storage credit of 5,000 afy will be used to maximize the pumping in FY 2020-21 and thereafter. Sylmar Basin production was increased to 4,500 AFY from FY 2014-15 to FY 2029-30 to avoid the expiration of stored water credits, then go back to its entitlement of 3,405 AFY in FY 2030-31.

Exhibit 11G
Service Area Reliability Assessment for Multi-Dry Years (2011-2015)

Demand and Supply Projections (in acre-feet)	FY2009-10 Actual	Multiple Dry Years (FY1988-89 to FY1992-93) Fiscal Year Ending on June 30				
		2011	2012	2013	2014	2015
Total Demand	**555,477**	**590,000**	**608,200**	**626,500**	**602,900**	**627,100**
Existing / Planned Supplies						
Los Angeles Aqueduct[1]	199,739	86,330	98,560	48,520	94,360	105,770
Groundwater[2]	76,982	61,090	53,660	46,260	47,300	40,500
Conservation	8,178	9,380	10,580	11,780	12,980	14,180
Recycled Water						0
- Irrigation and Industrial Use	6,703	7,500	8,300	9,000	15,500	20,000
- Groundwater Replenishment	0	0	0	0	0	0
Water Transfers	0	0	0	0	0	40,000
Subtotal	291,602	164,300	171,100	115,560	170,140	220,450
MWD Water Purchases With Existing/Planned Supplies	263,875	425,700	437,100	510,940	432,760	406,650
Total Supplies	**555,477**	**590,000**	**608,200**	**626,500**	**602,900**	**627,100**
Potential Supplies						
Stormwater Capture						
- Capture and Reuse (Harvesting)	0	0	0	0	0	2,000
- Increased Groundwater Production (Recharge)	0	0	0	0	0	0
Subtotal	0	0	0	0	0	2,000
MWD Water Purchases With Existing/Planned/Potential Supplies	263,875	425,700	437,100	510,940	432,760	404,650
Total Supplies	**555,477**	**590,000**	**608,200**	**626,500**	**602,900**	**627,100**

[1] Los Angeles Aqueduct supply is estimated to decrease 0.1652% per year due to climate change impacts.
[2] North Hollywood/Rinaldi-Toluca Treatment Complex is expected to be in operation in FY 2019-20. Tujunga Groundwater Treatment Plant is expected to be in operation in 2020-21. Storage credit of 5,000 afy will be used to maximize the pumping in FY 2020-21 and thereafter. Sylmar Basin production was increased to 4,500 AFY from FY 2014-15 to FY 2029-30 to avoid the expiration of stored water credits, then go back to its entitlement of 3,405 AFY in FY 2030-31.

Exhibit 11H
Service Area Reliability Assessment for Multi-Dry Years (2016-2020)

Demand and Supply Projections (in acre-feet)	Multiple Dry Years (FY1988-89 to FY1992-93) Fiscal Year Ending on June 30				
	2016	2017	2018	2019	2020
Total Demand	**647,100**	**661,200**	**675,400**	**644,600**	**665,100**
Existing / Planned Supplies					
Los Angeles Aqueduct[1]	86,330	98,560	48,520	94,360	105,770
Groundwater[2]	37,350	37,350	37,350	42,280	96,300
Conservation	16,800	19,410	22,030	24,640	27,260
Recycled Water					0
- Irrigation and Industrial Use	20,000	20,200	20,300	20,400	20,400
- Groundwater Replenishment	0	0	0	0	0
Water Transfers	40,000	40,000	40,000	40,000	40,000
Subtotal	200,480	215,520	168,200	221,680	289,730
MWD Water Purchases With Existing/Planned Supplies	446,620	445,680	507,200	422,920	375,370
Total Supplies	**647,100**	**661,200**	**675,400**	**644,600**	**665,100**
Potential Supplies					
Stormwater Capture					
- Capture and Reuse (Harvesting)	2,400	2,800	3,200	3,600	4,000
- Increased Groundwater Production (Recharge)	400	800	1,200	1,600	2,000
Subtotal	2,800	3,600	4,400	5,200	6,000
MWD Water Purchases With Existing/Planned/Potential Supplies	443,820	442,080	502,800	417,720	369,370
Total Supplies	**647,100**	**661,200**	**675,400**	**644,600**	**665,100**

[1] Los Angeles Aqueduct supply is estimated to decrease 0.1652% per year due to climate change impacts.
[2] North Hollywood/Rinaldi-Toluca Treatment Complex is expected to be in operation in FY 2019-20. Tujunga Groundwater Treatment Plant is expected to be in operation in 2020-21. Storage credit of 5,000 afy will be used to maximize the pumping in FY 2020-21 and thereafter. Sylmar Basin production was increased to 4,500 AFY from FY 2014-15 to FY 2029-30 to avoid the expiration of stored water credits, then go back to its entitlement of 3,405 AFY in FY 2030-31.

Exhibit 11I
Service Area Reliability Assessment for Multi-Dry Years (2021-2025)

Demand and Supply Projections (in acre-feet)	Multiple Dry Years (FY1988-89 to FY1992-93) Fiscal Year Ending on June 30				
	2021	2022	2023	2024	2025
Total Demand	**683,000**	**694,500**	**706,100**	**670,900**	**689,100**
Existing / Planned Supplies					
Los Angeles Aqueduct[1]	86,330	98,560	48,520	94,360	105,770
Groundwater[2]	111,500	111,500	111,500	111,500	111,500
Conservation	29,880	32,490	35,110	37,720	40,340
Recycled Water					0
- Irrigation and Industrial Use	20,400	21,000	23,000	25,000	27,000
- Groundwater Replenishment		15,000	15,000	15,000	15,000
Water Transfers	40,000	40,000	40,000	40,000	40,000
Subtotal	288,110	318,550	273,130	323,580	339,610
MWD Water Purchases With Existing/Planned Supplies	394,890	375,950	432,970	347,320	349,490
Total Supplies	**683,000**	**694,500**	**706,100**	**670,900**	**689,100**
Potential Supplies					
Stormwater Capture					
- Capture and Reuse (Harvesting)	4,400	4,800	5,200	5,600	6,000
- Increased Groundwater Production (Recharge)	2,400	2,800	3,200	3,600	4,000
Subtotal	6,800	7,600	8,400	9,200	10,000
MWD Water Purchases With Existing/Planned/Potential Supplies	388,090	368,350	424,570	338,120	339,490
Total Supplies	**683,000**	**694,500**	**706,100**	**670,900**	**689,100**

[1] Los Angeles Aqueduct supply is estimated to decrease 0.1652% per year due to climate change impacts.
[2] North Hollywood/Rinaldi-Toluca Treatment Complex is expected to be in operation in FY 2019-20. Tujunga Groundwater Treatment Plant is expected to be in operation in 2020-21. Storage credit of 5,000 afy will be used to maximize the pumping in FY 2020-21 and thereafter. Sylmar Basin production was increased to 4,500 AFY from FY 2014-15 to FY 2029-30 to avoid the expiration of stored water credits, then go back to its entitlement of 3,405 AFY in FY 2030-31.

Exhibit 11J
Service Area Reliability Assessment for Multi-Dry Years (2026-2030)

Demand and Supply Projections (in acre-feet)	**Multiple Dry Years (FY1988-89 to FY1992-93) Fiscal Year Ending on June 30**				
	2026	2027	2028	2029	2030
Total Demand	**707,900**	**720,100**	**732,400**	**696,100**	**715,200**
Existing / Planned Supplies					
Los Angeles Aqueduct[1]	86,330	98,560	48,520	94,360	105,770
Groundwater[2]	111,500	111,500	111,500	111,500	111,500
Conservation	42,960	45,570	48,190	50,800	53,420
Recycled Water					0
- Irrigation and Industrial Use	27,500	28,000	28,500	29,000	29,000
- Groundwater Replenishment	16,500	18,000	19,500	21,000	22,500
Water Transfers	40,000	40,000	40,000	40,000	40,000
Subtotal	324,790	341,630	296,210	346,660	362,190
MWD Water Purchases With Existing/Planned Supplies	383,110	378,470	436,190	349,440	353,010
Total Supplies	**707,900**	**720,100**	**732,400**	**696,100**	**715,200**
Potential Supplies					
Stormwater Capture					
- Capture and Reuse (Harvesting)	6,400	6,800	7,200	7,600	8,000
- Increased Groundwater Production (Recharge)	4,800	5,600	6,400	7,200	8,000
Subtotal	11,200	12,400	13,600	14,800	16,000
MWD Water Purchases With Existing/Planned/Potential Supplies	371,910	366,070	422,590	334,640	337,010
Total Supplies	**707,900**	**720,100**	**732,400**	**696,100**	**715,200**

[1] Los Angeles Aqueduct supply is estimated to decrease 0.1652% per year due to climate change impacts.
[2] North Hollywood/Rinaldi-Toluca Treatment Complex is expected to be in operation in FY 2019-20. Tujunga Groundwater Treatment Plant is expected to be in operation in 2020-21. Storage credit of 5,000 afy will be used to maximize the pumping in FY 2020-21 and thereafter. Sylmar Basin production was increased to 4,500 AFY from FY 2014-15 to FY 2029-30 to avoid the expiration of stored water credits, then go back to its entitlement of 3,405 AFY in FY 2030-31.

Exhibit 11K
Service Area Reliability Assessment for Multi-Dry Years (2031-2035)

Demand and Supply Projections (in acre-feet)	Multiple Dry Years (FY1988-89 to FY1992-93) Fiscal Year Ending on June 30				
	2031	2032	2033	2034	2035
Total Demand	**731,200**	**740,300**	**749,300**	**708,800**	**725,000**
Existing / Planned Supplies					
Los Angeles Aqueduct[1]	86,330	98,560	48,520	94,360	105,770
Groundwater[2]	110,405	110,405	110,405	110,405	110,405
Conservation	55,600	57,800	60,000	62,200	64,368
Recycled Water					0
- Irrigation and Industrial Use	29,000	29,000	29,000	29,000	29,000
- Groundwater Replenishment	24,000	25,500	27,000	28,500	30,000
Water Transfers	40,000	40,000	40,000	40,000	40,000
Subtotal	345,335	361,265	314,925	364,465	379,543
MWD Water Purchases With Existing/Planned Supplies	385,865	379,035	434,375	344,335	345,457
Total Supplies	**731,200**	**740,300**	**749,300**	**708,800**	**725,000**
Potential Supplies					
Stormwater Capture					
- Capture and Reuse (Harvesting)	8,400	8,800	9,200	9,600	10,000
- Increased Groundwater Production (Recharge)	9,400	10,800	12,200	13,600	15,000
Subtotal	17,800	19,600	21,400	23,200	25,000
MWD Water Purchases With Existing/Planned/Potential Supplies	368,065	359,435	412,975	321,135	320,457
Total Supplies	**731,200**	**740,300**	**749,300**	**708,800**	**725,000**

[1] Los Angeles Aqueduct supply is estimated to decrease 0.1652% per year due to climate change impacts.
[2] North Hollywood/Rinaldi-Toluca Treatment Complex is expected to be in operation in FY 2019-20. Tujunga Groundwater Treatment Plant is expected to be in operation in 2020-21. Storage credit of 5,000 afy will be used to maximize the pumping in FY 2020-21 and thereafter. Sylmar Basin production was increased to 4,500 AFY from FY 2014-15 to FY 2029-30 to avoid the expiration of stored water credits, then go back to its entitlement of 3,405 AFY in FY 2030-31.

11.3 Water Shortage Contingency Plan

The Los Angeles City Municipal Code Chapter XII, Article I, Emergency Water Conservation Plan is the City's water shortage contingency plan (see Appendix I). It was developed to provide for a sufficient and continuous supply of water in case of a water supply shortage in the service area. There are two scenarios that can cause a water shortage: 1) a severe hydrologic dry period affecting surface and groundwater supplies and 2) a catastrophic event that severs major conveyance and/or distribution pipelines serving water to the City. The following discusses LADWP's compliance with the UWMP Act as outlined in Section 10632 (a) (1) through (9) of the California Water Code.

11.3.1 Stages of Action – 10632 (a) (1)

As set forth in the Emergency Water Conservation Plan, the City has conservation phases or stages of action that can be undertaken in response to water supply shortages. Although there are no specific percentages of water shortage levels assigned to each phase, LADWP continually monitors water supplies and demands. As necessary, LADWP's Board of Water and Power Commissioners makes recommendations to the Mayor and City Council on the suggested conservation phase to address the water shortage conditions. The implementation of progressive conservation phases will cope with up to a 50 percent reduction in water supplies and roughly correspond to the water shortage percentages described below:

No Shortage, Phase I (0 percent)

Phase I prohibited uses of water are in effect at all times within the City. These prohibited uses, defined in article 10632 (a) (4) (see section 11.3.4), are intended to eliminate waste and increase public awareness of the need to conserve water. There are further stages of compounding actions in addition to the Phase I prohibited uses that might be imposed. Phase II to Phase V progressively responds to different severities of shortage and implement additional prohibited uses of water.

Moderate Shortage, Phase II (roughly corresponding to >0 to 15 percent)

1. Should Phase II be implemented, uses applicable to Phase I shall continue to be applicable, except as specifically provided herein.

2. No landscape irrigation shall be permitted on any day other than Monday, Wednesday, or Friday for odd-numbered street addresses and Tuesday, Thursday, or Sunday for even-numbered street addresses. Street addresses ending in ½ or any fraction shall conform to the permitted uses for the last whole number in the address. Watering times shall be limited to: (a) Non-conserving nozzles (spray head sprinklers and bubblers) – no more than eight minutes per watering day per station for a total of 24 minutes per week; (b) Conserving nozzles (standard rotors and multi-stream rotary heads) – no more than 15 minutes per cycle and up to two cycles per watering day per station for a total of 90 minutes per week.

3. Upon written notice to LADWP, irrigation of sports fields may deviate from non-watering days to maintain play areas and accommodate event schedules; however, to be eligible for this means of compliance, a customer must reduce his overall monthly water use by LADWP's Board of Water and Power Commissioners' adopted degree of shortage plus an additional 5 percent from the customer baseline water usage within 30 days.

4. Upon written notice to LADWP, large landscape areas may deviate from the non-watering days by meeting the following requirements (1) must have approved weather-based irrigation controllers registered with LADWP (eligible weather-based irrigation controllers are those approved by MWD or the Irrigation Association Smart Water Application Technologies (SWAT) initiative (2) must reduce overall monthly water use by LADWP's Board of Water and Power Commissioners' adopted degree of shortage plus an additional 5 percent from the customer baseline water usage within 30 days; and (3) must use recycled water if it is available from LADWP.

5. These provisions do not apply to drip irrigation supplying water to a food source or to hand-held hose watering of vegetation, if the hose is equipped with a self-closing water shut-off device, which is allowed everyday during Phase II except between the hours of 9:00 am and 4:00 pm.

Severe Shortage, Phase III (roughly corresponding to 15 to 20 percent shortage)

1. Should Phase III be implemented, uses applicable to Phases I and II shall continue to be applicable, except as specifically provided herein.

2. No landscape irrigation shall be permitted on any day other than Monday for odd-numbered street addresses and Tuesday for even-numbered street addresses. Street addresses ending in ½ or any fraction shall conform to the permitted uses for the last whole number in the address.

3. No washing of vehicles allowed except at commercial car wash facilities.

4. No filling of residential swimming pools and spas with potable water.

5. Upon written notice to LADWP, irrigation of sports fields may deviate from the specific non-watering days and be granted one additional water day (for a total of two watering days allowed). To be eligible for this means of compliance, a customer must reduce his overall monthly water use by LADWP's Board of Water and Power Commissioners' adopted degree of shortage plus an additional 10 percent from the customer baseline water usage within 30 days.

6. Upon written notice to LADWP, large landscape areas may deviate from the specific non-watering days and be granted one additional watering day (for a total of two watering days allowed) by meeting the following requirements (1) must have approved weather-based irrigation controllers registered with LADWP (eligible weather-based irrigation controllers are those approved by MWD or the Irrigation Association Smart Water Application Technologies (SWAT) initiative (2) must reduce overall monthly water use by LADWP's Board of Water and Power Commissioners' adopted degree of shortage plus an additional 10 percent from the customer baseline water usage within 30 days; and (3) must use recycled water if it is available from LADWP.

7. These provisions do not apply to drip irrigation supplying water to a food source or to hand-held hose watering of vegetation, if the hose is equipped with a self-closing water shut-off device, which is allowed everyday during Phase III except between the hours of 9:00 am and 4:00 pm.

Critical Shortage, Phase IV (roughly corresponding to 20 to 35 percent shortage)

1. Should Phase IV be implemented, uses applicable to Phases I, II, and III shall continue to be applicable, except as specifically provided herein.

2. No landscape irrigation allowed.

Super Critical Shortage, Phase V (roughly corresponding to 35 to 50 percent shortage)

1. Phase I, II, III, and IV shall continue to remain in effect.

2. The Board of Water and Power Commissioners is hereby authorized to implement additional prohibited uses of water based on the water supply situation. Any additional prohibitions shall be published at least once in a daily newspaper of general circulation and shall become effective immediately upon such publication and shall remain in effect until cancelled.

11.3.2 Driest Three-Year Supply – 10632 (a) (2)

In the event that three consecutive dry-years curtailing the City's LAA System deliveries should follow the 2010 water supply conditions, LADWP will rely on increased groundwater pumping and purchases from MWD to meet City water demands. This particular sequence is quantified in Exhibit 11L, including relevant assumptions.

During such severe drought periods, the City's supplemental water supplier MWD will use its WSAP in conjunction with the framework developed in its WSDM Plan. Developed by MWD with substantial input from its member agencies, the WSDM

Exhibit 11L
Driest Three-Year Water Supply Sequence

Demand and Supply Projections (in acre-feet)	FY2009-10 Actual	**Followed by Repeat of Driest Three Consecutive Years FY1958/59 to 1960/61 Hydrology Fiscal Year Ending on June 30**		
		2011	2012	2013
Total Demand	**555,447**	**590,000**	**608,200**	**626,500**
Existing / Planned Supplies				
Los Angeles Aqueduct	199,739	104,530	50,849	59,382
Groundwater	76,982	61,090	53,660	46,260
Conservation	8,178	9,380	10,580	11,780
Recycled Water				
- Irrigation and Industrial Use	6,703	7,500	8,300	9,000
- Groundwater Replenishment	0	0	0	0
Water Transfers	0	0	0	0
Subtotal	291,602	182,500	123,389	126,422
MWD Water Purchases With Existing/Planned Supplies	263,845	407,500	484,811	500,078
Total Supplies	**555,447**	**590,000**	**608,200**	**626,500**

Assumptions
1. Driest three consecutive years on record in LAA watershed (FY1958-59 to FY1960-61) averaged 28 percent of normal runoff.
2. LAA deliveries reflect increased releases for environmental restoration in the Owens Valley and Mono Basin.
3. Dry year demands are 5 percent greater than normal year demands
4. MWD's Water Surplus and Drought Management Plan actions are sufficient to meet LADWP demands.

Plan provides for the WSAP's needs-based allocation strategy, and establishes priorities for the use of MWD's water supplies to achieve retail reliability.

The following are actions that could be taken by MWD, in accordance with their WSDM Plan, to augment its water supplies prior to implementation of any WSAP drought allocation action:

1. Draw on Diamond Valley Lake storage.
2. Draw on out-of-region storage in Semitropic and Arvin-Edison Groundwater Banks.
3. Reduce/suspend local groundwater replenishment deliveries.
4. Draw on contractual groundwater storage programs in MWD's service area.
5. Draw on State Water Project terminal reservoir storage (per Monterey Agreement).
6. Call for voluntary conservation and public education.
7. Reduce deliveries from MWD's Interim Agricultural Water Program.
8. Call on water transfer options contracts.
9. Purchase transfers on the spot market.
10. Allocate imported water in accordance with the WSAP if necessary.

In 2008 MWD adopted the WSAP which is designed to allocate supplies among its member agencies in a fair and efficient manner. The WSAP establishes the formula for calculating member agency allocations if MWD cannot meet firm demands in a given year.

11.3.3 Catastrophic Supply Interruption Plan – 10632 (a) (3)

Seismic Assessment of Major Imported Supplies

MWD performed a seismic risk assessment of its water distribution network to evaluate the impacts of seismic activity in the greater Southern California area. For MWD, there are three sources of imported water to the region: the Colorado River Aqueduct (CRA), the East SWP branch, and the West SWP branch. Each source was evaluated for the potential of failure during a seismic event. The SWP East branch is considered more vulnerable because the California Aqueduct's alignment follows the San Andreas fault-line and crosses over the San Andreas Fault at multiple locations. The SWP West branch and CRA are somewhat less vulnerable due to their proximity to the San Andreas fault-line, although the San Andreas Fault crosses all aqueducts entering the Southern California region. It crosses the SWP East branch three times, the SWP West branch once, the CRA once, and the LAA once.

LADWP investigated the ability of MWD to deliver Colorado River water into the west San Fernando Valley in the event that SWP supplies and LAA supplies are interrupted. This investigation included the two MWD service areas adjacent to the West San Fernando Valley, the Calleguas and Las Virgines Municipal Water Districts. If imported supply from the SWP and LAA are severed, MWD has prolonged emergency storage in Castaic and Pyramid Lakes. Given the proximity of MWD infrastructure to seismic activity on the San Andreas Fault, MWD staff predicts that if Castaic and Pyramid Lakes become disconnected from the City emergency repairs can be made to ensure that supply is not interrupted for an extended period of time. In a worst case scenario, if these sources are cut off from the City, 50 cubic feet per second of CRA water could be moved through

MWD's system to serve the west San Fernando Valley, Calleguas MWD, and Las Virgines MWD until repairs to the MWD facilities could be made. On-call contractors working around the clock could be deployed to repair seismic damage in as short as a two-week time period depending on the severity and location of the break(s). Due to these risks MWD's current storage policy is to maintain maximum emergency storage in both Pyramid and Castaic Lakes.

Emergency Response Plan

LADWP has Emergency Response Plans (ERPs revised January 2011) in place to restore water service for essential use in the City if a disaster, such as earthquakes and power outages, should result in the temporary interruption of water supply. Department personnel responsible for water transportation, distribution, and treatment have established ERPs to guide the assessment, prioritization, and repair of City facilities that have incurred damage during a disaster.

An Emergency Operations Center (EOC) serves as a centralized point for citywide management of information about disasters and for coordination of all available resources. The EOC supports the City's Emergency Operations Organization to achieve its mission of saving lives, protecting property, and returning the City to normal operations in the event of a disaster. LADWP coordinates its efforts with the EOC and will utilize the EOC to resume water supply service after a catastrophic event.

Earthquakes
In the event of a major earthquake, LADWP has a Disaster Response Plan dedicated for the LAA in addition to its overall Emergency Response Plan. The Disaster Response Plan details procedures for operating the LAA following an earthquake in order to prevent further damage of the LAA. If the LAA is severed by seismic activity on the San Andreas fault and is temporarily unable to provide water to the City, LADWP will be able to use its water storage in the Bouquet Reservoir to provide water supply to the City while repairs are made. In addition to this resource, if the California Aqueduct is intact south of the Neenach Pump Station (First Los Angeles Aqueduct – State Water Project Connection), arrangements may be made to transfer LAA water through this connection into the California Aqueduct for delivery to MWD. Arrangements can then be made to deliver water to the City through one of MWD's connections.

Power Outages
Most of LADWP's major pump stations have backup generators in the event a major power outage disrupts the primary energy system. Backup generators are either powered by a separate electric source or have independent diesel power. The diesel powered backup supplies are capable of running for at least 24 hours. In the event of a major power outage, all pump stations are designed to automatically switch to their backup generators to prevent disruption of water service. In addition, LADWP keeps an adequate storage supply which is able to keep the water distribution system operable until power is restored.

11.3.4 Mandatory Water Use Prohibitions – 10632 (a) (4)

Phase I prohibited uses of the Emergency Water Conservation Plan contain 13 wasteful water use practices that are permanently prohibited for all City of Los Angeles customers. These prohibited uses are intended to eliminate waste and increase public awareness of the need to conserve water. During times of shortage, education and enforcement of the following provisions will be increased:

1. No customer shall use a water hose to wash any paved surfaces including, but not limited to, sidewalks, walkways, driveways, and parking areas, except to alleviate immediate

safety or sanitation hazards. This section shall not apply to LADWP approved water conserving spray cleaning devices. Use of water pressure devices for graffiti removal is exempt. A simple spray nozzle does not qualify as a water conserving spray cleaning device.

2. No customer shall use water to clean, fill, or maintain levels in decorative fountains, ponds, lakes, or similar structures used for aesthetic purposes unless such water is part of a recirculating system.

3. No restaurant, hotel, cafe, cafeteria, or other public place where food is sold, served, or offered for sale shall serve drinking water to any person unless expressly requested.

4. No customer shall permit water to leak from any pipe or fixture on the customer's premises; failure or refusal to affect a timely repair of any leak of which the customer knows or has reason to know shall subject said customer to all penalties for a prohibited use of water.

5. No customer shall wash a vehicle with a hose if the hose does not have a self-closing water shut-off device or device attached to it, or otherwise to allow a hose to run continuously while washing a vehicle.

6. No customer shall irrigate during periods of rain.

7. No customer shall water or irrigate lawn, landscape, or other vegetated areas between the hours of 9:00 a.m. and 4:00 p.m. During these hours, public and private golf courses greens and tees and professional sports fields may be irrigated in order to maintain play areas and accommodate event schedules. Supervised testing or repairing of irrigation systems is allowed anytime with proper signage.

8. All irrigating of landscape with potable water using spray head sprinklers and bubblers shall be limited to no more than ten minutes per watering station per day. All irrigating of landscape with potable water using standard rotors and multi-stream rotary heads shall be limited to no more than fifteen minutes per cycle and up to two cycles per watering day per station. Exempt from these irrigation restrictions are irrigation systems using very low drip type irrigation when no emitter produces more than four gallons of water per hour and micro-sprinklers using less than fourteen gallons per hour. This provision does not apply to Schedule F water customers or water service water service that has been granted the General Provision M rate adjustment under the City's Water Rates Ordinance, subject to the Customer having complied with best management practices for irrigation approved by the Department. The 9:00 a.m. to 4:00 p.m. irrigation restriction shall apply unless specifically exempt as stated in subsection 7 of the Emergency Water Conservation Ordinance.

9. No customer shall water or irrigate any lawn, landscape, or other vegetated area in a manner that causes or allows excess or continuous flow or runoff onto an adjoining sidewalk, driveway, street, gutter, or ditch.

10. No installation of single pass cooling systems shall be permitted in buildings requesting new water service.

11. No installation of non-recirculating systems shall be permitted in new conveyor car wash and new commercial laundry systems.

12. Operators of hotels and motels shall provide guests with the option of choosing not to have towels and linens laundered daily. The hotel or motel shall prominently display notice of this option in each bathroom using clear and easily understood language. LADWP shall make suitable displays available.

13. No large landscape areas shall have irrigation systems without rain sensors that shut-off the irrigation systems. Large landscape areas with approved weather-based irrigation controllers registered with LADWP are in compliance with this requirement.

11.3.5 Consumption Reduction Methods During Most Restrictive Stages – 10632 (a) (5)

Short-Term Actions

During a water shortage or emergency condition, LADWP utilizes its Emergency Water Conservation Plan (11.3.1) to decrease water use as needed based on the severity of the shortage. The Emergency Water Conservation Plan is capable of reducing water use by up to 50 percent.

In addition, LADWP's existing rate structure (enacted in 1993) serves as a basis for further reducing consumption. First tier water allotments are reduced during shortages by the degree of the shortage. For single-family residential users, the adjusted first tier allotments apply for the entire year. For other users, the adjusted first tier allotments apply only during the high season (June 1 through October 31). Details of LADWP's water rate structure are provided in Appendix C – Water Rate Ordinance.

To provide immediate demand reductions and increase public awareness of the need to conserve water, additional measures can be phased in as the dry period continues. Included among these measures are water conservation public service announcements (through television and/or radio), billboard ads, flyer distributions, and conservation workshops. LADWP also actively participates in public exhibits to disseminate water conservation information within its service area. Conservation is a permanent and long-term ethic adopted by the City to counter the potentially adverse impacts of water supply shortages.

State law further regulates distribution of water in extreme water shortage conditions. Section 350-354 of the California Water Code states that when a governing body of a distributor of a public water supply declares a water shortage emergency within its service area, water will be allocated to meet needs for domestic use, sanitation, fire protection, and other priorities. This will be done equitably and without discrimination between customers using water for the same purpose(s).

Long-Term Actions

LADWP's long-range water conservation program is driven by the need to continuously increase water use efficiency. This will reduce demand, extend supply, and therefore, provide greater reliability. Dry cycle experiences, public trust responsibilities, and regulatory mandates have raised the level of awareness within the City of Los Angeles of the need to approach demand reduction from a permanent and long-term perspective.

LADWP will continue to maintain and increase its existing conservation programs and pursue the development of new and innovative programs as outlined in Chapter 3, Water Conservation with the goal of reducing potable water demands by 60,000 AFY by 2035. Emphasis continues to be placed on structural conservation for the residential and CII sectors (HETs, high-efficiency washing machine rebates, etc.) which result in permanent per capita water use reduction. Substantial efforts are also being placed on landscape water use efficiency and CII conservation opportunities. It should, however, be recognized that the ability to achieve water reduction during shortages by requesting additional voluntary measures is likely to be more difficult in the future. As customers adjust to a conservation ethic and adopt permanent measures to reduce water use, their water demands harden and become less susceptible to voluntary conservation.

11.3.6 Penalties for Excessive Use (Non-Compliance to Prohibited Use) – 10632 (a) (6)

The Emergency Water Conservation Plan sets penalties for violations of prohibited uses outlined in Sections 10632 (a) (1) and (a) (4). The penalties vary by water meter size. For water meters smaller than two inches the following penalties shall apply:

1. The first violation consists of a written warning.
2. The second violation within the preceding 12 month period will result in a surcharge in the amount of $100 added to the customer's water bill.
3. The third violation within the preceding 12 month period will result in a surcharge in the amount of $200 added to the customer's water bill.
4. The fourth violation within the preceding 12 month period will result in a surcharge in the amount of $300 added to the customer's water bill.
5. After a fifth violation or subsequent violation within the preceding 12 month period, LADWP may install a flow-restricting device of 1 gpm capacity for services up to 1 ½ inches in size and comparatively sized restrictors for larger services or terminate a customer's service, in addition to the aforementioned financial surcharges. Such action shall only be taken after a hearing held by LADWP.

For water meters two inches and larger the following penalties shall apply:

1. The first violation consists of a written warning.
2. The second violation within the preceding 12 month period will result in a surcharge in the amount of $200 added to the customer's water bill.
3. The third violation within the preceding 12 month period will result in a surcharge in the amount of $400 added to the customer's water bill.
4. The fourth violation within the preceding 12 month period will result in a surcharge in the amount of $600 added to the customer's water bill.
5. After a fifth violation or subsequent violation within the preceding 12 month period, LADWP may install a flow-restricting device or terminate a customer's service, in addition to the aforementioned financial surcharges. Such action shall only be taken after a hearing held by LADWP.

11.3.7 Analysis and Effects on Revenues and Expenditures of Reduced Sales during Shortages – 10632 (a) (7)

The City's Water Rate Ordinance, adopted in June 1995 and last amended in June 2008, provides a remedy to the impact of reduced water sales on revenues in the form of a Water Revenue Adjustment Factor (Adjustment). The Adjustment recovers any shortage in revenue due to variation in water sales. It is intended to support a fiscal year revenue target that is deemed sufficient to cover LADWP's essential expenses. The formula takes into account target and actual revenues as well as projected water sales to determine the appropriate Adjustment.

The Adjustment is currently limited to $.18 per hundred-cubic-feet (one billing unit). It cannot exceed this limit unless the Board of Water and Power Commissioners determines that a surcharge in excess of $0.18 per hundred-cubic-feet is financially required and approval from the Los Angeles City Council is obtained. The Board of Water and Power Commissioners also has the authority to reduce the factor to less than the formula-calculated amount.

A billing factor is calculated annually on January 1 and is added to the standard commodity charge. The factor is set to zero if a negative value is calculated. A Water Revenue Adjustment Account is maintained and updated each month by LADWP. This account is adjusted annually on July 1.

The City's Water Revenue Adjustment Factor ensures that resources are available to fund LADWP activities aimed at providing continuous water service to Los Angeles water users, even during periods of low water sales.

11.3.8 Water Shortage Contingency Resolution or Ordinance – 10632 (a) (8)

A draft water shortage contingency declaration resolution is shown in Exhibit 11M. Moreover, the City's Emergency Water Conservation Plan Section 121.07.B has the following conservation phase implementation procedures:

"The Department (LADWP) shall monitor and evaluate the projected supply and demand for water by its Customers monthly, and shall recommend to the Mayor and Council by concurrent written notice the extent of the conservation required by the Customers of the Department in order for the Department to prudently plan for and supply water to its Customers. The Mayor shall, in turn, independently evaluate such recommendation and notify the Council of the Mayor's determination as to the particular phase of water conservation, Phase I through Phase V, that should be implemented. Thereafter, the Mayor may, with the concurrence of the Council, order that the appropriate phase of water conservation be implemented in accordance with the applicable provisions of this Article. Said order shall be made by public proclamation and shall be published one time only in a daily newspaper of general circulation and shall become effective immediately upon such publication. The prohibited water uses for each phase shall take effect with the first full billing period commencing on or after the effective date of the public proclamation by the Mayor. In the event the Mayor independently recommends to the Council a phase of conservation different from that recommended by the Department, the Mayor shall include detailed supporting data and the reasons for the independent recommendation in the notification to the Council of the Mayor's determination as to the appropriate phase of conservation to be implemented."

The City's Water Rate Ordinance No. 170435 also has specific provisions for LADWP's Board of Water and Power Commissioners, through a resolution, to determine the degree of shortage and apply corresponding commodity charges in case of a water shortage (see Section 11.3.5 and Appendix C – Water Rate Ordinance). If a water shortage is declared, certified copies of the resolution will be transmitted to the offices of the Mayor and of the Los Angeles City Clerk, and the Los Angeles City Council for final approval. This particular water shortage act is included under Section 3 – General Provisions, Article R – Shortage Year Rates of the City's Water Rate Ordinance.

11.3.9 Methodology to Determine Actual Water Use Reductions during Shortages – 10632 (a) (9)

Water use is monitored closely by LADWP throughout its service area regardless of the supply conditions. With 100 percent of its over 700,000 service connections metered, there is a high degree of accountability on the quantity of water used within the LADWP service area. Information from meter reads is collected for billing and accounting purposes, with reports prepared on a monthly basis from the data compiled. The actual

Exhibit 11M
Draft Water Shortage Contingency Declaration Resolution

BE IT RESOLVED that the Board of Water and Power Commissioners (Board) recognizes that a Water Shortage Contingency Plan has been prepared and incorporated into the City of Los Angeles 2010 Urban Water Management Plan pursuant to the Urban Water Management Planning Act; the Urban Water Management Plan is on file with the Secretary of the Board; this Board has reviewed and considered the information and recommendations contained in this document, and makes the following findings and determinations:

1.The water supply available to the City of Los Angeles is insufficient to meet the City's normal water supply needs; and

2.The Department of Water and Power has developed a Water Shortage Contingency Plan for the City of Los Angeles that compiles with all the requirements of the Urban Water Management Planning Act; and

3.The Urban Water Management Plan has been developed, adopted, and implemented pursuant to Article 3, Sections 10640 through 10645 of the Urban Water Management Planning Act; and

4.The Water Shortage Contingency Plan includes stages of action that can be taken in response to water supply shortages, including up to a 50 percent reduction in water supply, a driest three-year water supply scenario, mandatory water use prohibitions, and penalties for non-compliance; and

5.The Water Shortage Contingency Plan identifies both short-term and long-term actions to maximize water use efficiency and minimize the effects of the current water shortage as well as future water supply shortages.

BE IT FURTHER RESOLVED that this Board has adopted the Water Shortage Contingency Plan as incorporated in the Urban Water Management Plan, and declares the provisions of the Water Shortage Contingency Plan in full force and effect during the duration of this period of water shortage.

I HEREBY CERTIFY that the foregoing is a full, true, and correct copy of the resolution adopted by the Board of Water and Power Commissioners of the City of Los Angeles at its meeting held water reductions are determined by comparing the metered water use to the normal water use under average weather condition when no mandatory water conservation is imposed. Based on these criteria, the water use level of FY 2006/07 was selected as the base year or the normal year to determine the effectiveness of water reduction measures during the recent water supply shortage.

LADWP also used a conservation model to establish a weather-normalized demand to estimate conservation efforts within the City since the early 1990s. The model estimated City water demand without conservation efforts using population and weather variables. A new conservation model was developed in 2010 to account for additional factors such as economic recession and drought conservation. This model is discussed in Chapter 2, Water Demand. The City's conservation effort is derived by comparing estimated pre-conservation demand with actual demand. Conservation efforts derived from this model are shown in Chapter 3, Water Conservation.

11.4 Water Supply Assessments

Background

In 1994, the California Legislature enacted Water Code Section 10910 (Senate Bill 901), which requires cities and counties, as part of California Environmental Quality Act (CEQA) review, to request the applicable public water system to assess whether the system's projected water supplies were sufficient to meet a proposed development's anticipated water demand. The intent was to link the land use and water supply planning processes to ensure that developers and water supply agencies communicate early in the planning process. However, a study of projects approved by local planning agencies revealed that numerous projects were exempted due to loopholes in the statute, and that the intent of the legislation had largely gone unfulfilled.

Subsequently, California Senate Bill (SB) 610 and SB 221, modeled after SB 901, amended State law effective January 1, 2002, to ensure that the original intent of the legislation is fulfilled. SB 610 and 221 are companion measures which seek to promote more collaborative planning between local water suppliers and cities and counties. These bills improve the link between information on water supply availability and certain land use decisions made by cities and counties. Both statutes require detailed information regarding water availability to be provided to the city and county decision-makers prior to approval of specified large development projects. Both statutes also require this detailed information be included in the administrative record that serves as the evidentiary basis for an approval action by the city or county on such projects. Both measures recognize local control and decision making regarding the availability of water for projects and the approval of projects.

Under SB 610, a water supply assessment (WSA) must be furnished to local governments for inclusion in any environmental documentation for specified types of development projects subject to CEQA. Specifically, SB 610 requires that for certain projects, the CEQA lead agency must identify a public water system that may supply water to the proposed project and request the public water system to determine the water demand associated with the project and whether such demand is included as part of the public water system's most recently adopted UWMP. If the projected water demand associated with the proposed project is accounted for in the most recently adopted UWMP, the public water system may incorporate the supporting information from the UWMP in preparing the elements of the assessment. If the proposed project's water demand is not accounted for in the most recently adopted UWMP, the WSA for the project shall include a discussion with regard to

whether the public water system's total projected water supplies available in normal, single dry, and multiple dry water years during a 20-year projection will meet the proposed project's water demand.

Per Section 10912 of the California Water Code, a project which is subject to the requirements of SB 610 includes: (1) a proposed residential development of more than 500 dwelling units; (2) a proposed shopping center or business establishment employing more than 1,000 persons or having more than 500,000 square feet of floor space; (3) a proposed commercial office building employing more than 1,000 persons or having more than 250,000 square feet of floor space; (4) a proposed hotel or motel, or both, having more than 500 rooms; (5) a proposed industrial, manufacturing, or processing plant, or industrial park planned to house more than 1,000 persons, occupying more than 40 acres of land, or having more than 650,000 square feet of floor area; (6) a mixed-use project that includes one or more of the projects specified in this subdivision; or (7) a project that would demand an amount of water equivalent to, or greater than, the amount of water required by a 500 dwelling unit project.

The assessment would include an identification of existing water supply entitlements, water rights, or water service contracts relevant to the identified water supply for the proposed project and water received in prior years pursuant to those entitlements, rights, and contracts. If the assessment concludes that water supplies will be insufficient, plans for acquiring additional water supplies would need to be presented.

Under SB 221, approval by a city or county of new large development projects requires an affirmative written verification of sufficient water supply; which is a "fail safe" mechanism to ensure that collaboration on finding the needed water supplies to serve a new large development occurs before construction begins.

Methodology

During the years from 2005 to 2010, LADWP has received requests to develop over 40 WSAs. Each WSA performed by LADWP is carefully evaluated within the context of the current adopted UWMP and current conditions, such as restrictions on SWP pumping from the Sacramento-San Joaquin Delta imposed by a Federal court. MWD, from whom the City purchases its SWP and Colorado River water supplies, has also been actively developing plans and making efforts to provide additional water supply reliability for the entire Southern California region. LADWP coordinates closely with MWD to ensure implementation of MWD's water resource development plans and supplemental water reliability report prepared by MWD.

LADWP's UWMP uses a service area-wide method in developing City water demand projections. This methodology does not rely on individual development demands to determine area-wide growth. Rather, the growth in water use for the entire service area was considered in developing long-term water projections for the City to the year 2035. The driving factors for this growth are demographics, weather, and conservation. LADWP used anticipated growth in the various customer class sectors as provided by MWD who reallocated projected demographic data from the Southern California Association of Governments (SCAG) into member agencies' service areas. The data used was based on SCAG's 2008 Regional Transportation Plan Forecast.

As governed by City Charter Sections 673 and 677, LADWP can serve surplus water supplies to areas outside of the City boundaries. There are approximately 4,500 services for customers outside of the City, with a combined annual water use less than 1 percent of all water delivered. Water served outside of the City includes a surcharge to account for the increased MWD purchased water.

The water demand forecast model in the UWMP was developed using LADWP total water use, including the water served by LADWP for use outside of the City. The service area reliability assessment was performed for three hydrologic conditions: average year, single dry year, and multiple-dry years; and a Shortage Contingency Plan was developed to provide for a sufficient and continuous supply in LADWP's service area. This Shortage Contingency Plan included water provided for use outside of the City.

An important part of the water planning process is for LADWP to work collaboratively with MWD to ensure that anticipated water demands are incorporated into MWD's long-term water resources development plan and water supply allocation plan. The City's allotment of MWD water supplies under MWD's Water Supply Allocation Plan is based on the City's total water demand which includes services to areas outside the City. The ongoing collaboration between LADWP and MWD is critical in ensuring that the City's anticipated water demands are incorporated into the development of MWD's long-term Integrated Resources Plan (IRP). MWD's IRP directs a continuous regional effort to develop regional water resources involving all of MWD's member agencies. Successful implementation of MWD's IRP has resulted in reliable supplemental water supplies for the City from MWD.

In summary, the WSAs are performed to ensure that adequate water supplies would be available to meet the estimated water demands of the proposed developments during normal, single-dry, and multiple-dry water years, as well as existing and planned future uses of the City's water system. LADWP will continue to perform WSAs as part of its long-term water supply planning efforts for its service area.

WSA Procedure

The CEQA lead agency, such as the City Planning Department or the Community Redevelopment Agency of the City of Los Angeles, evaluates the proposed project against the requirements for a WSA in accordance with the Water Code.

If the proposed project falls within the requirements for a WSA, a formal request is submitted to LADWP to perform a WSA.

In evaluating a proposed project's water demand, LADWP applies the Sewer Generation Factors (published by City of Los Angeles Bureau of Sanitation) to the development's project description for calculating indoor water use. Outdoor landscape water demand is calculated by using computer software which takes into account various factors such as landscape area square footage, location, and plant types. Historical billing records are used to establish existing baseline water demand on the property.

LADWP also encourages all projects to implement additional water conservation measures above and beyond the current water conservation ordinance requirements. As an example, if the proposed development is near an existing or future recycled water pipeline system, commitment to use recycled water for irrigation, toilet flushing and cooling towers is highly recommended as part of the additional conservation measures for the proposed development.

The net increase/decrease in water demand, which is the projected additional water demand of the development, is calculated by subtracting the existing baseline water demand and water saving amount from the total proposed water demand. If the land use of the proposed development is consistent with the City's General Plan, the projected water demand of the development is considered to be accounted for in the most recently adopted UWMP. The City incorporates the projected demographic data from the SCAG in its General Plan. MWD utilizes a land use based planning tool that allocates SCAG's projected demographic data into water service areas for their member agencies, which was adopted for water demand projection in the UWMP.

If the proposed land use is not consistent with the City's General Plan, the WSA will further evaluate if the projected supplies from the UWMP are able to accommodate the proposed project's water demand, which may include other resource options to offset the projected water demand.

All WSAs are subject to approval by the Board of Water and Power Commissioners. Upon approval, the CEQA lead agency is responsible for enforcing the requirements of the WSA as part of the approval for the project.

Chapter Twelve

Climate Change

12.0 Overview

LADWP is considering the impacts of climate change on its water resources as an integral part of its long-term water supply planning. Climate change is a global-scale concern, but is particularly important in the western United States where potential impacts on water supplies can be significant for water agencies. Climate change can impact surface supplies from the Los Angeles Aqueduct (LAA), imported supplies from Metropolitan Water District (MWD), and local demands. As part of this impact analysis, LADWP completed a study to analyze the operational and water supply impacts of potential shifts in the timing and quantity of runoff along the LAA system due to climate change in the 21st Century. Such potential shifts may require LADWP to modify both the management of local water resources and LAA supplies. Projected changes in climate are expected to alter hydrologic patterns in the LAA's eastern Sierra Nevada Watershed through changes in precipitation, snowmelt, relative ratios of rain and snow, winter storm patterns, and evapotranspiration.

To understand some of the key issues surrounding climate change impacts, it is important to put it into the context of LADWP's water supplies. California lies within multiple climate zones. Therefore, each region will experience unique impacts due to climate change. Because LADWP relies on both local and imported water sources, it is necessary to consider the potential impacts climate change could have on the local watershed as well as the western and eastern Sierra Nevada watersheds. The western Sierra Nevada is where a portion of MWD's imported water originates and the eastern Sierra Nevada is where LAA supplies originate. It is also necessary to consider impact in the Colorado River Basin where Colorado River Aqueduct supplies originate.

Generally speaking, any water supplies that are dependent on natural hydrology are vulnerable to climate change, especially if the water source originates from mountain snowpack. For LADWP, the most vulnerable water sources subject to climate change impacts are imported water supplies from MWD and the LAA. However, local sources can expect to see some changes in the future as well. In addition to water supply impacts, changes in local temperature and precipitation are expected to alter water demand patterns. However, there is still general uncertainty within the scientific community regarding the potential impacts of climate change within the City of Los Angeles. LADWP will continue to stay abreast of developments in climate change to better understand its potential implications for the City's local and imported water supplies and in-city demands.

12.1 Potential Impacts of Climate Change on Water Service Reliability

Scientists predict future climate change scenarios using highly complex computer global climate models (GCMs) to simulate climate systems. Although most of the scientific community agrees that climate change is occurring and, as a result, mean temperatures for the planet will increase, the specific degree of this temperature increase cannot be accurately predicted. Predictions of changes in precipitation are even more speculative, with some scenarios showing precipitation increasing in the future and others showing the opposite.

It is important to acknowledge that the predictions of the GCMs lack the desired precision due to the presence of uncertainties inherent in the analyses. The uncertainty relating to future emissions of greenhouse gases (GHG) and the chaotic nature of the climate system leads to uncertainty in regard to the response of the global climate system to increases in GHG. In addition, the science of climate change still lacks a complete understanding of regional manifestations resulting from global changes, thus restraining the projecting ability of these models. However, these model's projections are consistent with the state of science today, and they help predict the manner in which hydrologic variables are likely to respond to a range of possible future climate conditions, and thus they provide invaluable insight for water managers in their decisions pertaining to water supply reliability.

The regional areas of interest in assessing climate change impacts to LADWP include the local service area and sources of origination for imported water supplies in northern California, eastern Sierra Nevada Mountains, and the Colorado River Basin. Data regarding climate change impacts for the various regions of interest is provided in this section.

12.1.1 Local Impacts

Most scientific experts believe that because of the uncertainty involved with each model, several models should be used to test the potential impact of climate change. To downsize the global coarse-scale climate projections to a regional level incorporating local weather and topography, the GCMs are "downscaled". For the City of Los Angeles, future projections of precipitation and temperature were obtained for six GCMs under two GHG emission scenarios (A2 - higher and B1 - lower) , . Exhibits 12A and 12B plot the changes in projected average annual mean temperature and precipitation, respectively for the model scenarios. The bold line represents the running average of all six models for each emission scenario. These six models were also used in preparation of the California Energy Commision – Public Interest Energy Research Program's study entitled *Climate Change Scenarios and Sea Level Rise Estimates for the 2008 California Climate Change Scenarios Assessment*, which investigated possible future climate changes throughout California.

Local climate changes within the vicinity of the LADWP service area are expected to include:

- An increase in average temperatures that will be more pronounced in the summer than in the winter with annual mean temperatures in year 2100 increasing greater than 3ºF when lower GHG emission scenarios are used and may exceed 6ºF when high higher emissions scenarios are used dependent upon the GCM employed.
- An increase in extreme temperatures.
- An increase in heat waves and dry periods that will extend for a longer duration.
- A slight decrease in precipitation coupled with increases in temperature will result in greater evapotranspiration.
- An increase in short-duration/high volume intense storm events during the winter.

The impact of these climate effects will likely be increased water demands for irrigation and cooling purposes earlier in the year and for longer periods coupled with decreased local surface runoff available to recharge groundwater basins. Other impacts might include an increase

Exhibit 12A
Climate Change Impacts to Local Temperatures for Los Angeles

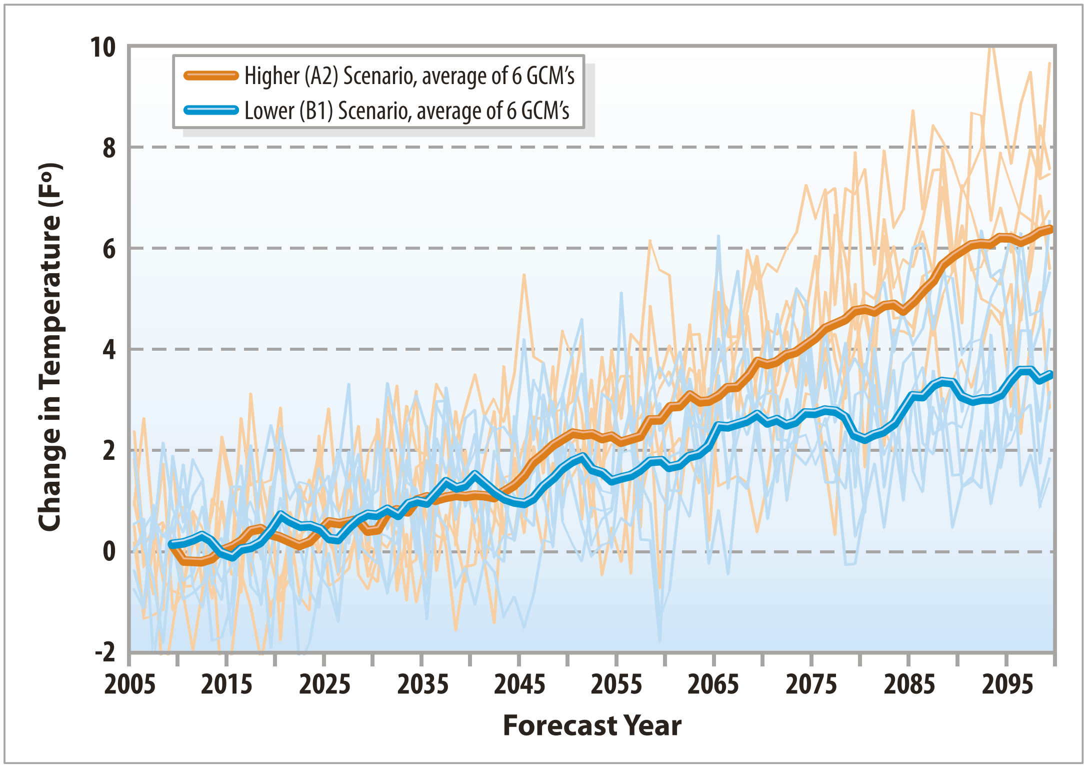
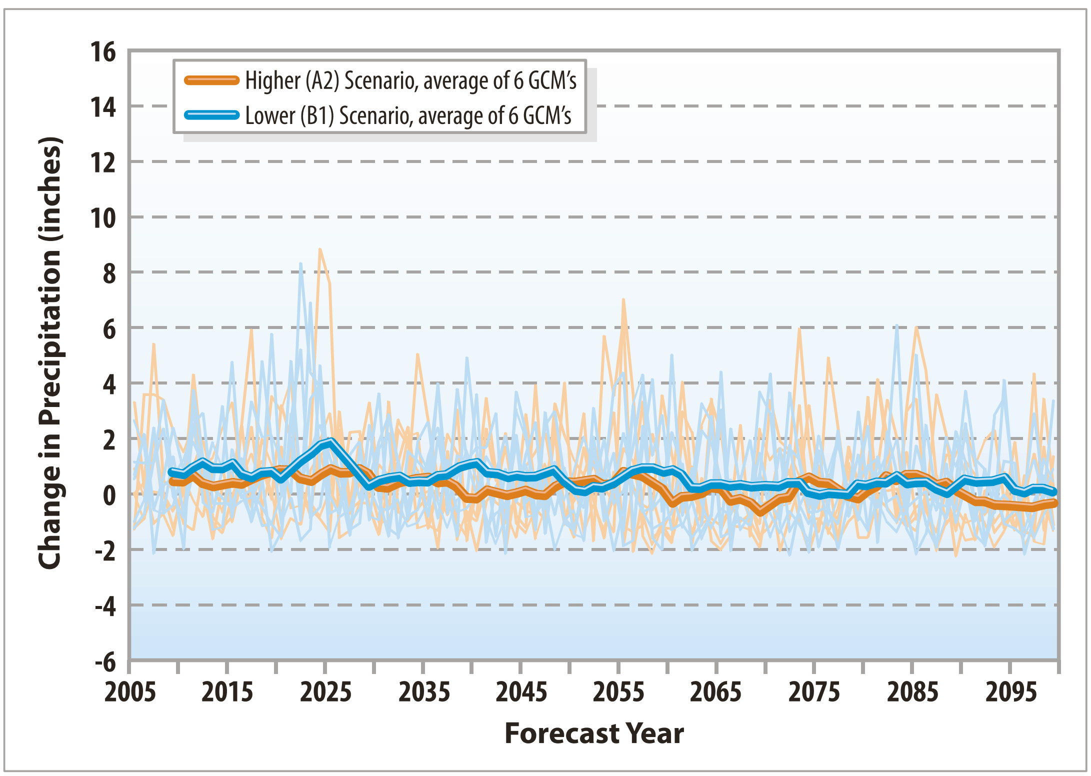


Exhibit 12B
Climate Change Impacts to Local Precipitation for Los Angeles



Dan Cayan and Mary Tyree (University of California, San Diego, Scripps Institute of Oceanography) provided downscaled data for the City of Los Angeles under two emissions scenarios from six climate models: CNRM CM3, GFDL CM2.1, Miroc3.2 (medium resolution), MPI ECHAM5, NCAR CCSM3, NCAR PCM1.

Note: These scenarios do not bracket the highest and lowest emission futures possible, but represent a status quo approach (A2) and a pro-active mitigation (B1) approach to reduce carbon emissions in fire events impacting water quality and sedimentation, a decrease in groundwater recharge due to lower soil moisture, and sea level rise increasing seawater intrusion into coastal groundwater basins.

12.1.2 Los Angeles Aqueduct Impacts

The LAA is one of the major imported water sources delivering a reliable water supply to the City of Los Angeles. The LAA originates approximately 340 miles away gathering snowmelt runoff in the eastern Sierra Nevada; hence the LAA is subject to hydrologic variability which will be impacted by climate change. Since the majority of precipitation occurs during winter in the eastern Sierra Nevada watershed, water is stored in natural reservoirs in the form of snowpack, and is gradually released into streams that feed into the LAA during spring and summer. More detailed information regarding the LAA is presented in Chapter 5, Los Angeles Aqueduct Systems.

Higher concentrations of GHG in the atmosphere are often indications of pending climate change. These changes threaten the hydrologic stability of the eastern Sierra Nevada watershed through alterations in precipitation, snowmelt, relative ratios of rain and snow, winter storm patterns, and evapotranspiration, all of which have major potential impacts on the LAA water supply and deliveries.

To address the possible challenges posed by climate change on the LAA, LADWP completed a climate change study. The study evaluated the potential impacts of climate change on the eastern Sierra Nevada watershed and on LAA water supply and deliveries. It also investigated opportunities to improve the LAA system as a result of potential impacts in the 21st century. In this study, future climate conditions are predicted using a set of sixteen GCMs and two GHG emission scenarios.

The impacts of these climate change scenarios and the associated hydrology on the LAA's eastern Sierra Watershed includes an analysis of historical temperature, precipitation, water quality, and runoff records. Hydrologic modeling was performed to estimate runoff changes from current conditions and to determine the impact of these runoff changes on the performance of the LAA infrastructure with regards to storage and conveyance to Los Angeles. As part of the evaluation of potential adaptation measures if existing infrastructure proves to be inadequate, recommendations were provided on how to modify the LAA infrastructure and operations to accommodate these impacts.

Results of the study show steady temperature increases throughout the 21st century and are consistent with other prior studies performed in the scientific community. Exhibit 12C displays the time series of 30-year running means of the projected temperature for the A2 GHG emission scenario (higher GHG emissions) averaged over the simulation area for each of the sixteen GCM models. All GCMs project temperature increases throughout the 21st century.

Exhibit 12C
30-Year Time Series Projected Temperature Means for Eastern Sierra Nevada Watershed

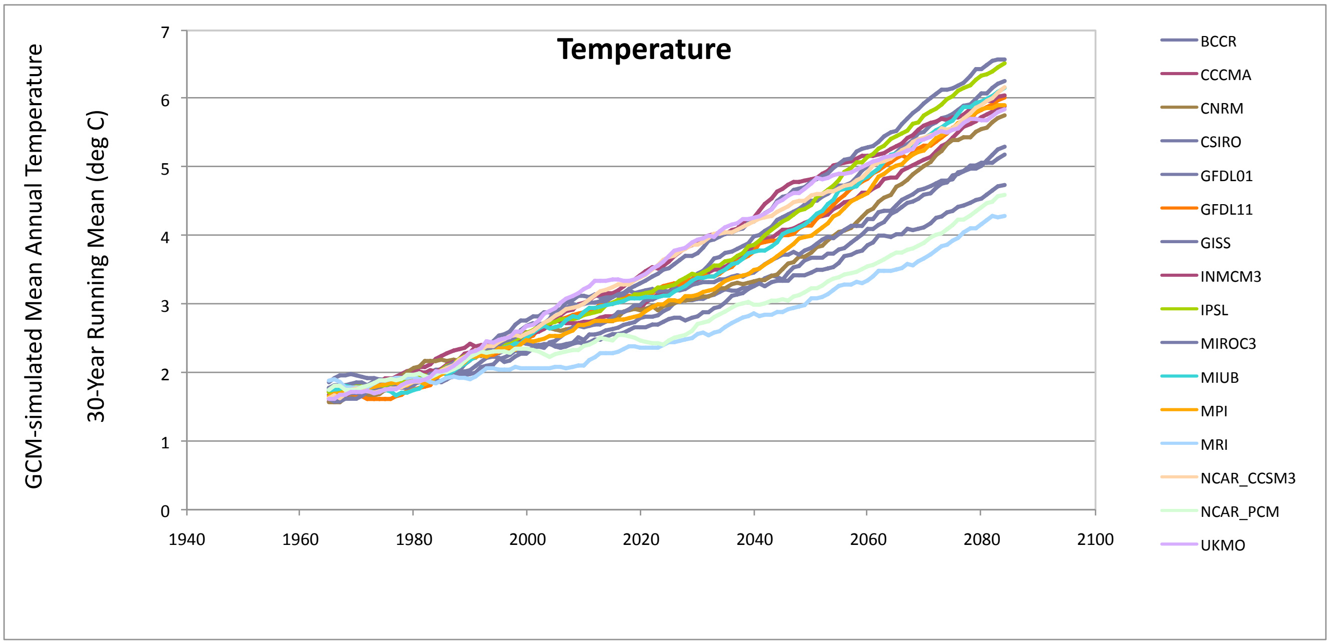
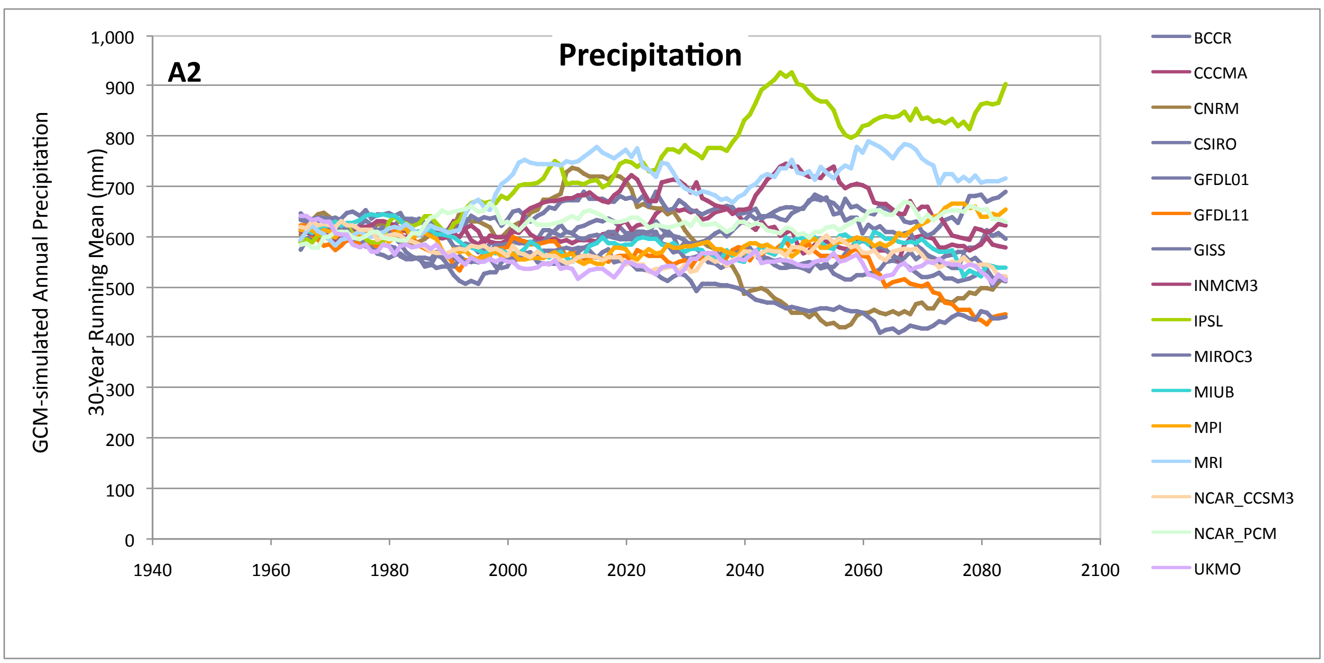


Exhibit 12D
30-Year Time Series Projected Precipitation Means for Eastern Sierra Nevada Watershed



On the other hand, forecasts for precipitation differ greatly between the GCMs. Some GCMs projected increases, but the majority of the model outputs projected decreases in precipitation over the study period. Exhibit 12D displays the time series of 30-year running means of the projected precipitation using the A2 GHG emission scenario (higher GHG emissions) averaged over the simulation area for each of the sixteen GCM models.

Temperature is the main climate variable that is projected to rise significantly in the coming years and decades. The rise in temperature directly affects several variables including:

- Whether precipitation falls as snow or rain.

- The ground-level temperature that determines the timing and rate of snowmelt.

- The temperature profile in the canopy that determines the rate of evapotranspiration.

Results have shown that future predictions for the early-21st century suggest a warming trend of 0.9 to 2.7˚F and almost no change in average precipitation. Mid-21st century projections suggest a warming trend of 3.6 to 5.4˚F and a small average decrease in precipitation, approximately 5 percent. This warming trend is expected to increase by the end of the 21st century, as the results indicate further warming of 4.5 to 8.1 ˚F and a decrease in precipitation of approximately 10 percent. In addition, results indicate an increase in the frequency and length of droughts in the end-of-century period.

Projected changes in temperature (warmer winters) will change precipitation patterns from snowfall to rainfall with a larger percentage coming as rain than historically encountered. Consequently, peak Snow Water Equivalent (SWE) and runoff are projected to undergo a shift in timing to earlier dates.

With a long term-shift in mean temperature of 3.6˚F, the snowpack of the eastern Sierras, at elevations of up to about 9,800 feet, is susceptible to earlier melt and less accumulation. On average, mean temperature rises are in the range of 3.6 to 10.8 ˚F resulting in about a 17 to 50 percent loss in snowpack storage, respectively. This vulnerability shows up in average to warm winters and will directly affect stream levels and stream discharge. This raises potential operational concerns for LADWP regarding adequate storage, especially the capacity of the LAA system to store the earlier runoff in surface reservoirs.

The projected temperature and precipitation dataset form the basis of the hydrologic model projections for runoff, SWE, and rain-to-snow ratio. To compare the future projections of these variables, the trends that dominated the second half of the 20th century are considered baselines for future trends. The baseline values for runoff, SWE, and rain-to-snow ratio are 0.6 million acre-feet (MAF), 15 inches, and 0.2, respectively. By early 21st century (2010 – 2039), results illustrate runoff is projected to undergo increases and decreases averaging between 0.5 to 0.85 MAF, the SWE is projected to undergo decreases and increases ranging between 10.6 to 19.0 inches, and the rain-to-snow ratio is projected to increase between 0.24 to 0.33. By mid-century (2040 – 2069), the same trends are expected to dominate, with runoff ranging between 0.34 to 0.9 MAF, the SWE ranging between 7.0 to 19.7 inches, and the rain-to-snow ratio increasing between 0.25 to 0.43. These trends are expected to govern until the end-of-century (2070 -2099) with runoff ranging between 0.35 to 1.1 MAF, the SWE ranging between 5.0 to 16.0 inches, and the rain-to-snow ratio increasing between 0.28 to 0.54. Exhibit 12E summarizes the projections for runoff, SWE, and rain-to-snow ratio for the 21st century.

Exhibit 12E
Projected Runoff, Snow-Water Equivalent, and Rain-to-Snow Ratio for Eastern Sierra Nevada Watershed

	Runoff (MAF)	April 1 SWE (Inches)	Rain/Snow Ratio
Baseline (Second Half of 20th Century)	**0.6**	**15.0**	**0.2**
Early 21st-century (2010-2039)	0.5 - 0.85	10.6 - 19.0	0.24 - 0.33
Mid-century (2040-2069)	0.34 - 0.9	7.0 - 19.7	0.25 - 0.43
End-of-century (2070-2099)	0.35 – 1.1	5.0 - 16.0	0.28 - 0.54

Exhibit 12F
Projected Rain to Precipitation Ratio Based on Projected Precipitation and Temperature

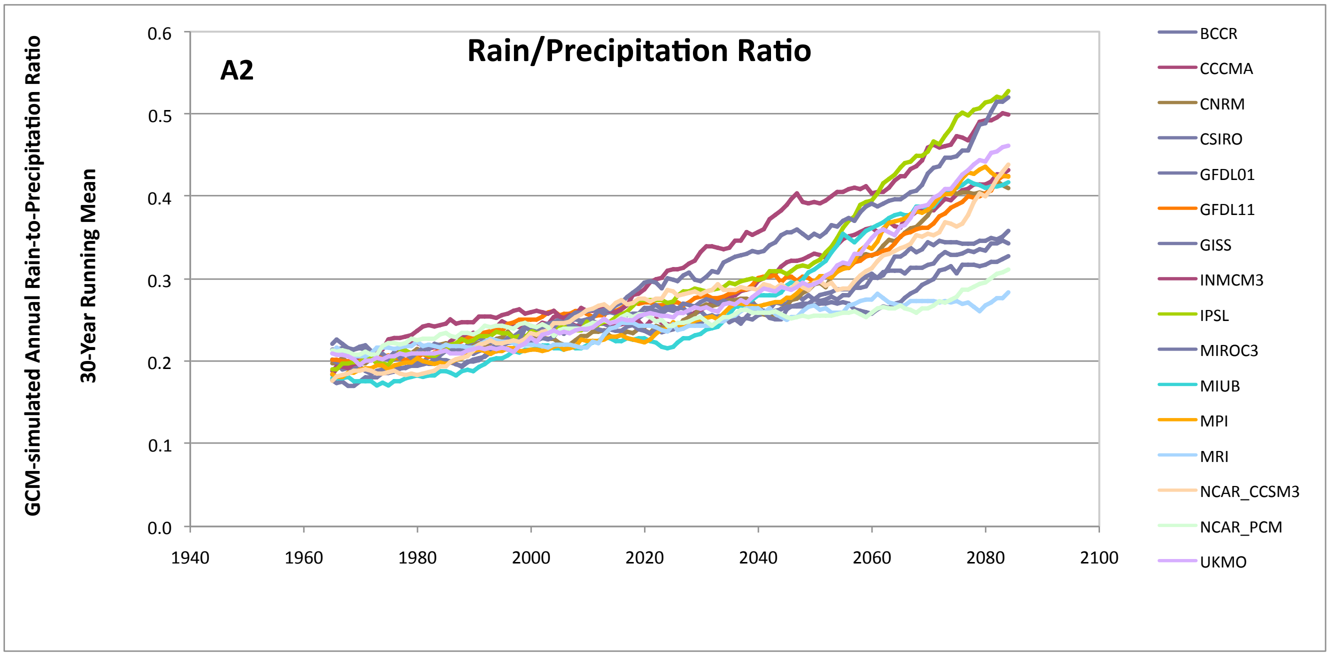


Exhibit 12F displays the rain-to-snow ratio based on the projected precipitation and temperature for the 16 GCMs. The rain-to-snow ratio is projected to increase throughout the 21st century, ranging between 0.24 to 0.33 by early 21st century, between 0.25 to 0.43 by mid-century, and between 0.28 to 0.54 by the end-of-century.

The increase of rain-to-snow ratio indicates the shift from snowfall to rainfall, specifically at low to moderate elevations, where the temperature tends to be warmer. This shift indicates more precipitation as liquid, and in turn, leads to loss of the snowpack. The snowpack is critical in providing seasonal storage by releasing winter precipitation in the spring and summer. The spring and summer snowmelt provides for increased soil moisture and stream flows needed to sustain both ecosystems and human populations.

Although the results above are quantitative in nature, it is important to account for the uncertainties inherent in these predictions. The results of this study will help guide the water managers in planning and developing water supply and infrastructure to ensure the reliability and sustainability of adequate water supply and delivery well into the future.

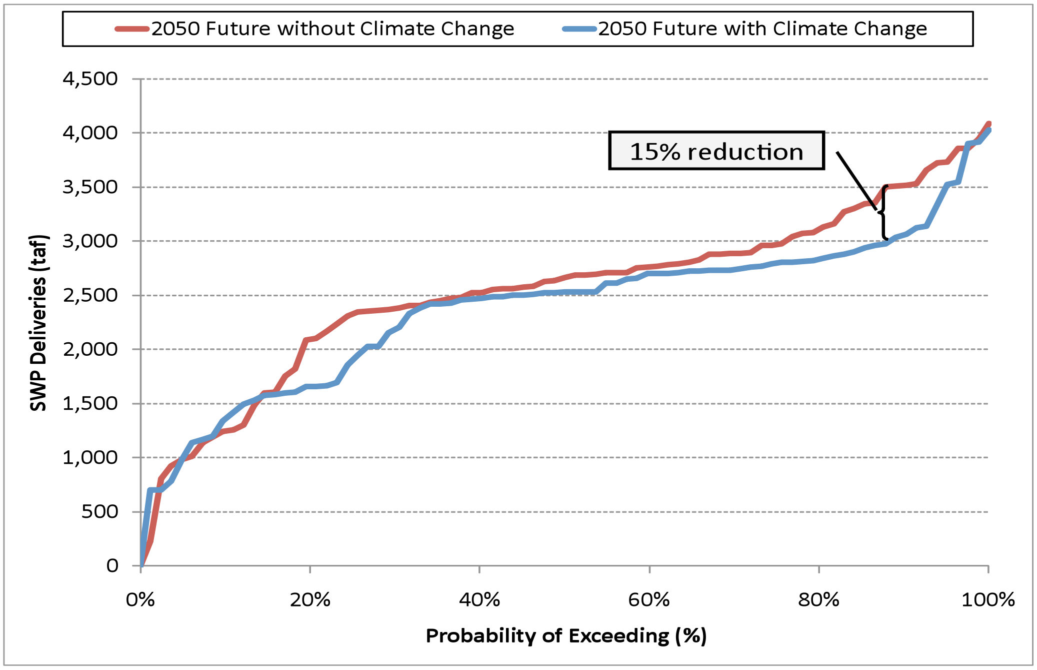
12.1.3 State Water Project Impacts

To date, most studies on climate change impacts to California's water supply have been conducted for the Northern California region. In August 2010, DWR released the 2009 State Water Project Delivery Reliability Report, which specifically analyzes changes in volume of water available under various climate change scenarios. DWR projected that SWP deliveries could be reduced by as much as 15 percent in some cases as illustrated in Exhibit 12G.

To incorporate climate change into its reliability reports, DWR reviewed 6 GCMs for year 2050 projections using lower emission and higher emission scenarios contained in *Using Future Climate Projections to Support Water Resources Decision Making in California* prepared in April 2009 by DWR. DWR selected the model most representing median effects on the SWP, which included a higher GHG scenario.

Climate change has the potential to disrupt SWP source supplies, impact conveyance, and alter storage levels in reservoir carryover storage. Annual Bay-Delta exports to areas south of the Bay-

Exhibit 12G
Climate Change Impacts on SWP Delivery



Delta are expected to decline 7 percent for the lower GHG emissions scenario and 10 percent for the higher emissions scenario. However, it should be noted that for the six GCMs under the lower and higher emission scenarios the range varies from a 2 percent increase to a 19 percent decrease illustrating the variability in the various GCMs.

By 2050, median reservoir carryover storage is projected to decline by 15 percent for the lower emissions scenario and 19 percent for the higher emissions scenario thereby reducing operational options if water shortages were to occur. Furthermore, by 2050 it is projected a water shortage worse than the 1977 drought could potentially occur in 1 out of every 6 to 8 years requiring acquisition of other supplies, reductions in water demands, or a combination thereof. An additional 575 to 850 TAF would be needed to maintain minimum SWP operation requirements and meet regulatory requirements. The main supply reservoirs on the SWP must maintain minimum water levels to allow water to pass through their lower release outlets in the dams. However, the April 2009 report does not consider the SWP vulnerable to a system interruption such as this under current conditions.

The primary effects of climate change on the SWP identified in the 2009 Reliability Report include, among others:

- More precipitation will fall as rain than snow.
- Reductions in Sierra snowpack.
- Sea level rise threatening the Bay-Delta levee system.
- Increased salinity in the Bay-Delta due to sea level rise requiring releases of freshwater from upstream reservoirs to maintain water quality standards.
- Shifted timing of snowmelt runoff into streams – spring runoff comes earlier resulting in increased winter flows and decreased spring flows.
- Increased flood events.

The most severe climate impacts in California are expected to occur in the Sierra watershed, where the SWP supply originates. Therefore, imported SWP water is extremely vulnerable to climate change.

12.1.4 Colorado River Aqueduct Impacts

Per MWD Board report titled "Report on Sustainable Water Deliveries from the Colorado River Factoring in Climate Change" and dated August 28, 2009, there have been numerous studies attempting to predict the impacts of climate change on the Colorado River. Several of the studies concluded that the Colorado River flow could be reduced by climate change by anywhere from 5 percent to 45 percent by the year 2050. The range of potential impacts can be very large thereby making it very challenging for water agencies to develop water management plans to address climate change impacts on the Colorado River Basin. Factors that have been identified and may contribute to this difficulty in narrowing the range of potential impacts of climate change on the Colorado River Basin include the following:

- The topography of the Colorado River Basin is difficult to model. Hydrologists have found that 80 percent of the flow of the Colorado River Basin is dependent upon the precipitation that falls in about 20 percent of the highest portions of the Upper Basin, in the mountains above 8,000 feet. Most global climate models are not precise enough to take into account the highly variable nature of the Colorado River Basin and can provide misleading results.

- There is a lack of data for much of the Colorado River Basin. While the runoff in the Colorado River Basin is well known, many other important watershed datasets are not readily available, including vegetation and soil type, soil moisture, wind, and solar radiation. These factors are important to predict future Colorado River flow and lack of data in remote areas presents uncertainty.

- Differences in modeling methods. Different modeling methods predict different runoff impacts from temperature increases due to GHG emissions. Each study used a different technique ranging from (1) using output from global climate models, to (2) statistical relationships relating temperature and precipitation to stream flow, to (3) a sophisticated model simulating soil moisture, snow accumulation and melt and evapotranspiration. Additionally, there is uncertainty in the level of GHG in the future based on the existing scientific literature.

In response to the potential impacts, MWD has worked to reduce demands by implementing water use efficiency programs in their service area including aggressive water conservation programs, and by increasing Colorado River supplies through programs such as agricultural to urban transfers.

12.2 Water and Energy Nexus

It is widely believed in the scientific community that the increase in concentrations of GHG in the atmosphere is a major contributing factor to climate change. As such, California is leading the way with laws that require reductions in GHG emissions and requirements to incorporate climate change impacts into long range water resource planning.

Carbon dioxide emissions into the atmosphere and the emissions of other GHGs are often associated with the burning of fossil fuels like crude oil and

coal in the generation of energy. As a significant amount of energy is required for the movement of water over long distances and elevations, a link was subsequently realized between water supply conveyance and corresponding GHG emissions through its energy consumption. An assessment of the GHG emissions, sometimes also known as carbon footprint expressed in units of tons CO_2, could be estimated for water. Once the size of a carbon footprint is known, a strategy can be developed to better manage and reduce its impact on climate change.

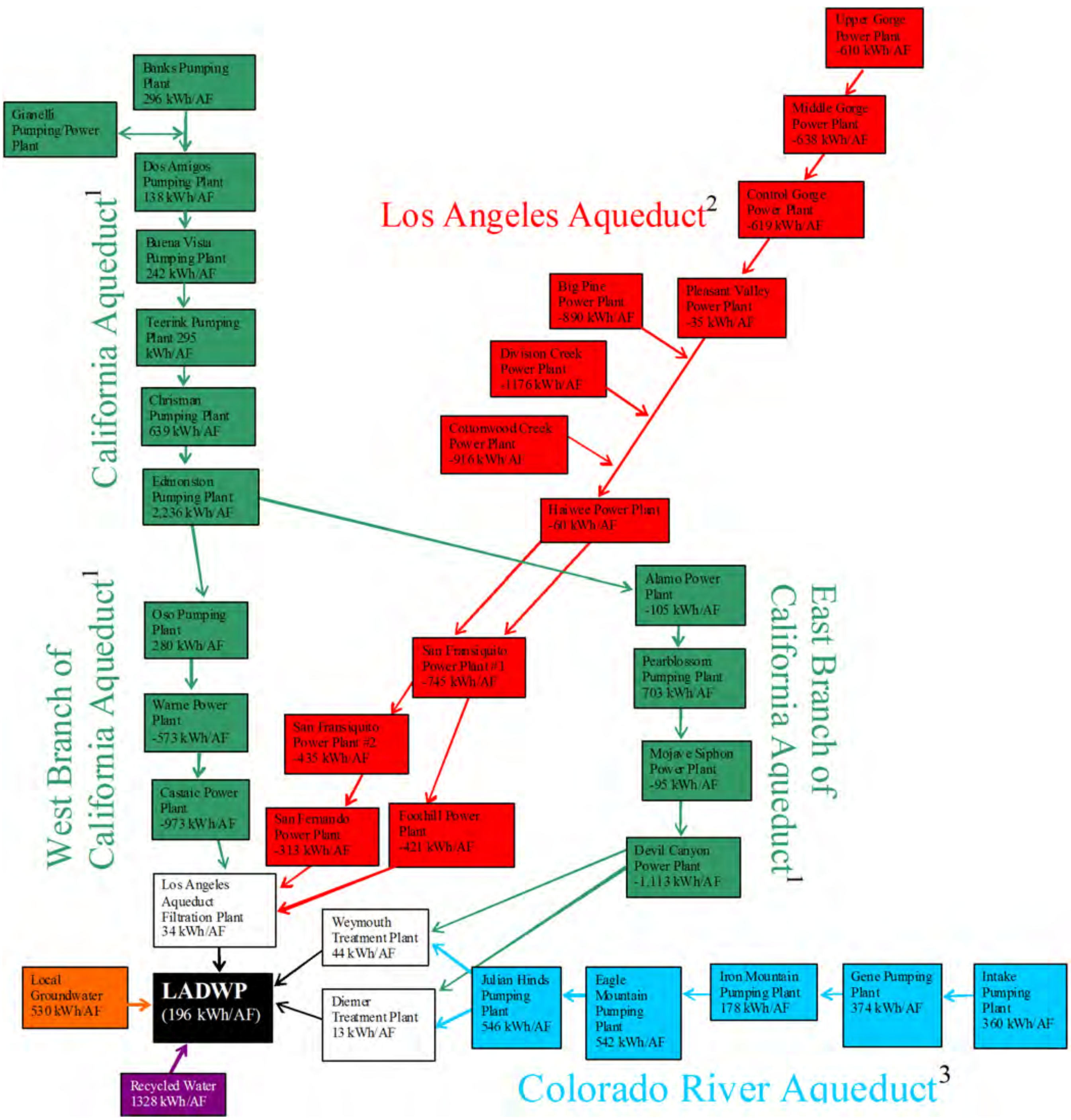
LADWP has taken the initiative to study the nexus between water and energy consumption and to evaluate the associated carbon footprint of its water system. The most energy intensive source of water for LADWP is water purchased from MWD, which imports SWP supplies via the California Aqueduct and Colorado River supplies via the CRA. LADWP also imports water via the LAA, which is a net producer of energy. Local sources of water for LADWP include groundwater and recycled water. Exhibit 12H outlines the sources of LADWP's water supply as well as the energy profiles of each facility that provides water to LADWP. For those sources of water operated by LADWP, the energy intensity has been computed by dividing the total energy consumed/generated by the total water produced or processed by that source.

12.2.1 State Water Project Supplies

Water supplied to Los Angeles via the SWP originates from Northern California and the Bay-Delta and is conveyed along the 444-mile long California Aqueduct to Southern California. Six pump stations are required to lift the water to the point at which the California Aqueduct splits into two branches. At the zenith of the California Aqueduct in the Tehachapi Mountains, approximately 3,846 kilowatt hours per acre foot (kWh/AF) is required to lift the water from the start of the aqueduct. After the water passes through Edmonston Pumping Plant, the California Aqueduct separates into two branches, the West Branch and the East Branch. Along the West Branch, the water is lifted once more at the Oso Pumping Plant and then energy is recovered through hydro-electric generation at the Warne and Castaic Power Plants. By the time the West Branch reaches its terminus at Lake Castaic, the net energy consumed in transporting the water from the Bay-Delta is approximately 2,580 kWh/AF. Water supplied through the West Branch is provided to the San Fernando Valley, Western Los Angeles, and Central Los Angeles communities.

Along the East Branch, the water generates power at the Alamo Power Plant, is lifted once more at Pearblossom Pumping Plant, and then used for generation at Mojave Siphon and Devil Canyon Power Plants. At the East Branch terminus at Lake Perris, approximately 3,236 kWh/AF of energy has been expended in the transport. Water conveyed through the East Branch is provided to the Eastern Los Angeles and Harbor communities. The water supplied from the SWP is the most energy intensive source of water available to LADWP.

Exhibit 12H
Energy Intensity of LADWP's Water Sources



1.Source: Methodology for Analysis of the Energy Intensity of California's Water Systems. p. 27.

2.Generation on the Los Angeles Aqueduct is not considered in LADWP's total energy intensity.

3.Energy intensities for the Colorado River Aqueduct pumping stations were derived by multiplying the total energy intensity for the aqueduct by the proportion of load for each individual pumping station in relation to the total load for all five pump stations.

4.Positive numbers indicate power consumption due to pumping and negative numbers indicate power generation.

12.2.2 Colorado River Aqueduct Supplies

Water supplied from the Colorado River is imported via the 242 mile CRA operated by MWD. From the start of the aqueduct at Lake Havasu to its terminus at Lake Mathews, the water is lifted approximately 1,617 feet. Five pumping stations along the aqueduct lift the water to MWD's service area requiring approximately 2,000 kWh/AF. CRA water is the second most energy intensive water source for Los Angeles and is supplied to the eastern Los Angeles and Harbor communities. Together SWP water and CRA water comprise the total imported provided by MWD to LADWP. MWD imported water is the most expensive water source for LADWP in terms of both cost and energy.

12.2.3 Los Angeles Aqueduct Supplies

The LAA provides water from the Eastern Sierra watershed and is entirely gravity fed. As a result, no energy is required to import LAA water, making it the most desirable source of water in terms of energy intensity. There are twelve power generation facilities along the aqueduct system. On average, the LAA generates approximately 6,848 kWh/AF from water directly used to generate power. This number was determined using the same methodology as was used to determine the energy intensity for the two branches of the SWP. The individual energy intensities for each individual generating facility were summed up to arrive at the total energy intensity for the water used to generate power. However, when considered from the perspective of total amount of water delivered to Los Angeles via the LAA, the energy generated along the aqueduct is approximately 2,456 kWh/AF. The variance between the numbers can be attributed to the fact that not all water wheeled through the aqueduct is used to generate power and the fact that a portion of the water is introduced into the aqueduct system at a point downstream of several of the power plants. For the purposes of determining LADWP's total energy intensity, the energy intensity of the LAA is considered to be zero since the power generated does not directly offset the energy required for other sources of water. However, in terms of supply the LAA is able to offset the more energy intensive sources of water, consequently reducing the overall energy intensity of LADWP's water supplies. As LAA flows to Los Angeles are decreased due to environmental enhancement efforts in the Owens Valley and Mono Basin, LADWP is forced to increasingly rely on energy intensive water purchased from MWD. LAA water currently supplies approximately 37 percent of the demand for Los Angeles.

12.2.4 Local Groundwater Supplies

Groundwater currently accounts for approximately 11 percent of LADWP's water supply and has an average energy intensity of approximately 530 kWh/AF. As LADWP continues with its cleanup of the contaminated water in the San Fernando Basin, groundwater will play an increasingly important role in Los Angeles' water supply. Although there is potential for a future increase in the energy required to produce groundwater due to the introduction of new treatment technologies, groundwater is expected to remain a low energy source of water when compared to imported supplies purchased from MWD. Increasing groundwater production will allow LADWP to offset the energy intensive MWD sources and reduce its overall energy intensity.

12.2.5 Recycled Water Supplies

Recycled water is currently the smallest component of LADWP's water supply portfolio, with municipal and industrial uses accounting for less than 1 percent of total supplies. Currently, LADWP directly receives recycled water from three wastewater treatment plants operated by Bureau of Sanitation (BOS), two of which provide recycled water treated to a tertiary level: Los Angeles Glendale (LAG) Treatment Plant and Donald C. Tillman (DCT) Treatment Plant. The Terminal Island Treatment Plant (TITP) performs advanced treatment of recycled water in addition to tertiary treatment. LADWP also directly receives a small portion of recycled water from the West Basin Municipal Water District (WBMWD), which provides additional treatment of wastewater from the Hyperion Treatment Plant (HTP) in El Segundo. Since all water at the plants directly supplying recycled water to LADWP is treated to at least a tertiary level regardless of disposal or reuse, the energy cost to treat the water to this level is considered a sunk cost because the water would be treated whether it offsets potable use or not. The advanced treatment process at the TITP is beyond the requirements for discharge and is therefore not considered a sunk cost. The incremental energy required to treat water from tertiary levels to advanced treatment levels at TITP requires approximately 2,200 kWh/AF. Since the treatment energy at the other two plants is not considered additional energy, only the pumping energy is included in the overall LADWP recycled water energy intensity. For the LAG, the pumping requires approximately 690 kWh/AF, and for the DCT the pumping requires approximately 450 kWh/AF. A weighted average of these values gives recycled water an energy intensity of approximately 1,139 kWh/AF. In the future, this number will likely change as the recycled water infrastructure is expanded. In addition to the municipal and industrial recycled water that is considered in LADWP's total supplies, the plants produce significant additional volumes of recycled water that is beneficially used. Beneficial uses include the seawater barrier for the Dominquez Gap using recycled water from TITP and the Japanese Garden and Los Angeles River from DCT.

12.2.6 Treatment Energy

Another factor in determining the energy intensity of LADWP's water is the energy required to treat water. All LAA water and nearly all West Branch SWP water purchased by LADWP are treated at the Los Angeles Aqueduct Filtration Plant (LAAFP). For the LAAFP, the average treatment energy intensity is approximately 34 kWh/AF. The East Branch SWP water and the CRA water are primarily treated at the Weymouth Treatment Plant in the San Gabriel Valley and the Diemer Treatment Plant in Orange County. Both of these treatment plants are operated by MWD. The average energy intensity for Weymouth Treatment Plant is approximately 42 kWh/AF and supplies water to the East Los Angeles Community. The average energy intensity for the Diemer Treatment Plant is 13 kWh/AF and supplies water to the Harbor Community. The mix of SWP East Branch water and CRA water that flows through these two treatment plants varies depending on the regional hydrology of the two sources, but on average approximately 55 percent SWP East Branch water and 45 percent CRA water flows through each of these MWD treatment plants.

The proportion that each of the above mentioned sources contributes to the LADWP's total supplies is displayed in Exhibit 12I. Of note is the relationship that the volume of LAA flow has to the amount of SWP water imported into the system. In this case, the energy free LAA water is replaced by the energy intensive SWP water resulting in an increase in the overall energy intensity.

12.2.7 Distribution Energy

LADWP benefits from the topography of its service area in that much of the hydraulic head required for water distribution is provided by gravity. With the major sources of LADWP's water entering the service area at higher elevation than the rest of the City, the energy required for distribution is lower than much of the region. The average energy intensity for LADWP water distribution is approximately 196 kWh/AF.

Exhibit 12J shows the sum of the energy intensities for LADWP from each of the individual sources between 2003 and 2009. Exhibit 12K shows a graphical representation of the total energy intensity for LADWP for the same time period. An important detail is the influence that LAA water has on the total energy intensity for a given year. For those years with large volumes of LAA water, such as 2005 and 2006, the total energy intensity was correspondingly low. Alternatively, those years with low volumes of LAA water have high total energy intensity as a result of the energy requirements for imported MWD supplies

Exhibit 12I
Proportion of Volume Delivered and Total Energy Intensity (Inclusive of Treatment)

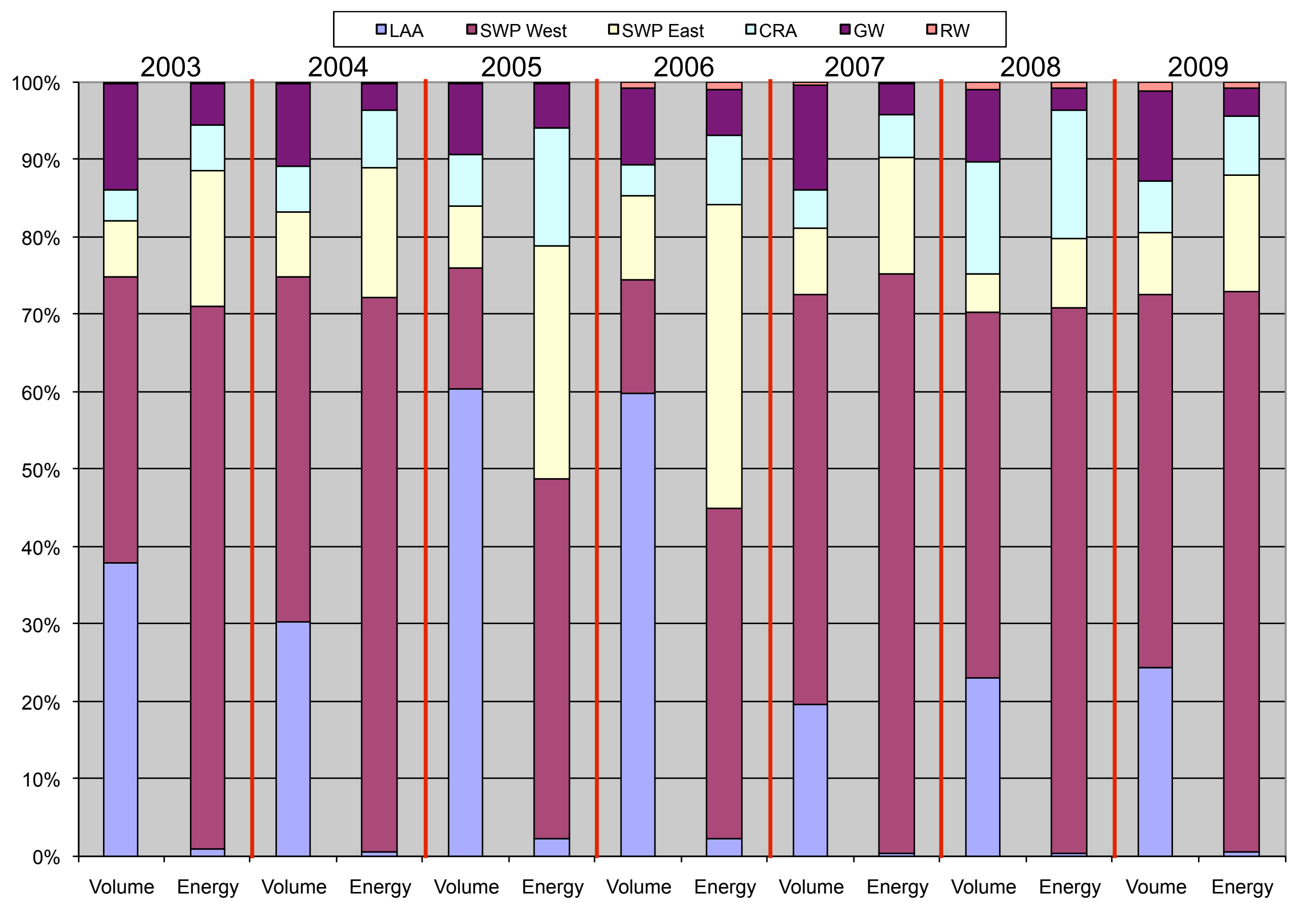


Exhibit 12J
LADWP Energy Intensity 2003-2009

		2003	2004	2005	2006	2007	2008	2009
Los Angeles Aqueduct (0 kWh/AF)	Volume (AF)	251,942	202,547	368,839	378,922	129,400	147,365	137,084
	Treatment Energy Intensity (kWh/AF)[1]	34	34	34	34	34	34	34
	Weighted Energy Intensity (kWh/AF)	13	10	20	20	7	8	8
State Water Project West Branch (2580 kWh/AF)	Volume (AF)	244,218	296,722	95,538	93,694	350,302	304,221	270,653
	Treatment Energy Intensity (kWh/AF)[1]	34	34	34	34	34	34	34
	Weighted Energy Intensity (kWh/AF)	961	1,161	408	386	1,384	1,237	1,258
State Water Project East Branch[3] (3236 kWh/AF)	Volume (AF)	48,980	56,301	49,526	68,796	56,357	31,016	45,246
	Treatment Energy Intensity (kWh/AF)[2]	27	27	27	27	27	27	27
	Weighted Energy Intensity (kWh/AF)	241	275	264	354	278	157	262
Colorado River Aqueduct[3] (2000 kWh/AF)	Volume (AF)	26,374	39,124	40,522	25,445	33,098	93,047	37,012
	Treatment Energy Intensity (kWh/AF)[2]	27	27	27	27	27	27	27
	Weighted Energy Intensity (kWh/AF)	80	119	134	81	101	293	133
Local Groundwater (530 kWh/AF)	Volume (AF)	90,835	71,831	56,547	63,270	89,018	60,149	64,996
	Weighted Energy Intensity (kWh/AF)	72	57	49	53	71	50	61
Recycled Water[4] (1,139 kWh/AF)	Volume (AF)	1,759	1,774	1,401	4,890	3,639	7,081	7,489
	Weighted Energy Intensity	3	3	3	9	6	13	15
Distribution (196 kWh/AF)	Volume (AF)	664,108	668,300	612,373	635,017	661,814	642,879	562,480
	Weighted Energy Intensity (kWh/AF)	196	196	196	196	196	196	196
Total Volume Delivered (AF)		664,108	668,300	612,373	635,017	661,814	642,879	562,480
Total Energy Intensity (kWh/AF)		1,567	1,820	1,074	1,098	2,043	1,954	1,934

1. Los Angeles Aqueduct and State Water Project West Branch supplies are treated at the Los Angeles Aqueduct Filtration Plant
2. Colorado River Aqueduct and State Water Project East Branch supplies are treated at Weymouth and Diemer Filtration Plants operated by Metropolitan Water District of Southern California. The listed energy intensity is based on an average of the energy intensity for the two plants.
3. Amount of SWP water and CRA water delivered is based on the reported average ratio of the two sources in Weymouth Treatment Plant and Diemer Treatment Plant effluent from MWD annual Water Quality Report
4. Recycled water volume is based on use for municipal and industrial uses, not all beneficial uses. Energy intensity is a weighted average of energy used for pumping to customers and the incremental energy to treat from tertiary to advanced treatment.

12.2.8 Carbon Footprint

All of LADWP's water supply sources have an associated carbon footprint related to the energy required to pump the water. Exhibit 12L provides the annual carbon footprint by water source. Exhibit 12M shows a graphical representation of the total annual carbon footprint for the same time period. For imported sources, the 2007 CAMX (Western Electricity Coordinating Council California Subregion name) California average carbon emission of 0.72412 lbs CO_2/kWh was used to estimate the amount of carbon emissions produced per acre-foot of water imported. For local sources, the CO_2 metric LADWP reported to the California Climate Action Registry in 2007 was used to estimate the carbon emissions released in the production of this water. LAA is a net producer of energy and produces only green hydropower. There are no carbon emissions associated with water imported through the LAA.

As Los Angeles increases its reliance on energy intensive imported supplies from MWD, its overall energy intensity will increase. Reductions in LAA flows due to environmental mitigation have the consequence of increasing Los Angeles' reliance on supplies imported through the SWP via the California Aqueduct, and Colorado River through the CRA.

Exhibit 12K
LADWP Annual Energy Intensity

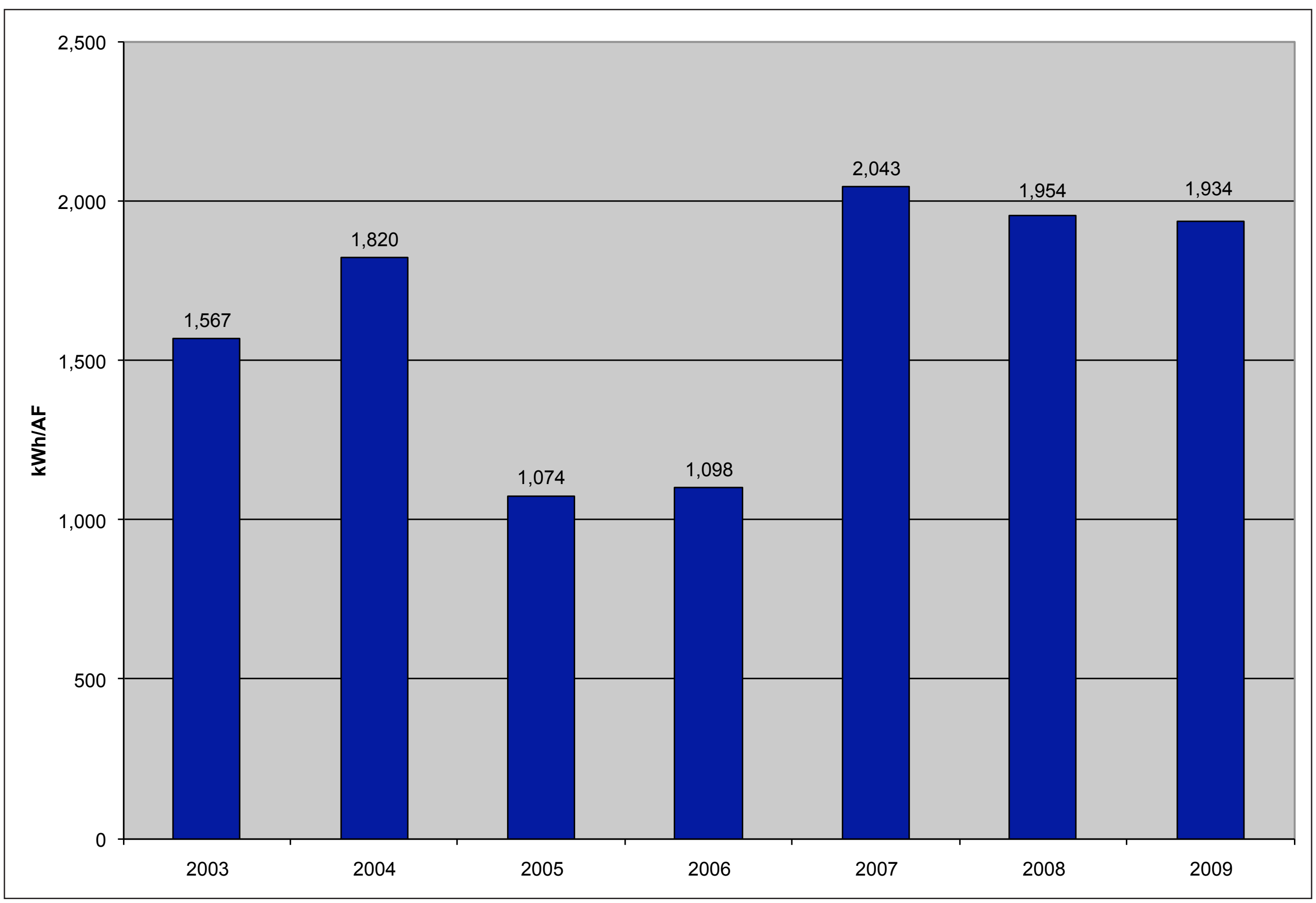


Exhibit 12L
Annual Footprint by Carbon Source

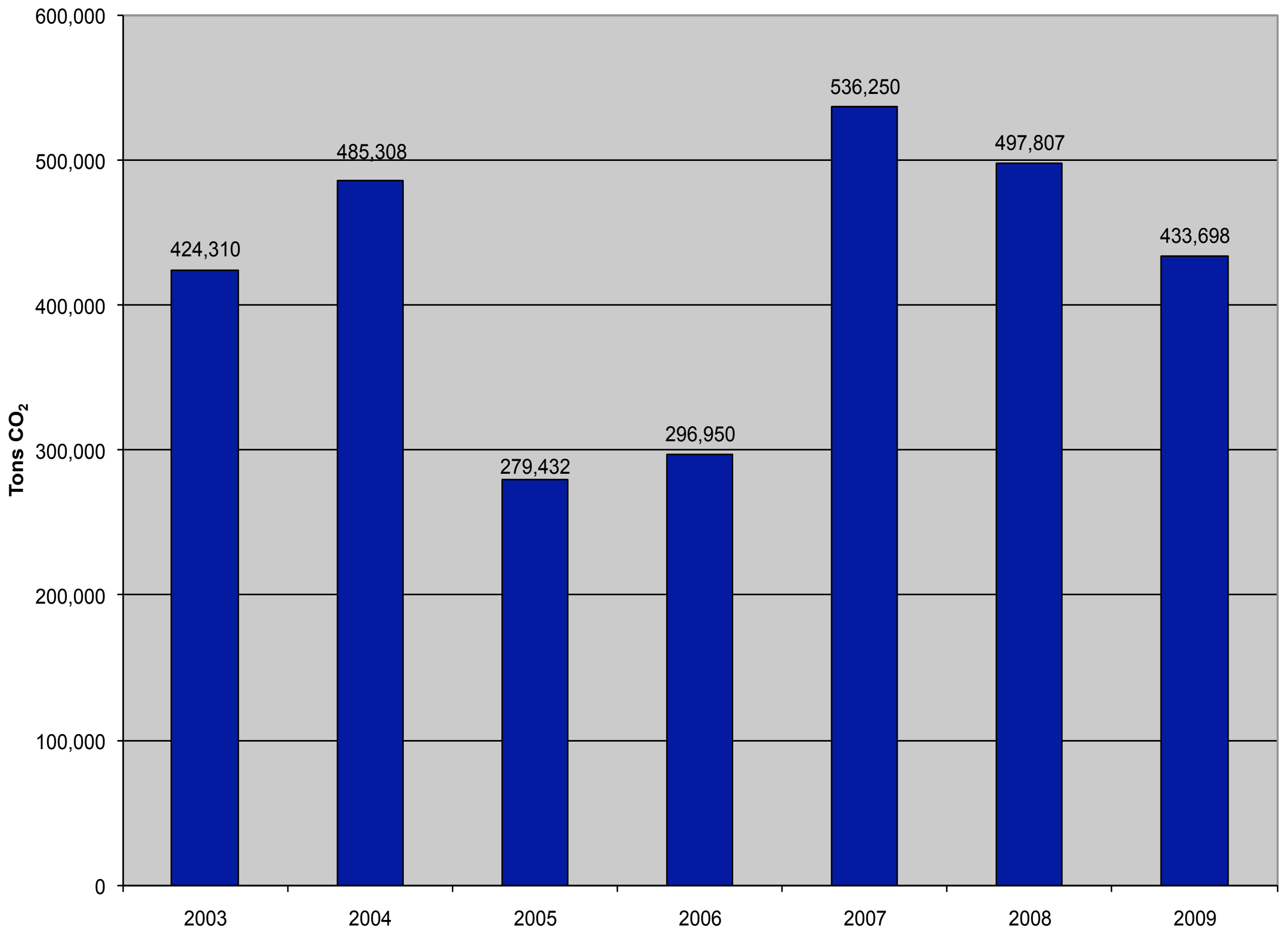
		2003	2004	2005	2006	2007	2008	2009
Los Angeles Aqueduct (0 kWh/AF)	Volume Delivered (AF)	251,942	202,547	368,839	378,922	129,400	147,365	137,084
	Energy Intensity (kWh/AF)	0	0	0	0	0	0	0
	Weighted Energy Intensity (kWh/AF)	13	10	20	20	7	8	8
	Carbon Footprint (tons CO_2)[2]	5,259	4,228	7,699	7,909	2,701	3,076	2,861
State Water Project West Branch (2,580 kWh/AF)	Volume Delivered (AF)	244,218	296,722	95,538	93,694	350,302	304,221	270,653
	Weighted Energy Intensity (kWh/AF)	961	1,161	408	386	1,384	1,237	1,258
	Carbon Footprint (tons CO_2)[3]	231,134	280,825	90,420	88,674	331,535	287,922	256,153
State Water Project East Branch (3,236 kWh/AF)	Volume Delivered (AF)	48,980	56,301	49,526	68,796	56,357	31,016	45,246
	Weighted Energy Intensity (kWh/AF)	241	275	264	354	278	157	262
	Carbon Footprint (tons CO_2)[3]	57,865	66,514	58,510	81,276	66,580	36,642	53,454
Colorado River Aqueduct[1] (2,000 kWh/AF)	Volume Delivered (AF)	26,374	39,124	40,522	25,445	33,098	93,047	37,012
	Weighted Energy Intensity (kWh/AF)	80	119	134	81	101	293	133
	Carbon Intensity (lbs CO2/kWh)	0.72412	0.72412	0.72412	0.72412	0.72412	0.72412	0.72412
	Carbon Footprint (tons CO_2)[3]	19,356	28,713	29,739	18,674	24,290	68,287	27,163
Local Groundwater (530 kWh/AF)	Volume Delivered (AF)	90,835	71,831	56,547	63,270	89,018	60,149	64,996
	Weighted Energy Intensity (kWh/AF)	72	57	49	53	71	50	61
	Carbon Footprint (tons CO_2)[2]	29,556	23,372	18,399	20,587	28,964	19,571	21,148
Recycled Water (1,139 kWh/AF)	Volume Delivered (AF)	1,759	1,774	1,401	4,890	3,639	7,081	7,489
	Weighted Energy Intensity (kWh/AF)	3	3	3	9	6	13	15
	Carbon Footprint (tons CO_2)[2]	1,230	1,240	980	3,419	2,545	4,951	5,237
Distribution (196 kWh/AF)	Volume Delivered (AF)	664,108	668,299	612,373	635,017	661,814	642,879	562,480
	Weighted Energy Intensity (kWh/AF)	196	196	196	196	196	196	196
	Carbon Footprint (tons CO_2)[3]	79,911	80,415	73,686	76,411	79,635	77,357	67,682
Total Volume Delivered (AF)		664,108	668,299	612,373	635,017	661,814	642,879	562,480
Total Energy Intensity (kWh/AF)		1,567	1,820	1,074	1,098	2,043	1,954	1,934
Total Carbon Footprint (tons CO_2)		424,310	485,308	279,432	296,950	536,250	497,807	433,698

1. Amount of SWP water and CRA water delivered is based on average of the proportion of the two sources delivered to MWD Weymouth Treatment Plant and Diemer Treatment Plant for the calendar year

2. Based on 2007 CO_2 metric of 1.22789 lbs CO_2/kWh reported to the California Climate Action Registry

3. Based on eGRID 2007 CAMX (California Average) of 0.72412 lbs CO_2/kWh

Exhibit 12M
Total Annual Carbon Footprint for Water Supply Portfolio



12.3 Climate Change Adaption and Mitigation

Climate change strategies fall under two main categories: adaptation and mitigation. For water resources planning, a climate change adaptation strategy involves taking steps to effectively manage the impacts of climate change by making water demands more efficient and relying on supply sources that are less vulnerable to climate change. A mitigation strategy involves proactive measures that reduce greenhouse gas emissions, such as placing a stronger emphasis on using water resources requiring less greenhouse gas emissions. Both LADWP and its wholesale supplier for imported water, MWD, are implementing adaption and mitigation strategies as they become aware of potential climate change impacts.

It is imperative that supply options are carefully vetted and evaluated against both adaptation and mitigation goals, as they may conflict and work against each other. For example, desalination is a typical supply option that performs quite well in adapting to climate change impacts; however, due to the energy necessary to draw from and manage the supply source, it could result in higher greenhouse gas emissions if conventional energy sources are utilized.

12.3.1 LADWP Adaption and Mitigation

LADWP has outlined strategies to dramatically increase conservation and water recycling. Increasing conservation and water recycling encompasses both adaption and mitigation goals to address climate change. The UWMP calls for reducing potable demands by an additional 64,368 AFY through conservation and 59,000 AFY of additional recycled water use by fiscal year 2030. Additional adaption strategies under investigation by LADWP and the City includes beneficial reuse of stormwater as discussed in Chapters Seven and Nine, Watershed Management and Other Potential Water Supplies, respectively.

Conservation has a double savings in terms of energy intensity because not only does it save energy in importing or producing the water, but it also saves energy through reduction of end use, such as heating water for a shower or for a dishwasher and wastewater treatment. The anticipated conservation savings will not only help to provide Los Angeles a secure and dependable water supply, but it will also reduce the energy footprint of the water supply, and consequently the carbon footprint. A further discussion regarding conservation is provided in Chapter Three, Conservation.

Recycled water use reduces reliance on potable water imported through MWD and provides a year round drought resistant water supply source. While the energy consumption requirements to produce recycled water are greater than local and LAA supply sources, recycled water assists LADWP in bolstering its supply portfolio to address potential supply changes related to climate change. A further discussion regarding recycled water is provided in Chapter 4, Recycled Water.

There is still general uncertainty within the scientific community regarding the potential impacts of climate change for the City of Los Angeles. LADWP will continue to stay abreast of developments in climate change to better understand its potential implications to the City's water supplies to assist in further developing adaption and mitigation strategies.

12.3.2 MWD Adaption and Mitigation

MWD is taking an active approach to adapt and mitigate against climate changes in its operations. Adaption and mitigation measures include:

- Investments in local resources to diversify MWD's water supply portfolio.
- Tracking climate change legislation – MWD provides input and direction on legislation.
- Collaborating on climate change with state, federal, and non-governmental agencies.
- Monitoring state and local climate change actions.
- Investigating the water supply and energy nexus.
- Coordinating with large water retailers.
- Integrating climate change into integrated resource planning as discussed in Chapter 10, Integrated Resource Planning.
- Sharing climate change knowledge and providing support – founding member of Water Utility Climate Alliance.
- Adopting energy management policies to support cost-effective and environmentally responsible programs, projects, and initiative.

MWD has also taken structural adaption measures including construction of the Inland Feeder. The Inland Feeder completed in 2009 connects SWP supplies with MWD's CRA supplies and allows delivery of SWP supplies to MWD's major reservoir, Diamond Valley Lake. In relation to climate change, the project will increase conveyance capacity allowing more rain to be conveyed as projected snowpack levels decrease and allow MWD to capture rain associated with projected short duration high intensity storms.

Urban Water
Management Plan
Appendix A

Urban Water Management Planning Act

CALIFORNIA WATER CODE DIVISION 6
PART 2.6. URBAN WATER MANAGEMENT PLANNING

All California Codes have been updated to include the 2010 Statutes.

CHAPTER 1.	GENERAL DECLARATION AND POLICY	10610-10610.4
CHAPTER 2.	DEFINITIONS	10611-10617
CHAPTER 3.	URBAN WATER MANAGEMENT PLANS	
Article 1.	General Provisions	10620-10621
Article 2.	Contents of Plans	10630-10634
Article 2.5.	Water Service Reliability	10635
Article 3.	Adoption and Implementation of Plans	10640-10645
CHAPTER 4.	MISCELLANEOUS PROVISIONS	10650-10656

WATER CODE
SECTION 10610-10610.4

10610. This part shall be known and may be cited as the "Urban Water Management Planning Act."

10610.2. (a) The Legislature finds and declares all of the following:

(1) The waters of the state are a limited and renewable resource subject to ever-increasing demands.

(2) The conservation and efficient use of urban water supplies are of statewide concern; however, the planning for that use and the implementation of those plans can best be accomplished at the local level.

(3) A long-term, reliable supply of water is essential to protect the productivity of California's businesses and economic climate.

(4) As part of its long-range planning activities, every urban water supplier should make every effort to ensure the appropriate level of reliability in its water service sufficient to meet the needs of its various categories of customers during normal, dry, and multiple dry water years.

(5) Public health issues have been raised over a number of contaminants that have been identified in certain local and imported water supplies.

(6) Implementing effective water management strategies, including groundwater storage projects and recycled water projects, may require specific water quality and salinity targets for meeting groundwater basins water quality objectives and promoting beneficial use of recycled water.

(7) Water quality regulations are becoming an increasingly important factor in water agencies' selection of raw water sources, treatment alternatives, and modifications to existing treatment facilities.

(8) Changes in drinking water quality standards may also impact the usefulness of water supplies and may ultimately impact supply reliability.

(9) The quality of source supplies can have a significant impact

on water management strategies and supply reliability.
(b) This part is intended to provide assistance to water agencies in carrying out their long-term resource planning responsibilities to ensure adequate water supplies to meet existing and future demands for water.

10610.4. The Legislature finds and declares that it is the policy of the state as follows:
(a) The management of urban water demands and efficient use of water shall be actively pursued to protect both the people of the state and their water resources.
(b) The management of urban water demands and efficient use of urban water supplies shall be a guiding criterion in public decisions.
(c) Urban water suppliers shall be required to develop water management plans to actively pursue the efficient use of available supplies.

WATER CODE SECTION 10611-10617

10611. Unless the context otherwise requires, the definitions of this chapter govern the construction of this part.

10611.5. "Demand management" means those water conservation measures, programs, and incentives that prevent the waste of water and promote the reasonable and efficient use and reuse of available supplies.

10612. "Customer" means a purchaser of water from a water supplier who uses the water for municipal purposes, including residential, commercial, governmental, and industrial uses.

10613. "Efficient use" means those management measures that result in the most effective use of water so as to prevent its waste or unreasonable use or unreasonable method of use.

10614. "Person" means any individual, firm, association, organization, partnership, business, trust, corporation, company, public agency, or any agency of such an entity.

10615. "Plan" means an urban water management plan prepared pursuant to this part. A plan shall describe and evaluate sources of supply, reasonable and practical efficient uses, reclamation and demand management activities. The components of the plan may vary according to an individual community or area's characteristics and its capabilities to efficiently use and conserve water. The plan shall address measures for residential, commercial, governmental, and industrial water demand management as set forth in Article 2 (commencing with Section 10630) of Chapter 3. In addition, a strategy and time schedule for implementation shall be included in the plan.

10616. "Public agency" means any board, commission, county, city and county, city, regional agency, district, or other public entity.

10616.5. "Recycled water" means the reclamation and reuse of wastewater for beneficial use.

10617. "Urban water supplier" means a supplier, either publicly or privately owned, providing water for municipal purposes either directly or indirectly to more than 3,000 customers or supplying more than 3,000 acre-feet of water annually. An urban water supplier includes a supplier or contractor for water, regardless of the basis of right, which distributes or sells for ultimate resale to customers. This part applies only to water supplied from public water systems subject to Chapter 4 (commencing with Section 116275) of Part 12 of Division 104 of the Health and Safety Code.

WATER CODE
SECTION 10620-10621

10620. (a) Every urban water supplier shall prepare and adopt an urban water management plan in the manner set forth in Article 3 (commencing with Section 10640).

(b) Every person that becomes an urban water supplier shall adopt an urban water management plan within one year after it has become an urban water supplier.

(c) An urban water supplier indirectly providing water shall not include planning elements in its water management plan as provided in Article 2 (commencing with Section 10630) that would be applicable to urban water suppliers or public agencies directly providing water, or to their customers, without the consent of those suppliers or public agencies.

(d) (1) An urban water supplier may satisfy the requirements of this part by participation in areawide, regional, watershed, or basinwide urban water management planning where those plans will reduce preparation costs and contribute to the achievement of conservation and efficient water use.

(2) Each urban water supplier shall coordinate the preparation of its plan with other appropriate agencies in the area, including other water suppliers that share a common source, water management agencies, and relevant public agencies, to the extent practicable.

(e) The urban water supplier may prepare the plan with its own staff, by contract, or in cooperation with other governmental agencies.

(f) An urban water supplier shall describe in the plan water management tools and options used by that entity that will maximize resources and minimize the need to import water from other regions.

10621. (a) Each urban water supplier shall update its plan at least once every five years on or before December 31, in years ending in five and zero.

(b) Every urban water supplier required to prepare a plan pursuant to this part shall, at least 60 days prior to the public hearing on the plan required by Section 10642, notify any city or county within which the supplier provides water supplies that the urban water supplier will be reviewing the plan and considering amendments or changes to the plan. The urban water supplier may consult with, and obtain comments from, any city or county that receives notice pursuant to this subdivision.

(c) The amendments to, or changes in, the plan shall be adopted and filed in the manner set forth in Article 3 (commencing with Section 10640).

WATER CODE SECTION 10630-10634

10630. It is the intention of the Legislature, in enacting this part, to permit levels of water management planning commensurate with the numbers of customers served and the volume of water supplied.

10631. A plan shall be adopted in accordance with this chapter that shall do all of the following:

(a) Describe the service area of the supplier, including current and projected population, climate, and other demographic factors affecting the supplier's water management planning. The projected population estimates shall be based upon data from the state, regional, or local service agency population projections within the service area of the urban water supplier and shall be in five-year increments to 20 years or as far as data is available.

(b) Identify and quantify, to the extent practicable, the existing and planned sources of water available to the supplier over the same five-year increments described in subdivision (a). If groundwater is identified as an existing or planned source of water available to the supplier, all of the following information shall be included in the plan:

(1) A copy of any groundwater management plan adopted by the urban water supplier, including plans adopted pursuant to Part 2.75 (commencing with Section 10750), or any other specific authorization for groundwater management.

(2) A description of any groundwater basin or basins from which the urban water supplier pumps groundwater. For those basins for which a court or the board has adjudicated the rights to pump groundwater, a copy of the order or decree adopted by the court or the board and a description of the amount of groundwater the urban water supplier has the legal right to pump under the order or decree. For basins that have not been adjudicated, information as to whether the department has identified the basin or basins as overdrafted or has projected that the basin will become overdrafted if present management conditions continue, in the most current official departmental bulletin that characterizes the condition of the groundwater basin, and a detailed description of the efforts being undertaken by the urban water supplier to eliminate the long-term overdraft condition.

(3) A detailed description and analysis of the location, amount, and sufficiency of groundwater pumped by the urban water supplier for the past five years. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historic use records.

(4) A detailed description and analysis of the amount and location of groundwater that is projected to be pumped by the urban water supplier. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historic use records.

(c) (1) Describe the reliability of the water supply and vulnerability to seasonal or climatic shortage, to the extent practicable, and provide data for each of the following:

(A) An average water year.

(B) A single dry water year.

(C) Multiple dry water years.

(2) For any water source that may not be available at a consistent level of use, given specific legal, environmental, water quality, or climatic factors, describe plans to supplement or replace that source with alternative sources or water demand management measures, to the extent practicable.

(d) Describe the opportunities for exchanges or transfers of water on a short-term or long-term basis.

(e) (1) Quantify, to the extent records are available, past and current water use, over the same five-year increments described in subdivision (a), and projected water use, identifying the uses among water use sectors, including, but not necessarily limited to, all of the following uses:

(A) Single-family residential.

(B) Multifamily.

(C) Commercial.

(D) Industrial.

(E) Institutional and governmental.

(F) Landscape.

(G) Sales to other agencies.

(H) Saline water intrusion barriers, groundwater recharge, or conjunctive use, or any combination thereof.

(I) Agricultural.

(2) The water use projections shall be in the same five-year increments described in subdivision (a).

(f) Provide a description of the supplier's water demand management measures. This description shall include all of the following:

(1) A description of each water demand management measure that is currently being implemented, or scheduled for implementation, including the steps necessary to implement any proposed measures, including, but not limited to, all of the following:

(A) Water survey programs for single-family residential and multifamily residential customers.

(B) Residential plumbing retrofit.

(C) System water audits, leak detection, and repair.

(D) Metering with commodity rates for all new connections and retrofit of existing connections.

(E) Large landscape conservation programs and incentives.

(F) High-efficiency washing machine rebate programs.

(G) Public information programs.

(H) School education programs.

(I) Conservation programs for commercial, industrial, and institutional accounts.

(J) Wholesale agency programs.
(K) Conservation pricing.
(L) Water conservation coordinator.
(M) Water waste prohibition.
(N) Residential ultra-low-flush toilet replacement programs.

(2) A schedule of implementation for all water demand management measures proposed or described in the plan.

(3) A description of the methods, if any, that the supplier will use to evaluate the effectiveness of water demand management measures implemented or described under the plan.

(4) An estimate, if available, of existing conservation savings on water use within the supplier's service area, and the effect of the savings on the supplier's ability to further reduce demand.

(g) An evaluation of each water demand management measure listed in paragraph (1) of subdivision (f) that is not currently being implemented or scheduled for implementation. In the course of the evaluation, first consideration shall be given to water demand management measures, or combination of measures, that offer lower incremental costs than expanded or additional water supplies. This evaluation shall do all of the following:

(1) Take into account economic and noneconomic factors, including environmental, social, health, customer impact, and technological factors.

(2) Include a cost-benefit analysis, identifying total benefits and total costs.

(3) Include a description of funding available to implement any planned water supply project that would provide water at a higher unit cost.

(4) Include a description of the water supplier's legal authority to implement the measure and efforts to work with other relevant agencies to ensure the implementation of the measure and to share the cost of implementation.

(h) Include a description of all water supply projects and water supply programs that may be undertaken by the urban water supplier to meet the total projected water use as established pursuant to subdivision (a) of Section 10635. The urban water supplier shall include a detailed description of expected future projects and programs, other than the demand management programs identified pursuant to paragraph (1) of subdivision (f), that the urban water supplier may implement to increase the amount of the water supply available to the urban water supplier in average, single-dry, and multiple-dry water years. The description shall identify specific projects and include a description of the increase in water supply that is expected to be available from each project. The description shall include an estimate with regard to the implementation timeline for each project or program.

(i) Describe the opportunities for development of desalinated water, including, but not limited to, ocean water, brackish water, and groundwater, as a long-term supply.

(j) For purposes of this part, urban water suppliers that are members of the California Urban Water Conservation Council shall be deemed in compliance with the requirements of subdivisions (f) and (g) by complying with all the provisions of the "Memorandum of Understanding Regarding Urban Water Conservation in California," dated December 10, 2008, as it may be amended, and by submitting the annual reports required by Section 6.2 of that memorandum.

(k) Urban water suppliers that rely upon a wholesale agency for a source of water shall provide the wholesale agency with water use projections from that agency for that source of water in five-year increments to 20 years or as far as data is available. The wholesale agency shall provide information to the urban water supplier for inclusion in the urban water supplier's plan that identifies and quantifies, to the extent practicable, the existing and planned sources of water as required by subdivision (b), available from the wholesale agency to the urban water supplier over the same five-year increments, and during various water-year types in accordance with subdivision (c). An urban water supplier may rely upon water supply information provided by the wholesale agency in fulfilling the plan informational requirements of subdivisions (b) and (c).

10631.1. (a) The water use projections required by Section 10631 shall include projected water use for single-family and multifamily residential housing needed for lower income households, as defined in Section 50079.5 of the Health and Safety Code, as identified in the housing element of any city, county, or city and county in the service area of the supplier.

(b) It is the intent of the Legislature that the identification of projected water use for single-family and multifamily residential housing for lower income households will assist a supplier in complying with the requirement under Section 65589.7 of the Government Code to grant a priority for the provision of service to housing units affordable to lower income households.

10631.5. (a) (1) Beginning January 1, 2009, the terms of, and eligibility for, a water management grant or loan made to an urban water supplier and awarded or administered by the department, state board, or California Bay-Delta Authority or its successor agency shall be conditioned on the implementation of the water demand management measures described in Section 10631, as determined by the department pursuant to subdivision (b).

(2) For the purposes of this section, water management grants and loans include funding for programs and projects for surface water or groundwater storage, recycling, desalination, water conservation, water supply reliability, and water supply augmentation. This section does not apply to water management projects funded by the federal American Recovery and Reinvestment Act of 2009 (Public Law 111-5).

(3) Notwithstanding paragraph (1), the department shall determine that an urban water supplier is eligible for a water management grant or loan even though the supplier is not implementing all of the water demand management measures described in Section 10631, if the urban water supplier has submitted to the department for approval a schedule, financing plan, and budget, to be included in the grant or loan agreement, for implementation of the water demand management measures. The supplier may request grant or loan funds to implement the water demand management measures to the extent the request is consistent with the eligibility requirements applicable to the water management funds.

(4) (A) Notwithstanding paragraph (1), the department shall

determine that an urban water supplier is eligible for a water management grant or loan even though the supplier is not implementing all of the water demand management measures described in Section 10631, if an urban water supplier submits to the department for approval documentation demonstrating that a water demand management measure is not locally cost effective. If the department determines that the documentation submitted by the urban water supplier fails to demonstrate that a water demand management measure is not locally cost effective, the department shall notify the urban water supplier and the agency administering the grant or loan program within 120 days that the documentation does not satisfy the requirements for an exemption, and include in that notification a detailed statement to support the determination.

(B) For purposes of this paragraph, "not locally cost effective" means that the present value of the local benefits of implementing a water demand management measure is less than the present value of the local costs of implementing that measure.

(b) (1) The department, in consultation with the state board and the California Bay-Delta Authority or its successor agency, and after soliciting public comment regarding eligibility requirements, shall develop eligibility requirements to implement the requirement of paragraph (1) of subdivision (a). In establishing these eligibility requirements, the department shall do both of the following:

(A) Consider the conservation measures described in the Memorandum of Understanding Regarding Urban Water Conservation in California, and alternative conservation approaches that provide equal or greater water savings.

(B) Recognize the different legal, technical, fiscal, and practical roles and responsibilities of wholesale water suppliers and retail water suppliers.

(2) (A) For the purposes of this section, the department shall determine whether an urban water supplier is implementing all of the water demand management measures described in Section 10631 based on either, or a combination, of the following:

(i) Compliance on an individual basis.

(ii) Compliance on a regional basis. Regional compliance shall require participation in a regional conservation program consisting of two or more urban water suppliers that achieves the level of conservation or water efficiency savings equivalent to the amount of conservation or savings achieved if each of the participating urban water suppliers implemented the water demand management measures. The urban water supplier administering the regional program shall provide participating urban water suppliers and the department with data to demonstrate that the regional program is consistent with this clause. The department shall review the data to determine whether the urban water suppliers in the regional program are meeting the eligibility requirements.

(B) The department may require additional information for any determination pursuant to this section.

(3) The department shall not deny eligibility to an urban water supplier in compliance with the requirements of this section that is participating in a multiagency water project, or an integrated regional water management plan, developed pursuant to Section 75026 of the Public Resources Code, solely on the basis that one or more of

the agencies participating in the project or plan is not implementing all of the water demand management measures described in Section 10631.

(c) In establishing guidelines pursuant to the specific funding authorization for any water management grant or loan program subject to this section, the agency administering the grant or loan program shall include in the guidelines the eligibility requirements developed by the department pursuant to subdivision (b).

(d) Upon receipt of a water management grant or loan application by an agency administering a grant and loan program subject to this section, the agency shall request an eligibility determination from the department with respect to the requirements of this section. The department shall respond to the request within 60 days of the request.

(e) The urban water supplier may submit to the department copies of its annual reports and other relevant documents to assist the department in determining whether the urban water supplier is implementing or scheduling the implementation of water demand management activities. In addition, for urban water suppliers that are signatories to the Memorandum of Understanding Regarding Urban Water Conservation in California and submit biennial reports to the California Urban Water Conservation Council in accordance with the memorandum, the department may use these reports to assist in tracking the implementation of water demand management measures.

(f) This section shall remain in effect only until July 1, 2016, and as of that date is repealed, unless a later enacted statute, that is enacted before July 1, 2016, deletes or extends that date.

10631.7. The department, in consultation with the California Urban Water Conservation Council, shall convene an independent technical panel to provide information and recommendations to the department and the Legislature on new demand management measures, technologies, and approaches. The panel shall consist of no more than seven members, who shall be selected by the department to reflect a balanced representation of experts. The panel shall have at least one, but no more than two, representatives from each of the following: retail water suppliers, environmental organizations, the business community, wholesale water suppliers, and academia. The panel shall be convened by January 1, 2009, and shall report to the Legislature no later than January 1, 2010, and every five years thereafter. The department shall review the panel report and include in the final report to the Legislature the department's recommendations and comments regarding the panel process and the panel's recommendations.

10632. (a) The plan shall provide an urban water shortage contingency analysis that includes each of the following elements that are within the authority of the urban water supplier:

(1) Stages of action to be undertaken by the urban water supplier in response to water supply shortages, including up to a 50 percent reduction in water supply, and an outline of specific water supply conditions that are applicable to each stage.

(2) An estimate of the minimum water supply available during each of the next three water years based on the driest three-year historic

sequence for the agency's water supply.
(3) Actions to be undertaken by the urban water supplier to prepare for, and implement during, a catastrophic interruption of water supplies including, but not limited to, a regional power outage, an earthquake, or other disaster.
(4) Additional, mandatory prohibitions against specific water use practices during water shortages, including, but not limited to, prohibiting the use of potable water for street cleaning.
(5) Consumption reduction methods in the most restrictive stages. Each urban water supplier may use any type of consumption reduction methods in its water shortage contingency analysis that would reduce water use, are appropriate for its area, and have the ability to achieve a water use reduction consistent with up to a 50 percent reduction in water supply.
(6) Penalties or charges for excessive use, where applicable.
(7) An analysis of the impacts of each of the actions and conditions described in paragraphs (1) to (6), inclusive, on the revenues and expenditures of the urban water supplier, and proposed measures to overcome those impacts, such as the development of reserves and rate adjustments.
(8) A draft water shortage contingency resolution or ordinance.
(9) A mechanism for determining actual reductions in water use pursuant to the urban water shortage contingency analysis.
(b) Commencing with the urban water management plan update due December 31, 2015, for purposes of developing the water shortage contingency analysis pursuant to subdivision (a), the urban water supplier shall analyze and define water features that are artificially supplied with water, including ponds, lakes, waterfalls, and fountains, separately from swimming pools and spas, as defined in subdivision (a) of Section 115921 of the Health and Safety Code.

10633. The plan shall provide, to the extent available, information on recycled water and its potential for use as a water source in the service area of the urban water supplier. The preparation of the plan shall be coordinated with local water, wastewater, groundwater, and planning agencies that operate within the supplier's service area, and shall include all of the following:
(a) A description of the wastewater collection and treatment systems in the supplier's service area, including a quantification of the amount of wastewater collected and treated and the methods of wastewater disposal.
(b) A description of the quantity of treated wastewater that meets recycled water standards, is being discharged, and is otherwise available for use in a recycled water project.
(c) A description of the recycled water currently being used in the supplier's service area, including, but not limited to, the type, place, and quantity of use.
(d) A description and quantification of the potential uses of recycled water, including, but not limited to, agricultural irrigation, landscape irrigation, wildlife habitat enhancement, wetlands, industrial reuse, groundwater recharge, indirect potable reuse, and other appropriate uses, and a determination with regard to the technical and economic feasibility of serving those uses.
(e) The projected use of recycled water within the supplier's

service area at the end of 5, 10, 15, and 20 years, and a description of the actual use of recycled water in comparison to uses previously projected pursuant to this subdivision.

(f) A description of actions, including financial incentives, which may be taken to encourage the use of recycled water, and the projected results of these actions in terms of acre-feet of recycled water used per year.

(g) A plan for optimizing the use of recycled water in the supplier's service area, including actions to facilitate the installation of dual distribution systems, to promote recirculating uses, to facilitate the increased use of treated wastewater that meets recycled water standards, and to overcome any obstacles to achieving that increased use.

10634. The plan shall include information, to the extent practicable, relating to the quality of existing sources of water available to the supplier over the same five-year increments as described in subdivision (a) of Section 10631, and the manner in which water quality affects water management strategies and supply reliability.

WATER CODE SECTION 10635

10635. (a) Every urban water supplier shall include, as part of its urban water management plan, an assessment of the reliability of its water service to its customers during normal, dry, and multiple dry water years. This water supply and demand assessment shall compare the total water supply sources available to the water supplier with the total projected water use over the next 20 years, in five-year increments, for a normal water year, a single dry water year, and multiple dry water years. The water service reliability assessment shall be based upon the information compiled pursuant to Section 10631, including available data from state, regional, or local agency population projections within the service area of the urban water supplier.

(b) The urban water supplier shall provide that portion of its urban water management plan prepared pursuant to this article to any city or county within which it provides water supplies no later than 60 days after the submission of its urban water management plan.

(c) Nothing in this article is intended to create a right or entitlement to water service or any specific level of water service.

(d) Nothing in this article is intended to change existing law concerning an urban water supplier's obligation to provide water service to its existing customers or to any potential future customers.

WATER CODE
SECTION 10640-10645

10640. Every urban water supplier required to prepare a plan pursuant to this part shall prepare its plan pursuant to Article 2 (commencing with Section 10630).

The supplier shall likewise periodically review the plan as required by Section 10621, and any amendments or changes required as a result of that review shall be adopted pursuant to this article.

10641. An urban water supplier required to prepare a plan may consult with, and obtain comments from, any public agency or state agency or any person who has special expertise with respect to water demand management methods and techniques.

10642. Each urban water supplier shall encourage the active involvement of diverse social, cultural, and economic elements of the population within the service area prior to and during the preparation of the plan. Prior to adopting a plan, the urban water supplier shall make the plan available for public inspection and shall hold a public hearing thereon. Prior to the hearing, notice of the time and place of hearing shall be published within the jurisdiction of the publicly owned water supplier pursuant to Section 6066 of the Government Code. The urban water supplier shall provide notice of the time and place of hearing to any city or county within which the supplier provides water supplies. A privately owned water supplier shall provide an equivalent notice within its service area. After the hearing, the plan shall be adopted as prepared or as modified after the hearing.

10643. An urban water supplier shall implement its plan adopted pursuant to this chapter in accordance with the schedule set forth in its plan.

10644. (a) An urban water supplier shall submit to the department, the California State Library, and any city or county within which the supplier provides water supplies a copy of its plan no later than 30 days after adoption. Copies of amendments or changes to the plans shall be submitted to the department, the California State Library, and any city or county within which the supplier provides water supplies within 30 days after adoption.

(b) The department shall prepare and submit to the Legislature, on or before December 31, in the years ending in six and one, a report summarizing the status of the plans adopted pursuant to this part. The report prepared by the department shall identify the exemplary elements of the individual plans. The department shall provide a copy of the report to each urban water supplier that has submitted its plan to the department. The department shall also prepare reports and provide data for any legislative hearings designed to consider the effectiveness of plans submitted pursuant to this part.

(c) (1) For the purpose of identifying the exemplary elements of the individual plans, the department shall identify in the report those water demand management measures adopted and implemented by specific urban water suppliers, and identified pursuant to Section

10631, that achieve water savings significantly above the levels established by the department to meet the requirements of Section 10631.5.

(2) The department shall distribute to the panel convened pursuant to Section 10631.7 the results achieved by the implementation of those water demand management measures described in paragraph (1).

(3) The department shall make available to the public the standard the department will use to identify exemplary water demand management measures.

10645. Not later than 30 days after filing a copy of its plan with the department, the urban water supplier and the department shall make the plan available for public review during normal business hours.

WATER CODE
SECTION 10650-10656

10650. Any actions or proceedings to attack, review, set aside, void, or annul the acts or decisions of an urban water supplier on the grounds of noncompliance with this part shall be commenced as follows:

(a) An action or proceeding alleging failure to adopt a plan shall be commenced within 18 months after that adoption is required by this part.

(b) Any action or proceeding alleging that a plan, or action taken pursuant to the plan, does not comply with this part shall be commenced within 90 days after filing of the plan or amendment thereto pursuant to Section 10644 or the taking of that action.

10651. In any action or proceeding to attack, review, set aside, void, or annul a plan, or an action taken pursuant to the plan by an urban water supplier on the grounds of noncompliance with this part, the inquiry shall extend only to whether there was a prejudicial abuse of discretion. Abuse of discretion is established if the supplier has not proceeded in a manner required by law or if the action by the water supplier is not supported by substantial evidence.

10652. The California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public Resources Code) does not apply to the preparation and adoption of plans pursuant to this part or to the implementation of actions taken pursuant to Section 10632. Nothing in this part shall be interpreted as exempting from the California Environmental Quality Act any project that would significantly affect water supplies for fish and wildlife, or any project for implementation of the plan, other than projects implementing Section 10632, or any project for expanded or additional water supplies.

10653. The adoption of a plan shall satisfy any requirements of state law, regulation, or order, including those of the State Water Resources Control Board and the Public Utilities Commission, for the preparation of water management plans or conservation plans; provided, that if the State Water Resources Control Board or the Public Utilities Commission requires additional information concerning water conservation to implement its existing authority, nothing in this part shall be deemed to limit the board or the commission in obtaining that information. The requirements of this part shall be satisfied by any urban water demand management plan prepared to meet federal laws or regulations after the effective date of this part, and which substantially meets the requirements of this part, or by any existing urban water management plan which includes the contents of a plan required under this part.

10654. An urban water supplier may recover in its rates the costs incurred in preparing its plan and implementing the reasonable water conservation measures included in the plan. Any best water management practice that is included in the plan that is identified in the

"Memorandum of Understanding Regarding Urban Water Conservation in California" is deemed to be reasonable for the purposes of this section.

10655. If any provision of this part or the application thereof to any person or circumstances is held invalid, that invalidity shall not affect other provisions or applications of this part which can be given effect without the invalid provision or application thereof, and to this end the provisions of this part are severable.

10656. An urban water supplier that does not prepare, adopt, and submit its urban water management plan to the department in accordance with this part, is ineligible to receive funding pursuant to Division 24 (commencing with Section 78500) or Division 26 (commencing with Section 79000), or receive drought assistance from the state until the urban water management plan is submitted pursuant to this article.

Urban Water Management Plan

Appendix B

Urban Water Management Plan Checklist and Standard Tables

2010 UWMP Checklist

No.	UWMP Requirements	CA Water Code Reference	Subject	UWMP Location	UWMP Guidebook Standardized Table Locations	Additional Clarification
1	Provide baseline daily per capita water use, urban water use target, interim urban water use target, and compliance daily per capita water use, along with the bases for determining those estimates, including references to supporting data.	10608.20(e)	System Demands	p 51-52 (Sec 3.1.2), Appendix G (2020 Water Use Target)	13, 14, 15	
2	Wholesalers: Include an assessment of present and proposed future measures, programs, and policies to help achieve the water use reductions. Retailers: Conduct at least one public hearing that includes general discussion of the urban retail water supplier's implementation plan for complying with the Water Conservation Bill of 2009.	10608.36, 10608.26 (a)	System Demands	Appendix D - Four public worshops were held on 1/2/10, 1/20/10, 2/3/11, & 2/9/11. Final public hearings for the adoption was held on 5/3/11.	Not Applicable	
3	Report progress in meeting urban water use targets using the standardized form.	10608.40	Not Applicable	Standardized form not yet available	Not Applicable	
4	Each urban water supplier shall coordinate the preparation of its plan with other appropriate agencies in the area, including other water suppliers that share a common source, water management agencies, and relevant public agencies, to the extent practicable	10620(d)(2)	Plan Preparation	Various pages reference reports, communication, and coordination with City Planning, Bureau of Sanitation, MWD, SCAG, TreePeople, and other agencies & stakeholders. Appendix D documents public involments.	1	
5	An urban water supplier shall describe in the plan water management tools and options used by that entity that will maximize resources and minimize the need to import water from other regions.	10620(f)	Water Supply Reliability	p 1	Not Applicable	
6	Every urban water supplier required to prepare a plan pursuant to this part shall, at least 60 days prior to the public hearing on the plan required by Section 10642, notify any city or county within which the supplier provides water supplies that the urban water supplier will be reviewing the plan and considering amendments of changes to the plan. The urban water supplier may consult with, and obtain comments from, any city or county that receives notice pursuant to this subdivision.	10621(b)	Plan Preparation	Appendix D (Notice of Meeting & Public Comments)	Not Applicable	
7	The amendments to, or changes in, the plan shall be adopted and filed in the manner set forth in Article 3 (commencing with Section 10640).	10621(c)	Plan Preparation	To be enclosed with transmittal letter to DWR.	Not Applicable	
8	Describe the service area of the supplier	10631(a)	System Description	p 1 & 30 (Sec 1.2)	Not Applicable	
9	(Describe the service area) climate	10631(a)	System Description	p 34 (Sec1.2.3 & Exhibit 1E)	Not Applicable	
10	(Describe the service area) current and projected population . . . The projected population estimates shall be based upon data from the state, regional, or local service agency population projections within the service area of the urban water supplier…	10631(a)	System Description	p 31-33 (Sec 1.2.2)	2	Provide the most recent population data possible. Use the method described in "Baseline Daily Per Capita Water Use." See Section M.
11	. . . (population projections) shall be in five-year increments to 20 years or as far as data is available.	10631(a)	System Description	p 32 (Exhibit 1C)	2	2035 and 2040 can also be provided to support consistency with Water Supply Assessments and Written Verification of Water Supply Documents
12	Describe . . . other demographic factors affecting the supplier's water management planning	10631(a)	System Description	p 32 (Exhibit 1C), p 43 (Exhibit 2G), p 44 (socioeconomic variables)	Not Applicable	
13	Identify and quantify, to the extent practicable, the existing and planned sources of water available to the supplier over the same five-year increments described in subdivision (a).	10631(b)	System Supplies	p 229 (Exhibit 11E)	16	The 'existing' water sources should be for the same year as the "current population" in line 10. 2035 and 2040 can also be provided to support consistency with Water Supply Assessments and Written Verification of Water Supply documents.
14	(Is) groundwater . . . identified as an existing or planned source of water available to the supplier . . .?	10631(b)	System Supplies	p 123 (Exhibit 6B) & p 136 (Exhibit 6G)	18, 19	Source classifications are: surface water, groundwater, recycled water, storm water, desalinated sea water, desalinated brackish groundwater, and other.

2010 UWMP Checklist

No.	UWMP Requirements	CA Water Code Reference	Subject	UWMP Location	UWMP Guidebook Standardized Table Locations	Additional Clarification
15	(Provide a) copy of any groundwater management plan adopted by the urban water supplier, including plans adopted pursuant to Part 2.75 (commencing with Section 10750), or any other specific authorization for groundwater management. Indicate whether a groundwater management plan been adopted by the water supplier or if there is anyother specific authorization for groundwater management. Include a copy of the plan or authorization.	10631(b)(1)	System Supplies	p 8 (Local Groundwater), Appendix F (Groundwater Basin Adjudications)	Not Applicable	
16	(Provide a) description of any groundwater basin or basins from which the urban water supplier pumps groundwater.	10631(b)(2)	System Supplies	p 123, 129, 130, 132 (description of individual basin)	Not Applicable	
17	For those basins for which a court or the board has adjudicated the rights to pump groundwater, (provide) a copy of the order or decree adopted by the court or the board	10631(b)(2)	System Supplies	Appendix F (Groundwater Basin Adjudications)	Not Applicable	
18	(Provide) a description of the amount of groundwater the urban water supplier has the legal right to pump under the order or decree.	10631(b)(2)	System Supplies	p 121 (Sec 6.1, Exhibit 6A)	Not Applicable	
19	For basins that have not been adjudicated, (provide) information as to whether the department has identified the basin or basins as overdrafted or has projected that the basin will become overdrafted if present management conditions continue, in the most current official departmental bulletin that characterizes the condition of the groundwater basin, and a detailed description of the efforts being undertaken by the urban water supplier to eliminate the long-term overdraft condition.	10631(b)(2)	System Supplies	Not Applicable	Not Applicable	
20	(Provide a) detailed description and analysis of the location, amount, and sufficiency of groundwater pumped by the urban water supplier for the past five years. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historic use records	10631(b)(3)	System Supplies	p 121-132, Exhibit 6B	18	
21	(Provide a) detailed description and analysis of the amount and location of groundwater that is projected to be pumped by the urban water supplier. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historic use records.	10631(b)(4)	System Supplies	p 136	19	Provide projections for 2015, 2020, 2025, and 2030.
22	Describe the reliability of the water supply and vulnerability to seasonal or climatic shortage, to the extent practicable, and provide data for each of the following: (A) An average water year, (B) A single dry water year, (C) Multiple dry water years.	10631(c)(1)	Water Supply Reliability	p 223-227 (Sec 11.2 with description), p 229-235 (data, Exhibits 11E-11K)	27, 28, 32, 33, 34	
23	For any water source that may not be available at a consistent level of use - given specific legal, environmental, water quality, or climatic factors - describe plans to supplement or replace that source with alternative sources or water demand management measures, to the extent practicable.	10631(c)(2)	Water Supply Reliability	Sec 11.2.3 to 11.2.7	29, 30	
24	Describe the opportunities for exchanges or transfers of water on a short-term or long-term basis.	10631(d)	System Supplies	p 195-199	20	

2010 UWMP Checklist

No.	UWMP Requirements	CA Water Code Reference	Subject	UWMP Location	UWMP Guidebook Standardized Table Locations	Additional Clarification
25	Quantify, to the extent records are available, past and current water use, and projected water use (over the same five-year increments described in subdivision (a)), identifying the uses among water use sectors, including, but not necessarily limited to, all of the following uses: (A) Single-family residential; (B) Multifamily; (C) Commercial; (D) Industrial; (E) Institutional and governmental; (F) Landscape; (G) Sales to other agencies; (H) Sakine water intrusion barriers, groundwater recharge, or conjunctive use, or any combination thereof; (I) Agricultural.	10631(e)(1)	System Demands	p 10 (Exhibit ES-G), p 45 (Exhibit 2J)	3, 4, 5, 6, 7, 11	Consider "past" to be 2005, present to be 2010, and projected to be 2015, 2020, 2025, and 2030. Provide numbers for each category for each of these years.
26	(Describe and provide a schedule of implementation for) each water demand management measure that is currently being implemented, or scheduled for implementation, including the steps necessary to implement any proposed measures, including, but not limited to, all of the following: (A) Water survey programs for single-family residential and multifamily residential customers; (B) Residential plumbing retrofit; (C) System water audits, leak detection, and repair; (D) Metering with commodity rates for all new connections and retrofit of existing connections;(E) Large landscape conservation programs and incentives; (F) High-efficiency washing machine rebate programs;(G) Public information programs; (H) School education programs; (I) Conservation programs for commercial, industrial, and institutional accounts; (J) Wholesale agency programs; (K) Conservation pricing; (L) Water conservation coordinator; (M) Water waste prohibition;(N) Residential ultralow- flush toilet replacement programs	10631(f)(1)	DMMs	p 52-70 (Sec 3.2)	Not Applicable	(A) Water Survey for Single and Multi-family residential customers: Exhibit 3F, Exhibit 3G, Section 3.2.4 - Residential Category (B) Residential Plumbing Retrofit: Section 3.2.1 and 3.2.4, Exhibit 3G (C) System Water Audits, Leak Detection, and Repair: Exhibit 3F, Exhibit 3G, Section 3.2.4 - System Maintenance Category (D) Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections: Exhibit 3F, Exhibit 3G, Section 3.2.2 (E) Large Landscape Conservation Programs and Incentives: Exhibit 3F, Exhibit 3G, Section 3.2.4 - Landscape (F) High-Efficiency Washing Machine Rebate Programs: Exhibit 3F, Exhibit 3G, Section 3.2.4 - Residential (G) Public Information Programs: Exhibit 3F, Exhibit 3G, Section 3.2.4 - Awareness/Support Measures (H) School Education Programs: Exhibit 3F, Exhibit 3G, Section 3.2.4 - Awareness/Support Measures(I) Conservation Programs for Commercial, Industrial, and Institutional Accounts: Exhibit 3F, Exhibit 3G, Section 3.2.4 - Commercial/Industrial/Institutional Category (J) Wholesale Agency Programs: Not applicable (stated so in 3.2.3) (K) Conservation pricing: Section 3.2.2, Exhibit 3F, Exhibit 3G (L) Water Conservation Coordinator: Exhibit 3F, Exhibit 3G, Section 3.2.4 (M) Water Waste Prohibition: Section 3.2.1, Exhibit 3F, Exhibit 3G (N) Residential Ultralow-flush Toilet Replacement Programs: Exhibit 3F, Exhibit 3G, Section 3.2.4 - Residential Category
27	A description of the methods, if any, that the supplier will use to evaluate the effectiveness of water demand management measures implemented or described under the plan.	10631(f)(3)	DMMs	p 41-42 (Sec 2.2, Exhibits 2E & 2F), p 245-246 (Sec 11.3.9)	Not Applicable	
28	An estimate, if available, of existing conservation savings on water use within the supplier's service area, and the effect of the savings on the supplier's ability to future reduce demand.	10631(f)(4)	DMMs	p 49 (Exhibit 3B)	16	

2010 UWMP Checklist

No.	UWMP Requirements	CA Water Code Reference	Subject	UWMP Location	UWMP Guidebook Standardized Table Locations	Additional Clarification
29	An evaluation of each water demand management measure listed in paragraph (1) of subdivision (f) that is not currently being implemented or scheduled for implementation. In the course of the evaluation, first consideration shall be given to water demand management measures, or combination of measures, that offer lower incremental costs than expanded or additional water supplies. This evaluation shall do all of the following: (1) Take into account economic and noneconomic factors, including environmental, social, health, customer impact, and technological factors; (2) Include a cost-benefit analysis, identifying total benefits and total costs; (3) Include a description of funding available to implement any planned water supply project that would provide water at a higher unit cost; (4) Include a description of the water supplier's legal authority to implement the measure and efforts to work with other relevant agencies to ensure the implementation of the measure and to share the cost of implementation	10631(g)	DMMs	Not Applicable. All items listed in paragraph (1) of subdivision (f) have been addressed aside from Wholesale agency programs which does not apply to LADWP	Not Applicable	This checklist item not applicable to LADWP. LADWP is implementing all demand management measures listed in paragraph (1) of subdivision (f)
30	(Describe) all water supply projects and water supply programs that may be undertaken by the urban water supplier to meet the total projected water use as established pursuant to subdivision (a) of Section 10635. The urban water supplier shall include a detailed description of expected future projects and programs, other than the demand management programs identified pursuant to paragraph (1) of subdivision (f), that the urban water supplier may implement to increase the amount of the water supply available to the urban water supplier in average, single-dry, and multiple-dry water years. The description shall identify specific projects and include a description of the increase in water supply that is expected to be available from each project. The description shall include an estimate with regard to the implementation timeline for each project or program.	10631(h)	System Supplies	p 98-101 (Exhibits 4L, 4M, 4N, 4O, 4P)	26	
31	Describe the opportunities for development of desalinated water, including, but not limited to, ocean water, brackish water, and groundwater, as a long-term supply.	10631(i)	System Supplies	p 20 & 199	10 (Not Applicable)	
32	Include the annual reports submitted to meet the Section 6.2 requirement (of the MOU), if a member of the CUWCC and signer of the December 10, 2008 MOU.	10631(j)	DMMs	Appendix H	Not Applicable	Since the CUWCC BMP Reporting Database is not available at this time, LADWP has attached the CUWCC BMP Reports from 2007-2008 which shows LADWP has met all the BMP coverage requirements. In addition, LADWP has submitted the necessary documentation to comply with the DMMs.
33	Urban water suppliers that rely upon a wholesale agency for a source of water shall provide the wholesale agency with water use projections from that agency for that source of water in five-year increments to 20 years or as far as data is available. The wholesale agency shall provide information to the urban water supplier for inclusion in the urban water supplier's plan that identifies and quantifies, to the extent practicable, the existing and planned sources of water as required by subdivision (b), available from the wholesale agency to the urban water supplier over the same five-year increments, and during various water-year types in accordance with subdivision (c). An urban water supplier may rely upon water supply information provided by the wholesale agency in fulfilling the plan informational requirements of subdivisions (b) and (c).	10631(k)	System Supplies	p 226 (Exhibit 11B), p 229-235 (Exhibits 11E to 11K), p 238 (Exhibit 11L)	12, 17, 29, 31	Average year, single dry year, multiple dry years for 2015, 2020, 2025, and 2030.

2010 UWMP Checklist

No.	UWMP Requirements	CA Water Code Reference	Subject	UWMP Location	UWMP Guidebook Standardized Table Locations	Additional Clarification
34	The water use projections required by Section 10631 shall include projected water use for single-family and multifamily residential housing needed for lower income households, as defined in Section 50079.5 of the Health and Safety Code, as identified in the housing element of any city, county, or city and county in the service area of the supplier.	10631.1(a)	System Demands	p 46 (Exhibit 2L)	8	
35	Stages of action to be undertaken by the urban water supplier in response to water supply shortages, including up to a 50 percent reduction in water supply, and an outline of specific water supply conditions which are applicable to each stage.	10632(a)(1)	Water Supply Reliability	p 236-238 (Sec 11.3.1)	35	
36	Provide an estimate of the minimum water supply available during each of the next three water years based on the driest three-year historic sequence for the agency's water supply.	10632(a)(2)	Water Supply Reliability	p 238-239 (Sec 11.3.2)	31	
37	(Identify) actions to be undertaken by the urban water supplier to prepare for, and implement during, a catastrophic interruption of water supplies including, but not limited to, a regional power outage, an earthquake, or other disaster.	10632(a)(3)	Water Supply Reliability	p 239-240 (Sec 11.3.3)	Not Applicable	
38	(Identify) additional, mandatory prohibitions against specific water use practices during water shortages, including, but not limited to, prohibiting the use of potable water for street cleaning.	10632(a)(4)	Water Supply Reliability	p 240-242 (Sec 11.3.4)	36	
39	(Specify) consumption reduction methods in the most restrictive stages. Each urban water supplier may use any type of consumption reduction methods in its water shortage contingency analysis that would reduce water use, are appropriate for its area, and have the ability to achieve a water use reduction consistent with up to a 50 percent reduction in water supply	10632(a)(5)	Water Supply Reliability	p 242-243 (Sec 11.3.5)	37	
40	(Indicated) penalties or charges for excessive use, where applicable.	10632(a)(6)	Water Supply Reliability	p 243 (Sec 11.3.6)	38	
41	An analysis of the impacts of each of the actions and conditions described in subdivisions (a) to (f), inclusive, on the revenues and expenditures of the urban water supplier, and proposed measures to overcome those impacts, such as the development of resserves and rate adjustments.	10632(a)(7)	Water Supply Reliability	p 244 (Sec 11.3.7)	Not Applicable	
42	(Provide) a draft water shortage contingency resolution or ordinance.	10632(a)(8)	Water Supply Reliability	p 244-245 (Sec 11.3.8) & Appendix I	Not Applicable	
43	(Indicate) a mechanism for determining actual reductions in water use pursuant to the urban water shortage contingency analysis.	10632(a)(9)	Water Supply Reliability	p 41-42 (Sec 2.2, Exhibits 2E & 2F), p 245-246 (Sec 11.3.9)	Not Applicable	
44	Provide, to the extent available, information on recycled water and its potential for use as a water source in the service area of the urban water supplier. The preparation of the plan shall be coordinated with local water, wastewater, groundwater, and planning agencies that operate within the supplier's service area	10633	System Supplies	p 14-15, p 81-82	16, 21	
45	(Describe) the wastewater collection and treatment systems in the supplier's service area, including a quantification of the amount of wastewater collected and treated and the methods of wasterwater disposal.	10633(a)	System Supplies	p 88-91 (Sec 4-2, Exhibit 4D)	21	
46	(Describe) the quantity of treated wastewater that meets recycled water standards, is being discharged, and is otherwise available for use in a recycled water project.	10633(b)	System Supplies	p 88-91 (Sec 4-2, Exhibits 4C & 4D)	21, 22	

2010 UWMP Checklist

No.	UWMP Requirements	CA Water Code Reference	Subject	UWMP Location	UWMP Guidebook Standardized Table Locations	Additional Clarification
47	(Describe) the recycled water currently being used in the supplier's service area, including, but not limited to, the type, place, and quantity of use.	10633(c)	System Supplies	p 92-97 (Sec 4.3, Exhibits 4E - 4J)	24	
48	(Describe and quantify) the potential uses of recycled water, including, but not limited to, agricultural irrigation, landscape irrigation, wildlife habitat enhancement, wetlands, industrial reuse, groundwater recharge, indirect potable reuse, and other appropriate uses, and a determination with regard to the technical and economic feasibility of serving those uses	10633(d)	System Supplies	p 97-105 (Sec 4.4.1 to 4.4.4, Exhibits 4K - 4Q)	23	
49	(Describe) The projected use of recycled water within the supplier's service area at the end of 5, 10, 15, and 20 years, and a description of the actual use of recycled water in comparison to uses previously projected pursuant to this subdivision.	10633(e)	System Supplies	p 97-98 (Sec 4.4, Exhibit 4L), p 96-97 (Sec 4.3.5, Exhibit 4J)	24, 25	
50	(Describe the) actions, including financial incentives, which may be taken to encourage the use of recycled water, and the projected results of these actions in terms of acre-feet of recycled water used per year.	10633(f)	System Supplies	p 105-106 (Sec 4.4.6)	25	
51	(Provide a) plan for optimizing the use of recycled water in the supplier's service area, including actions to facilitate the installation of dual distribution systems, to promote recirculating uses, to facilitate the increased use of treated wastewater that meets recycled water standards, and to overcome any obstacles to achieving that increased use	10633(g)	System Supplies	p 97-107 (Sec 4.4)	26	
52	The plan shall include information, to the extent practicable, relating to the quality of existing sources of water available to the supplier over the same five-year increments as described in subdivision (a) of Section 10631, and the manner in which water quality affects water management strategies and supply reliability	10634	Water Supply Reliability	p 20-22	30	For years 2015, 2020, 2025, 2030, and 2035 (changed this from 2010, 2015,…)
53	Every urban water supplier shall include, as part of its urban water management plan, an assessment of the reliability of its water service to its customers during normal, dry, and multiple dry water years. This water supply and demand assessment shall compare the total water supply sources available to the water supplier with the total projected water use over the next 20 years, in five-year increments, for a normal water year, a single dry water year, and multiple dry water years. The water service reliability assessment shall be based upon the information compiled pursuant to Section 10631, including available data from state, regional, or local agency population projections within the service area of the urban water supplier.	10635(a)	Water Supply Reliability	p 229-235 (Exhibits 11E to 11K)	32, 33, 34	
54	The urban water supplier shall provide that portion of its urban water management plan prepared pursuant to this article to any city or county within which it provides water supplies no later than 60 days after the submission of its urban water management plan	10635(b)	Plan Preparation	Appendix D	Not Applicable	
55	Each urban water supplier shall encourage the active involvement of diverse social, cultural, and economic elements of the population within the service area prior to and during the preparation of the plan.	10642	Plan Preparation	Appendix D	Not Applicable	

2010 UWMP Checklist

No.	UWMP Requirements	CA Water Code Reference	Subject	UWMP Location	UWMP Guidebook Standardized Table Locations	Additional Clarification
56	Prior to adopting a plan, the urban water supplier shall make the plan available for public inspection and shall hold a public hearing thereon. Prior to the hearing, notice of the time and place of hearing shall be published within the jurisdiction of the publicly owned water supplier pursuant to Section 6066 of the Government Code. The urban water supplier shall provide notice of the time and place of hearing to any city or county within which the supplier provides water supplies. A privately owned water supplier shall provide an equivalent notice within its service area.	10642	Plan Preparation	Appendix D	Not Applicable	
57	After the hearing, the plan shall be adopted as prepared or as modified after the hearing.	10642	Plan Preparation	Adoption resolution included within cover page	Not Applicable	
58	An urban water supplier shall implement its plan adopted pursuant to this chapter in accordance with the schedule set forth in its plan.	10643	Plan Preparation	p 2-3	Not Applicable	
59	An urban water supplier shall submit to the department, the California State Library, and any city or county within which the supplier provides water supplies a copy of its plan no later than 30 days after adoption. Copies of amendments or changes to the plans shall be submitted to the department, the California State Library, and any city or county within which the supplier provides water supplies within 30 days after adoption.	10644(a)	Plan Preparation	To be enclosed with transmittal letter to DWR.	Not Applicable	
60	Not later than 30 days after filing a copy of its plan with the department, the urban water supplier and the department shall make the plan available for public review during normal business hours.	10645	Plan Preparation	To be enclosed with transmittal letter to DWR.	Not Applicable	

Table 1
Coordination with appropriate agencies

Coordinating Agencies[1,2]	Participated in developing the plan	Commented on the draft	Attended public meetings	Was contacted for assistance	Was sent a copy of the draft plan	Was sent a notice of intention to adopt	Not involved / No information
Department of Water Resources				X	X		
Metropolitan Water District				X		X	
Tree People	X	X	X	X	X	X	
City of Los Angeles Dept. of Planning	X			X			
City of Los Angeles Department of Public Works, Bureau of Sanitation				X			
Upper Los Angeles River Area (ULARA) Watermaster			X				
Los Angeles County Department of Public Works Flood Control District			X				
San Gabriel Rivers Watershed Council			X				X
Safe Neighborhood Parks			X				
Panorama City Neighborhood Council			X				
West Hollywood Neighborhood Council			X				
Camp, Dresser, and McKee (CDM)	X	X	X	X	X	X	
Metropolitan Transit Authority (MTA)			X				
Forest Lawn Memorial Park			X				
Mt. Washington Association			X				
Council District 14			X				
Arroyo Seco Neighborhood Council			X				
Northridge West Neighborhood Council			X				
Greywater Corps			X				
Mar Vista Community Council			X				
Greater Cypress Park NC			X				
North East Trees			X				
Reseda Neighborhood Council			X				
LA Community Garden Council			X				
Midtown Noho Neighborhood Council			X				
River Project and Tujunga Watershed Council			X				
Encino Neighborhood Council			X				
Homeowners of Encino			X				
WaterWoman			X				
Sunland Tujunga Neighborhood Council			X				
Studio City Neighborhood Council			X				
Silverlake Reservoirs Conservancy			X				
Society of Hispanic Professional Engineers			X				
General public		X	X		X		

[1] Indicate the specific name of the agency with which coordination or outreach occurred.
[2] Check at least one box in each row.

Table 2 (Exhibit 1C)
Population — current and projected

	2010	2015	2020	2025	2030	2035 - optional	Data source[2]
Service area population[1]	4,100,260	4,172,760	4,250,861	4,326,012	4,398,408	4,467,560	SCAG Regional Transportation Plan (2008)

[1] Service area population is defined as the population served by the distribution system. See Technical Methodology 2: Service Area Population (2010 UWMP Guidebook, Section M).
[2] Provide the source of the population data provided.

Table 3 (Exhibit 2J)
Water deliveries — actual, 2005

	2005				
	Metered		Not metered		Total
Water use sectors	# of accounts	Volume	# of accounts	Volume	Volume
Single family	476,201	233,192			233,192
Multi-family	114,656	185,536			185,536
Commercial	51,428	107,414			107,414
Industrial/Governmental	10,588	62,418			62,418
Non-revenue (System Loss)		26,786			26,786
Total	652,873	615,346	0	0	615,346

*Units (circle one): **acre-feet per year** million gallons per year cubic feet per year*

Table 4 (Exhibit 2J)
Water deliveries — actual, 2010

	2010				
	Metered		Not metered		Total
Water use sectors	# of accounts	Volume	# of accounts	Volume	Volume
Single family	478,629	196,500			196,500
Multi-family	115,317	166,810			166,810
Commercial	50,017	96,675			96,675
Industrial/Governmental	10,671	52,877			52,877
Non-revenue (System Loss)		32,909			32,909
Total	654,634	545,771	0	0	545,771

*Units (circle one): **acre-feet per year** million gallons per year cubic feet per year*

Table 5 (Exhibit 2J) Water deliveries — projected, 2015					
	2015				
	Metered		Not metered		Total
Water use sectors	# of accounts	Volume	# of accounts	Volume	Volume
Single family		225,699			225,699
Multi-family		178,782			178,782
Commercial		135,112			135,112
Industrial/Governmental		18,600			18,600
Non-revenue (System Loss)		41,370			41,370
Total	0	599,563	0	0	599,563

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

Table 6 (Exhibit 2J) Water deliveries — projected, 2020					
	2020				
	Metered		Not metered		Total
Water use sectors	# of accounts	Volume	# of accounts	Volume	Volume
Single family		236,094			236,094
Multi-family		193,220			193,220
Commercial		133,597			133,597
Industrial/Governmental		16,852			16,852
Non-revenue (System Loss)		42,969			42,969
Total	0	622,732	0	0	622,732

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

Table 7 (Exhibit 2J) Water deliveries — projected 2025, 2030, and 2035						
	2025		2030		2035 - optional	
	metered		metered		metered	
Water use sectors	# of accounts	Volume	# of accounts	Volume	# of accounts	Volume
Single family		241,180		246,879		247,655
Multi-family		202,999		213,284		218,762
Commercial		129,761		126,567		120,420
Industrial/governmental		14,708		12,634		10,513
Non-revenue (System Loss)		43,627		44,421		44,272
Total	0	632,275	0	643,785	0	641,622

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

Table 8 (Exhibit 2L) Low-income projected water demands					
Low Income Water Demands[1]	2015	2020	2025	2030	2035 - opt
Single-family residential	11,917	12,466	12,734	13,036	13,076
Multi-family residential	23,313	25,196	26,471	27,812	28,527
Total	35,230	37,662	39,205	40,848	41,603

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

[1] Provide demands either as directly estimated values or as a percent of demand.

Table 9 - NOT APPLICABLE Sales to other water agencies							
Water distributed	2005	2010	2015	2020	2025	2030	2035 - opt
name of agency							
name of agency							
name of agency							
Total	0	0	0	0	0	0	0

Units (circle one): acre-feet per year million gallons per year cubic feet per year

Table 10 - NOT APPLICABLE Additional water uses and losses							
Water use[1]	2005	2010	2015	2020	2025	2030	2035 -opt
Saline barriers							
Groundwater recharge							
Conjunctive use							
Raw water							
Recycled water							
System losses							
Other (define)							
Total	0	0	0	0	0	0	0

Units (circle one): acre-feet per year million gallons per year cubic feet per year

[1] Any water accounted for in Tables 3 through 7 are not included in this table.

Table 11 (Exhibit 2J) Total water use							
Water Use	2005	2010	2015	2020	2025	2030	2035 - opt
Total water deliveries (from Tables 3 to 7)	615,346	545,771	599,563	622,732	632,275	643,785	641,622
Sales to other water agencies (from Table 9)	-	-	-	-	-	-	-
Additional water uses and losses (from Table 10)	-	-	-	-	-	-	-
Total	615,346	545,771	599,563	622,732	632,275	643,785	641,622

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

Table 12 (Exhibit 11E) Retail agency demand projections provided to wholesale suppliers							
Wholesaler	Contracted Volume[3]	2010	2015	2020	2025	2030	2035 -opt
LADWP provided LA's demand projections to MWD on Feb. 22, 2011	203,313	263,875	248,120	218,040	193,760	198,781	193,027

[3] Indicate the full amount of water (LADWP Purchase Order Commitment is minimum of 2,033,132.4 AF from 1/1/2003 to 1/1/2013. MWD is capable of providing more.)

Table 13 (Exhibit 3C; Appendix G) Base period ranges			
Base	Parameter	Value	Units
10- to 15-year base period	2008 total water deliveries	649,822	*see below*
	2008 total volume of delivered recycled water	4,181	*see below*
	2008 recycled water as a percent of total deliveries	1	percent
	Number of years in base period[1]	10	years
	Year beginning base period range	1996	
	Year ending base period range[2]	2005	
5-year base period	Number of years in base period	5	years
	Year beginning base period range	2004	
	Year ending base period range[3]	2008	

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

[1] If the 2008 recycled water percent is less than 10 percent, then the first base period is a continuous 10-year period. If the amount of recycled water delivered in 2008 is 10 percent or greater, the first base period is a continuous 10- to 15-year period.

[2] The ending year must be between December 31, 2004 and December 31, 2010.

[3] The ending year must be between December 31, 2007 and December 31, 2010.

Table 14 (Exhibit 3C; Appendix G) Base daily per capita water use — 10- to 15-year range				
Base period year		Distribution System Population	Daily system gross water use (AF)	Annual daily per capita water use (gpcd)
Sequence Year	Calendar Year			
1996		3,568,651	610,144	153
1997		3,584,227	628,265	156
1998		3,613,170	587,398	145
1999		3,653,878	619,467	151
2000		3,705,600	659,121	159
2001		3,770,806	657,873	156
2002		3,829,677	667,145	156
2003		3,881,069	650,664	150
2004		3,925,129	688,213	157
2005		3,955,022	614,072	139
			Base Daily Per Capita Water Use[1]	152

[1] Add the values in the column and divide by the number of rows.

Table 15 (Exhibit 3C; Appendix G) Base daily per capita water use — 5-year range				
Base period year		Distribution System Population	Daily system gross water use (AF)	Annual daily per capita water use (gpcd)
Sequence Year	Calendar Year			
2004		3,925,129	688,213	157
2005		3,955,022	614,072	139
2006		3,986,385	626,194	140
2007		4,006,145	665,030	148
2008		4,042,085	645,641	143
			Base Daily Per Capita Water Use[1]	145

[1] Add the values in the column and divid by the number of rows.

Table 16 (Exhibit 11E) Water supplies — current and projected							
Water Supply Sources		2010	2015	2020	2025	2030	2035 - opt
Water purchased from[1]:	Wholesaler supplied volume (yes/no)						
MWD Water Purchased	**Yes**	263,875	248,120	218,040	193,760	198,781	193,027
Supplier-produced groundwater[2]		76,982	40,500	96,300	111,500	111,500	110,405
Los Angeles Aqueduct		199,739	252,000	250,000	248,000	246,000	244,000
Conservation		8,178	14,180	27,260	40,340	53,419	64,368
Recycled Water - Irrigation/Industrial Use		6,703	20,000	20,400	27,000	29,000	29,000
Recycled Water - Groundwater Replenishment		0	0	0	15,000	22,500	30,000
Water Transfers		0	40,000	40,000	40,000	40,000	40,000
	Total	**555,477**	**614,800**	**652,000**	**675,600**	**701,200**	**710,800**

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

[1] Volumes shown here should be what was purchased in 2010 and what is anticipated to be purchased in the future. If these numbers differ from what is contracted, show the contracted quantities in Table 17.

[2] Volumes shown here should be consistent with Tables 17 and 18.

Table 17 (Exhibit 11E) Wholesale supplies — existing and planned sources of water						
Wholesale sources[1,2]	Contracted Volume[3]	2015	2020	2025	2030	2035 - opt
MWD provided LA's demand projections to LADWP on Jan. 24, 2011	203,313	397,748	413,628	414,180	417,533	418,378

[1] If the water supplier is a wholesaler, indicate all customers (excluding individual retail customers) to which water is sold. If the water supplier is a retailer, indicate each wholesale supplier, if more than one.

[2] Indicate the full amount of water (LADWP Purchase Order Commitment is minimum of 2,033,132.4 AF from 1/1/2003 to 1/1/2013. MWD is capable of providing more.)

Table 18 (Exhibit 6B) Groundwater — volume pumped						
Basin name(s)	Metered or Unmetered[1]	2006	2007	2008	2009	2010
San Fernando	Metered	35,486	75,640	57,060	49,106	62,218
Sylmar	Metered	1,844	3,901	4,046	576	2,998
Central	Metered	13,290	13,358	12,207	11,937	11,766
	Total groundwater pumped	50,620	92,899	73,313	61,619	76,982
	Groundwater as a percent of total water supply	8.0%	13.8%	11.3%	10.0%	14.1%

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

[1] Indicate whether volume is based on volumeteric meter data or another method

Table 19 (Exhibit 6G) Groundwater — volume projected to be pumped					
Basin name(s)	2015	2020	2025	2030	2035 - opt
San Fernando	21,000	76,800	92,000	92,000	92,000
Sylmar	4,500	4,500	4,500	4,500	3,405
Central	15,000	15,000	15,000	15,000	15,000
Total groundwater pumped	40,500	96,300	111,500	111,500	110,405
Percent of total water supply[1]	6.7%	15.4%	17.6%	17.2%	17.1%

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

Include future planned expansion

[1] As a percentage of wet supplies excluding water conservation

Table 20 (Page 9-1) Transfer and exchange opportunities			
Transfer agency	Transfer or exchange	Short term or long term	Proposed Volume
TBD	Transfer	Long Term	40,000
Total			

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

Table 21 (Exhibit 4D) Recycled water — wastewater collection and treatment							
Type of Wastewater	2005 (actual)	2010 (actual)	2015	2020	2025	2030	2035 - opt
(1) Wastewater collected & treated in service area	487,296	408,044	468,432	478,308	488,408	508,015	527,621
(2) Volume that meets recycled water standard	65,018	57,171	112,391	114,163	115,586	117,627	117,694
(3) Secondary water sent to West Basin for Recycling		34,115	44,230	45,365	45,365	50,865	50,865
Calculation to match Table 22 totals below = (1) - (2) - (3)		316,758	311,811	318,781	327,457	339,523	359,062

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

(1) Only includes recycled water from DCT, LAG and TIWRP AWTF.

(3) Secondary water sent to West Basin is not included as part of LADWP recycled water.

Table 22 Recycled water — non-recycled wastewater disposal							
Method of disposal	Treatment Level	2010	2015	2020	2025	2030	2035 - opt
Recycling and Pacific Ocean via Los Angeles River	Tertiary to Title 22 standards with Nitrification/Denitrification	0	0	0	0	695	3,464
Recycling and Ocean via Los Angeles River	Tertiary to Title 22 standards with Nitrification/Denitrification	0	3,027	4,932	7,062	9,192	11,322
Recycling and Outfall to Ocean	Tertiary; Advanced treatment (MF/RO)	15,694	13,004	13,228	13,564	14,125	14,573
Conveyance to WBMWD for Recycling and Ocean outfall	Full secondary	301,064	295,781	300,620	306,831	315,511	329,703
	Total	316,758	311,811	318,781	327,457	339,523	359,062

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

The following water is not included: All water treated to Title 22 standards, and Secondary Water delivered to West Basin.

Table 23 Recycled water — potential future use							
User type	Description	Feasibility[1]	2015	2020	2025	2030	2035 - opt
Agricultural irrigation			NA	NA	NA	NA	NA
Landscape irrigation[2]			4,220	4,220	4,220	6,135	15,135
Commercial[3]			165	165	165	165	165
Golf course irrigation			1,400	1,400	1,400	1,400	1,400
Wildlife habitat			26,990	26,990	26,990	26,990	26,990
Wetlands							
Industrial reuse			9,300	9,300	9,300	9,300	9,300
Groundwater recharge (GWR)			0	15,000	15,000	30,000	30,000
Seawater barrier			3,000	3,000	3,000	3,000	3,000
Getothermal/Energy			NA	NA	NA	NA	NA
Indirect potable reuse			NA	NA	NA	NA	NA
Other (user type)							
Other (user type)							
	Total	0	45,075	60,075	60,075	76,990	85,990

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

[1] Technical and economic feasibility.

[2] Includes parks, schools, cemeteries, churches, residential, or other public facilities

[3] Includes commercial building use such as landscaping, toilets, HVAC, and commercial uses (car washes, laundries, nurseries, etc)

Table 24 (Exhibit 4J) Recycled water — 2005 UWMP use projection compared to 2010 actual		
Use type	2010 actual use	2005 Projection for 2010[1]
Agricultural irrigation		
Landscape irrigation[2]		
Commercial[3]		
Golf course irrigation		
Wildlife habitat		
Wetlands		
Industrial reuse		
Groundwater recharge		
Seawater barrier		
Getothermal/Energy		
Indirect potable reuse		
Other (user type) - Municipal & Industrial Uses	6,703	16,950
Other (user type) - Environmental Uses	25,008	26,990
Total	31,711	43,940

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

[1] From the 2005 UWMP. There has been some modification of use types. Data from the 2005 UWMP can be left in the existing catagories or modified to the new catagories, at the discretion of the water supplier.

[2] Includes parks, schools, cemeteries, churches, residential, or other public facilities)

[3] Includes commercial building use such as landscaping, toilets, HVAC, etc) and commercial uses (car washes, laundries, nurseries, etc)

Table 25 (Exhibit 4L & Sec 4.4.6) Methods to encourage recycled water use (NA - Financial incentives incorporated into goals above)						
Actions	Projected Results					
	2010	2015	2020	2025	2030	2035 - opt
Financial incentives						
Cost savings, shared conservation of resources, environmental benefit, reliability	6,703	20,000	20,400	27,000	29,000	29,000
Sustainability (groundwater replenishment)				15,000	22,500	30,000
Total	6,703	20,000	20,400	42,000	51,500	59,000

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

Table 26 (Exhibits 4L, 4M, 4N, 4O, 4P) Future water supply projects								
Project name[1]	Projected start date	Projected completion date	Potential project constraints[2]	Normal-year supply[3]	Single-dry year supply[3]	Multiple-dry year first year supply[3]	Multiple-dry year second year supply[3]	Multiple-dry year third year supply[3]
Recycling Projects								
Harbor Irrigation, Commercial, Industrial	2009	2015	Funding	9520	9520	9520	9520	9520
Metro Irrigation (llittle Commercial, Industrial)	2009	2015	Funding	1813	1813	1813	1813	1813
Valley Irrigation(little Commercial/Industrial)	2009	2013	Funding	844	844	844	844	844
Westside Irrigation, Commercial, Industrial	2009	2015	Funding	350	350	350	350	350
Indirect Potable Reuse (Groundwater Recharge) Initial Stage	2015	2021	Funding	15000	15000	15000	15000	15000
Indirect Potable Reuse (Groundwater Recharge) 2nd Stage	2021	2035	Funding	15000	15000	15000	15000	15000
Other Municipal and Industrial Projects	2015	2035	Funding	16,473	16,473	16,473	16,473	16,473
		Total	0	59,000	59,000	59,000	59,000	59,000

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

[1] Water volumes presented here should be accounted for in Table 16.

[2] Indicate whether project is likely to happen and what constraints, if any, exist for project implementation.

[3] Provide estimated supply benefi ts, if available.

Table 27 (Section 11.2.8) Basis of water year data	
Water Year Type	Base Year(s)
Average Water Year	FY1956/57 to FY2005/06
Single-Dry Water Year	FY1990/91
Multiple-Dry Water Years - Driest 5-year sequence	FY1988/89 to FY1992/93
Multiple-Dry Water Years - Driest 3-year sequence	FY1958/59 to FY1960/61

Table 28 Supply reliability — historic conditions					
Average / Normal Water Year	Single Dry Water Year	Multiple Dry Water Years			
		Year 1	Year 2	Year 3	Year 4
FY1956/57 to FY2005/06	FY1990/91	FY1988/89	FY1989/90	FY1990/91	FY1991/92
360,509	130,325	327,181	206,215	130,325	176,888
Percent of Average/Normal Year:	36.2%	90.8%	57.2%	36.2%	49.1%

** Showing LA Aqueduct supply reliability only. Groundwater & Recycled Water don't vary with weather. MWD supply is used to supplement insufficient local supplies and is not directly co-related to weather.*

Table 29 Factors resulting in inconsistency of supply							
Water supply sources[1]	Specific source name, if any	Limitation quantification	Legal	Environmental	Water quality	Climatic	Additional information
Metropolitan Water District			x	x		x	
Supplier-produced groundwater				x	x		
Los Angeles Aqueduct			x	x		x	
Conservation						x	
Recycled Water - Irrigation/Industrial Use			x	x		x	

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

[1] From Table 16.

Table 30 (Exhibit 6G) Water quality — current and projected water supply impacts							
Water source	Description of condition	2010	2015	2020	2025	2030	2035 - opt
Groundwater - San Fernando Basin (See Exhibit 6G)*	Expected increased contamination issues (2015) and clean up programs expected to be completed (2021)	24,782	66,000	10,200	0	0	0

***Yearly Quantities listed represent total amount of water LADWP is unable to pump from the SFB due to groundwater contamination. Contamination issues are resolved after completion of clean-up programs in 2021**

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

Table 31 (Exhibit 11L) Supply reliability — current water sources				
Water supply sources[1]	Average / Normal Water Year Supply[2]	Multiple Dry Water Year Supply[2]		
		Year 2011	Year 2012	Year 2013
Los Angeles Aqueduct	**254,000**	104,530	50,849	59,382
Groundwater	**106,500**	61,090	53,660	46,260
Conservation	**8,178**	9,380	10,580	11,780
Recycled Water - Irrigation/Industrial Use	**7,500**	7,500	8,300	9,000
Recycled Water - Groundwater Replenishment	**0**	0	0	0
Water Transfers	**0**	0	0	0
MWD Water Purchases	**245,522**	407,500	484,811	500,078
Percent of normal year:	100.0%	94.9%	97.8%	100.8%

Units (circle one): ***acre-feet per year*** *million gallons per year* *cubic feet per year*

[1] From Table 16.

[2] See Table 27 for basis of water type years.

Table 32 (Exhibits 2J, 11E) Supply and demand comparison — normal year					
	2015	2020	2025	2030	2035 - opt
Supply totals (from Table 16)	614,800	652,000	675,600	701,200	710,800
Demand totals (From Table 11)	599,563	622,732	632,275	643,785	641,622
Difference (Conservation)	15,237	29,268	43,325	57,415	69,178
Difference as % of Supply	2.5%	4.5%	6.4%	8.2%	9.7%
Difference as % of Demand	2.5%	4.7%	6.9%	8.9%	10.8%

Units are in acre-feet per year.

Table 33 (Exhibit 11F) Supply and demand comparison — single dry year					
	2015	2020	2025	2030	2035 - opt
Supply totals[1,2]	651,700	691,100	716,100	743,200	753,400
Demand totals[2,3,4]	637,520	663,840	675,760	689,781	689,032
Difference	14,180	27,260	40,340	53,419	64,368
Difference as % of Supply	2.2%	3.9%	5.6%	7.2%	9.3%
Difference as % of Demand	2.2%	4.1%	6.0%	7.7%	9.3%

Units are in acre-feet per year.

[1] Consider the same sources as in Table 16. If new sources of water are planned, add a column to the table and specify the source, timing, and amount of water.

[2] Provide in the text of the UWMP text that discusses how single-dry-year water supply volumes were determined.

[3] Consider the same demands as in Table 3. If new water demands are anticipated, add a column to the table and specify the source, timing, and amount of water.

[4] The urban water target determined in this UWMP will be considered when developing the 2020 water demands included in this table.

Table 34 (Exhibit 11G - Exhibit 11K) Supply and demand comparison — multiple dry-year events						
		2015	2020	2025	2030	2035 - opt
Multiple-dry year first year supply	**Supply totals[1,2]**	608,200	661,200	694,500	720,100	740,300
	Demand totals[2,3,4]	597,620	641,790	662,010	674,530	682,500
	Difference	10,580	19,410	32,490	45,570	57,800
	Difference as % of Supply	1.7%	2.9%	4.7%	6.3%	7.8%
	Difference as % of Demand	1.8%	3.0%	4.9%	6.8%	8.5%
Multiple-dry year second year supply	**Supply totals[1,2]**	626,500	675,400	706,100	732,400	749,300
	Demand totals[2,3,4]	614,720	653,370	670,990	684,210	689,300
	Difference	11,780	22,030	35,110	48,190	60,000
	Difference as % of Supply	1.9%	3.3%	5.0%	6.6%	8.0%
	Difference as % of Demand	1.9%	3.4%	5.2%	7.0%	8.7%
Multiple-dry year third year supply	**Supply totals[1,2]**	602,900	644,600	670,900	696,100	708,800
	Demand totals[2,3,4]	589,920	619,960	633,180	645,300	646,600
	Difference	12,980	24,640	37,720	50,800	62,200
	Difference as % of Supply	2.2%	3.8%	5.6%	7.3%	8.8%
	Difference as % of Demand	2.2%	4.0%	6.0%	7.9%	9.6%

Units are in acre-feet per year.

[1] Consider the same sources as in Table 16. If new sources of water are planned, add a column to the table and specify the source, timing, and amount of water.

[2] Provide in the text of the UWMP text that discusses how single-dry-year water supply volumes were determined.

[3] Consider the same demands as in Table 3. If new water demands are anticipated, add a column to the table and specify the source, timing, and amount of water.

[4] The urban water target determined in this UWMP will be considered when developing the 2020 water demands included in this table.

Table 35 (Section 11.3.1) Water shortage contingency — rationing stages to address water supply shortages		
Stage No.	**Water Supply Conditions**	**% Shortage**
Phase I	No Shortage	0%
Phase II	Modereate Shortage	> 0 to 15%
Phase III	Severe Shortage	15 to 20%
Phase IV	Critical Shortage	20 to 35%
Phase V	Super Critical Shortage	35 to 50%

[1] One of the stages of action must be designed to address a 50 percent reduction in water supply.

Table 36 (Section 11.3.4) Water shortage contingency — mandatory prohibitions	
Examples of Prohibitions	**Stage When Prohibition Becomes Mandatory**
Using potable water for washing paved surfaces	Phase I
Using water to clean, fill, or maintain levels in decorative fountains, ponds, lakes, or similar structures for aethetic purposes	Phase I
Any public place where food is sold, served, or offered for sale should not serve water unless requested.	Phase I
No customer should permit water to leak from any pipe or fixture on customer's premises	Phase I
No customer shall wash a vehicle with a hose that does not have a self-closing water shut-off device	Phase I
No customer shall irrigate during periods of rain	Phase I
No customer shall irrigate between the hours of 9:00 a.m. and 4:00 p.m.	Phase I
Irrigating of landscape with potable water using spray head sprinklers and bubblers shall be limited to no more than ten minutes per watering station per day	Phase I
No customer shall irrigate in a manner that causes excess or continuous flow or runoff onto an adjoining sidewalk, driveway, street, gutter, or ditch	Phase I
No installation of single pass cooling systems shall be permitted in buildings requesting new water service.	Phase I
No installation of single pass cooling systems shall be permitted in new conveyor car wash and new commercial laundry systems	Phase I
Operators of hotels and motels provide guests with the option of choosing not to have towels and linens laundered daily	Phase I
No large landscape shall have irrigation systems without rain sensors that shut-off the irrigation systems	Phase I
No landscape irrigation shall be permitted on any day other than Monday, Wednesday, or Friday for odd-numbered street addresses and Tuesday, Thursday, or Sunday for even-numbered street addresses. Street addresses ending in ½ or any fraction shall conform to the permitted uses for the last whole number in the address. Watering times shall be limited to: (a) Non-conserving nozzles (spray head sprinklers and bubblers) – no more than eight minutes per watering day per station for a total of 24 minutes per week; (b) Conserving nozzles (standard rotors and multi-stream rotary heads) – no more than 15 minutes per cycle and up to two cycles per watering day per station for a total of 90 minutes per week.	Phase II
No landscape irrigation shall be permitted on any day other than Monday for odd-numbered street addresses and Tuesday for even-numbered street addresses. Street addresses ending in ½ or any fraction shall conform to the permitted uses for the last whole number in the address.	Phase III
No washing of vehicles allowed except at commercial car wash facilities.	Phase III
No filling of residential swimming pools and spas with potable water.	Phase III

Table 37 (Section 11.3.5) Water shortage contingency — consumption reduction methods		
Consumption Reduction Methods	**Stage When Method Takes Effect**	**Projected Reduction (%)**
LADWP's existing rate structure (enacted in 1993) serves as a basis for further reducing consumption. First tier water allotments are reduced during shortages by the degree of the shortage. For single-family residential users, the adjusted first tier allotments apply for the entire year. For other users, the adjusted first tier allotments apply only during the high season (June 1 through October 31). Details of LADWP's water rate structure are provided in Appendix C – Water Rate Ordinance.	During a water shortage or emergency condition	Up to 25%
Emergency Water Conservation Plan (UWMP Section 11.3.1)	Phase I is permanent with higher phases activated during a water shortage or emergency condition	Up to 50%
Water conservation public service announcements (through television and/or radio), billboard ads, flyer distributions, and conservation workshops. Participation in public exhibits to disseminate water conservation information within its service area. Conservation is a permanent and long-term application used within the City to counter the potentially adverse impacts of water supply shortages.	During a water shortage or emergency condition	
Water will be allocated to meet needs for domestic use, sanitation, fire protection, and other priorities. This will be done equitably and without discrimination between customers using water for the same purpose(s).	extreme water shortage conditions	

Table 38 (Section 11.3.6) Water shortage contingency — penalties and charges		
Penalties or Charges	**Stage When Penalty Takes Effect**	
Written Warning	First violation	For water meters smaller than two inches
Surchage in the amount of $100	Second violation within preceding 12-month period	
Surchage in the amount of $200	Third violation within preceding 12-month period	
Surchage in the amount of $300	Fourth violation within preceding 12-month period	
LADWP may install a flow-restricting device of 1 gpm capacity for services up to 1 1/2 inches in size and comparatively sized restrictors for larger services or terminate a customer's service, in addition to aforementioned financial surcharges	Fifth violation or subsequent violation within preceding 12-month period	
Written Warning	First violation	For water meters two inches and larger
Surcharge in the amount of $200	Second violation within preceding 12-month period	
Surcharge in the amount of $400	Third violation within preceding 12-month period	
Surcharge in the amount of $600	Fourth violation within preceding 12-month period	
LADWP may install a flow-restricting device or terminate a customer's service, in addition to aforementioned financial surcharges	Fifth violation or subsequent violation within preceding 12-month period	

Urban Water Management Plan

Appendix C

Water Rate Ordinance

Los Angeles

Water Rates

June 1, 1995

Amended July 28, 1997,
February 4, 2000, June 20, 2004,
November 27, 2006, and June 19, 2008

Los Angeles Department of Water and Power

Ordinance No. 170435

As Amended by Ordinance No. 171639, Ordinance No. 173017,
Ordinance No. 175964, Ordinance No. 177968
and Ordinance No. 179802

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R. SHORTAGE YEAR RATES

When the Board of Water and Power Commissioners, by resolution, finds and determines that the water supply available to the City of Los Angeles is insufficient to meet the City's normal water demand, it shall determine the degree of shortage and apply the corresponding commodity charges stated below, instead of the otherwise applicable commodity charges.

Certified copies of such resolution shall be transmitted to the offices of the Mayor, City Clerk, and the Council. At any time within such period as may be specified by resolution, which shall not be less than fifteen days after delivery of such certified copies to said offices, the Mayor, in writing, or the Council, by majority vote, may disapprove such resolution. If neither the Mayor nor the Council disapprove on said resolution within the period so specified, the same shall take effect upon the expiration of said period and shall be applicable to charges commencing on the first day of the billing cycle after the expiration of the period prescribed in the resolution. If the Mayor shall disapprove said resolution within said period, he shall forthwith advise the Council and the Board, in writing, of such disapproval. The Council shall thereupon consider such disapproval in the same manner as upon the reconsideration of an ordinance notwithstanding the veto of the Mayor, and if upon such consideration the Council shall, by the votes of two-thirds of the whole Council, determine that the Mayor's disapproval should be overruled, such disapproval by the Mayor shall be of no effect, and the said resolution of the Board shall forthwith take effect and shall be applicable to charges commencing on the first day of the billing cycle after the action by the Council overruling the Mayor's disapproval and the expiration of the period prescribed in the resolution.

The following commodity rates shall be substituted into the appropriate corresponding schedule and shall continue during the time that a water shortage determined by the Board of Water and Power Commissioners remains in effect.

1. Schedule A - Single-Dwelling Unit Residential Customers

    a. The first tier usage block shall be reduced by the degree of the shortage and shall be billed at the rate specified in Section 2.A.3.a.

    b. Second Tier Usage

    Usage above the first tier usage block as prescribed in Section 3.R.1.a above shall be billed as follows:

Commodity Charge	Rate Per Hundred Cubic Feet

10% Shortage

Low Season - November 1 through May 31
1.201 times the High Season rate specified in Section 2.A.3.b, rounded to the nearest penny

High Season - June 1 through October 31
1.201 times the High Season rate specified in Section 2.A.3.b, rounded to the nearest penny

15% Shortage

Low Season - November 1 through May 31
1.442 times the High Season rate specified in Section 2.A.3.b, rounded to the nearest penny

High Season - June 1 through October 31
1.442 times the High Season rate specified in Section 2.A.3.b, rounded to the nearest penny

20% Shortage

Low Season - November 1 through May 31
1.682 times the High Season rate specified in Section 2.A.3.b, rounded to the nearest penny

High Season - June 1 through October 31
1.682 times the High Season rate specified in Section 2.A.3.b, rounded to the nearest penny

25% Shortage

Low Season - November 1 through May 31
1.964 times the High Season rate specified in Section 2.A.3.b, rounded to the nearest penny

High Season - June 1 through May 31
1.964 times the High Season rate specified in Section 2.A.3.b, rounded to the nearest penny

2. Schedule B - Multi-Dwelling Unit Residential Customers

Commodity Charge	Rate Per Hundred Cubic Feet

10% Shortage

a. Up to 115% of Adjusted First Tier Usage Block shall be billed at the rate specified in Section 2.B.3.a.

b. Usage above 115% of Adjusted First Tier Usage Block shall be billed at 1.201 times the High Season rate specified in Section 2.B.3.b, rounded to the nearest penny.

15% Shortage

c. Up to 115% of Adjusted First Tier Usage Block shall be billed at the rate specified in Section 2.B.3.a.

d. Usage above 115% of First Tier Usage Block shall be billed at 1.442 times the High Season rate specified in Section 2.B.3.b, rounded to the nearest penny.

20% Shortage

e. Up to 110% of Adjusted First Tier Usage Block shall be billed at the rate specified in Section 2.B.3.a.

f. Usage above 110% of Adjusted First Tier Usage Block shall be billed at 1.682 times the High Season rate specified in Section 2.B.3.b, rounded to the nearest penny.

25% Shortage

g. Up to 110% of Adjusted First Tier Usage Block shall be billed at the rate specified in Section 2.B.3.a.

h. Usage above 110% of Adjusted First Tier Usage Block shall be billed at 1.964 times the High Season rate specified in Section 2.B.3.b, rounded to the nearest penny.

3. Schedule C – Commercial and Industrial Customers

Commodity Charge	Rate Per Hundred Cubic Feet

10% Shortage

a. Up to 115% of Adjusted First Tier Usage Block shall be billed at the rate specified in Section 2.C.3.a.

b. Usage above 115% of Adjusted First Tier Usage Block shall be billed at 1.201 times the High Season rate specified in Section 2.C.3.b, rounded to the nearest penny.

15% Shortage

c. Up to 115% of Adjusted First Tier Usage Block shall be billed at the rate specified Section 2.C.3.a.

d. Usage above 115% of Adjusted First Tier Usage Block shall be billed at 1.442 times the High Season rate specified in Section 2.C.3.b, rounded to the nearest penny.

20% Shortage

e. Up to 110% of Adjusted First Tier Usage Block shall be billed at the rate specified Section 2.C.3.a.

f. Usage above 110% of Adjusted First Tier Usage Block shall be billed at 1.682 times the High Season rate specified in Section 2.C.3.b, rounded to the nearest penny.

25% Shortage

g. Up to 110% of Adjusted First Tier Usage Block shall be billed at the rate specified Section 2.C.3.a.

h. Usage above 110% of Adjusted First Tier Usage Block shall be billed at 1.964 times the High Season rate specified in Section 2.C.3.b, rounded to the nearest penny.

4. Schedule F - Publicly-Sponsored Irrigation; Recreational; Agricultural, Horticultural, and Floricultural Uses; Community Gardens and Youth Sports

Commodity Charges	Rate Per Hundred Cubic Feet

10% Shortage

a. First Tier Usage Block shall be billed at the rate specified in Section 2.F.3.a.

Monthly first tier usage blocks shall be established by the Department for domestic water use, landscape and large area irrigation after an audit has been completed, considering site conditions and based upon best management practices approved by the Board of Water and Power Commissioners, and shall be subject to periodic review and revision by the Department.

b. Second Tier Usage

Usage above the first tier usage block as prescribed in Section 3.R.4.a above shall be billed at 1.201 times the High Season rate specified in Section 2.F.3.c, rounded to the nearest penny.

15% Shortage

c. First Tier Usage Block shall be billed at the rate specified in Section 2.F.3.a.

Monthly first tier usage blocks shall be established by the Department for domestic water use, landscape and large area irrigation after an audit has been completed, considering site conditions and based upon best management practices approved by the Board of Water and Power Commissioners, and shall be subject to periodic review and revision by the Department.

d. Second Tier Usage

Usage above the first tier usage block as prescribed in Section 3.R.4.c above shall be billed at 1.442 times the High Season rate specified in Section 2.F.3.c, rounded to the nearest penny.

<u>20% Shortage</u>

e. First Tier Usage Block shall be billed at the rate specified in Section 2.F.3.a.

Monthly first tier usage blocks shall be established by the Department for domestic water use, landscape and large area irrigation after an audit has been completed, considering site conditions and based upon best management practices approved by the Board of Water and Power Commissioners, and shall be subject to periodic review and revision by the Department.

f. Second Tier Usage

Usage above the first tier usage block as prescribed in Section 3.R.4.e above shall be billed at 1.682 times the High Season rate specified in Section 2.F.3.c, rounded to the nearest penny.

<u>25% Shortage</u>

g. First Tier Usage Block shall be billed at the rate specified in Section 2.F.3.a.

Monthly first tier usage blocks shall be established by the Department for domestic water use, landscape and large area irrigation after an audit has been completed, considering site conditions and based upon best management practices approved by the Board of Water and Power Commissioners, and shall be subject to periodic review and revision by the Department.

h. Second Tier Usage

Usage above the first tier usage block as prescribed in Section 3.R.4.g above shall be billed at 1.964 times the High Season rate specified in Section 2.F.3.c, rounded to the nearest penny.

5. Adjustments and credits pursuant to General Provisions F, G, H, I, K, L, O and P shall be applied to the commodity charges set forth in this General Provision R in the same manner that they apply to the commodity charge set forth in Rate Schedules A, B, C, D, E, and F, inclusive.

6. The Adjusted First Tier Usage Block shall be each customer's maximum December through March average consumption for the three winter periods preceding the declared water shortage event reduced by the degree of water shortage, except that the minimum adjusted first tier usage for Schedule B customers only shall be twenty-eight (28) hundred cubic feet per month reduced by the degree of water shortage and the minimum adjusted first tier usage for Schedule C customers shall be one one-hundred cubic feet per month.

   Each customer's December through March average consumption that is applied at the beginning of each declared water shortage event shall continue to be applied during the time that a water shortage determined by the Board of Water and Power Commissioners remains in effect.

7. Those Schedules B and C customers that are found to not have established an Adjusted First Tier Usage Block based on prior usage may have an adjusted first tier usage block computation made by the Department that is based on the customer's water use characteristics, site conditions, and all applicable best management practices for conservation approved by the Board of Water and Power Commissioners.

8. Application of this General Provision R shall be subject to rules and regulations adopted by the Board of Water and Power Commissioners.

9. When the Board of Water and Power Commissioners determines that the water supply available to the City of Los Angeles is either sufficient, or if not sufficient, is better able to meet the City's normal water supply, it shall, by resolution, either terminate the implementation of these shortage year rates or determine the lesser degree of shortage and apply the applicable commodity charges stated above instead of the commodity charges theretofore implemented pursuant to this Provision R. Such determination shall become effective upon publication of the resolution.

Urban Water Management Plan

Appendix D

Notice of Meeting and Public Comments

PUBLIC NOTICES

Public Notification

An extensive outreach campaign was conducted for the 2010 update of the LADWP Urban Water Management Plan (UWMP). As shown in the following table, a total of four workshops were conducted, seeking public input on the 2010 update. The first two workshops were held in January 2010 and were intended to receive input concurrent with the preparation of the 2010 UWMP draft. The third and fourth workshops were conducted in February 2011. These workshops were intended to present the 2010 draft UWMP and usher in the beginning of a 60 day period during which comments could be submitted. Comments were collected by LADWP and are shown in a separate section in the pages that follow.

Event	Date	Time	Location	Attendees
Workshop 1 (2010)	1/12/10	6:00 p.m.	Marvin Braude Constituent Center	23
Workshop 2 (2010)	1/20/10	5:00 p.m.	Los Angeles River Center	18
Workshop 1 (2011)	2/3/11	6:00 p.m.	LADWP Van Nuys Service Center	30
Workshop 2 (2011)	2/9/11	6:00 p.m.	LADWP John Ferraro Building, Downtown Los Angeles	44
Final Public Hearing for LADWP Board Adoption	5/3/11	1:30 p.m.	LADWP John Ferraro Building, Downtown Los Angeles	NA

Following incorporation of comments and the production of a finalized version, the UWMP was adopted by the LADWP Board of Commissioners on May 3, 2011.

E-mail Notification

For notification of both rounds of workshops, a flyer was e-mailed to all City of Los Angeles neighborhood councils, homeowners organizations, and stakeholders. The flyer announcement is shown in the pages that follow.

Media Publications

For the February 2011 workshops, an announcement (see next pages) was published in the publications listed in the following table on the dates indicated. As shown, the announcement was also translated and included in multiple foreign language publications. Three example foreign language ads are included in the pages that follow.

Media Outlet	Run date(s)
Wave/Independent/Equal Access Media	Thursday 1/27
Eastern Group Publications	Thursday 1/27
LA Watts Times	Thursday 1/27
LA Sentinel	Thursday 1/27
Korean Daily	Friday 1/28

Downtown News	Monday 1/24
Philippine Media (formally *California Examiner*) Filipino weekly (English language)	Thursday 1/27
La Opinion (Spanish)	Friday 1/28
Our Weekly Newspaper	Thursday 1/27
Palisadian Post	Thursday 1/27
Beverly Press/Park LaBrea News	Thursday 1/27
Tolucan Times-Wed.	Wednesday 1/26
Korean Times	Friday 1/28
Daily Breeze	Friday 1/28
Daily News	Friday 1/28
LA Business Journal	Monday 1/24
SF Valley Business Journal	Monday 1/24
Sing Tao (Chinese)	Friday 1/28
CityWatch Web Site	On-going to 2/9

Website Posting

The flyer notifications for both rounds of workshops and comments/responses from the January 2010 workshops were posted on the LADWP website www.ladwp.com. In addition, the workshop notification was posted on several other websites, including LADWPNews, Twitter, facebook, and neighborhood council web pages. Examples are included in the pages that follow.

60-Day Notification

60-days prior to LADWP Board adoption, the County of Los Angeles, and the Cities of Culver City and West Hollywood were notified (via e-mail and regular mail) of the anticipated adoption of the 2010 UWMP. In addition, the following publications were used for Notification of Board adoption on the dates specified. Letters and ads are shown in the pages that follow.

Media Outlet	Run date(s)
Metropolitan News	Thursday 3/3/11 and 3/10/11
La Opinion	

From: Repp, Chris
Sent: Wednesday, December 22, 2010 11:26 AM
Subject: Urban Water Management Plan (UWMP) Workshops Rescheduled
Attachments: UWMP Workshop Rev 12.22.10.pdf

The workshops originally scheduled for January 13, and January 18, 2011 have been postponed to the following dates, times, and locations. We apologize for any inconvenience.

Thursday, February 3, 2011
6:00 p.m.
VAN NUYS
Van Nuys Service Center
14401 Saticoy Street

Wednesday, February 9, 2011
6:00 p.m.
DOWNTOWN L.A.
LADWP John Ferraro Building, Cafeteria Conference Room
111 N. Hope St.

Free Parking will be provided. The draft 2010 UWMP will be available for review after January 13, 2011 at http://www.ladwp.com.

For more information, contact Simon Hsu at (213) 367-2970.

See attached (revised) flyer.

From: Repp, Chris
Sent: Tuesday, December 14, 2010 8:26 AM
Subject: LADWP's Draft 2010 Urban Water Management Plan Workshops

The public is invited to hear an overview of the LADWP Water System's strategic priorities and preview the draft 2010 Urban Water Management Plan (UWMP) that will outline the City's long-term water resources management strategy. The UWMP is the City's master plan for water supply and resources management. All large California urban water agencies prepare a UWMP and provide an update to their plan every five years.

Please join us at one of the following workshops:

Thursday, January 13 – 5:00 p.m.
CYPRESS PARK
Los Angeles River Center Los Feliz Room
570 West Avenue 26

Tuesday, January 18 – 5:00 p.m.
VAN NUYS
Van Nuys Service Center
7501 Tyrone Avenue

The draft 2010 UWMP will be available for review after January 13, 2011 at

http://www.ladwp.com.

For more information, contact Simon Hsu at (213) 367-2970.

See attached flyer.

Los Angeles Department of Water & Power

YOU ARE INVITED!

Please join the Los Angeles Department of Water and Power (LADWP) at a public workshop to share your views regarding Los Angeles' water supply as the City prepares it's

2010 Urban Water Management Plan

We would appreciate your thoughts and will be seeking your input on various topics and questions such as:

- What water resource options should LADWP pursue to meet future needs?
- What water management strategies should LADWP consider?
- How should LADWP manage water supplies during times of shortage?

TUESDAY, JANUARY 12, 6:00 P.M.

VAN NUYS
Marvin Braude Constituent Center
6262 Van Nuys Blvd.

WEDNESDAY, JANUARY 20, 5:00 P.M.

CYPRESS PARK
Los Angeles River Center – Los Feliz Room
570 West Avenue 26

Presentation to be followed by a group discussion. Light refreshments will be provided.

The City of Los Angeles 2005 Urban Water Management Plan is available on LADWP's web site at: http://www.ladwp.com/ladwp/cms/ladwp001354.jsp

For more information, please contact
Simon Hsu at (213) 367-2970, or simon.hsu@ladwp.com

About LADWP's Urban Water Management Plan (UWMP):
All large California urban water agencies prepare a UWMP and provide an update every five years. LADWP's UWMP offers a detailed discussion on the status of Los Angeles' imported water sources, and provides an update of future water supply and demand for the City. The Water Plan also discusses the management and development of water resources, as well as efforts relating to the efficient use water. Additional topics include existing and future water conservation measures, water recycling, and management of the City's groundwater basins.

As a covered entity under Title II of the Americans with Disabilities Act, the City of Los Angeles does not discriminate on the basis of disability and, upon request, will provide reasonable accommodation to ensure equal access to its programs, service and activities. To ensure availability, such request should be made 72 hours in advance by calling (213) 367-1361, TDD: 1(800) 432-7397.

Los Angeles Department of Water & Power

Draft 2010 Urban Water Management Plan

NEW WORKSHOP DATES*

The public is invited to hear an overview of the LADWP Water System's strategic priorities and preview the draft 2010 Urban Water Management Plan that will outline the City's long-term water resources management strategy.

*** Workshops originally scheduled for January 13 and 18 have been moved to:**

THURSDAY, FEBRUARY 3	WEDNESDAY, FEBRUARY 9
6:00 p.m.	6:00 p.m.
VAN NUYS	**DOWNTOWN LOS ANGELES**
Van Nuys Service Center	LADWP John Ferraro Building, Cafeteria Conference Room
14401 Saticoy Street	111 N. Hope St.

Free parking provided.

Presentation to be followed by public comment.
Public input received from the workshop will be considered for the final 2010 UWMP. The final 2010 UWMP will be presented for adoption by the LADWP Board of Commissioners in May 2011.

About the UWMP:
The UWMP will address requirements under California Water Code Sections 10610 through 10657. The purpose of the UWMP is to cover the management and development of water resources, as well as efforts relating to efficient use of water. The UWMP addresses the areas of existing and future water conservation measures, water recycling, stormwater capture, and management of the City's groundwater basins. In addition, the UWMP offers information on the status of Los Angeles' imported water sources, water quality issues, and projections of future water supply and demand for the City.

Draft 2010 UWMP will be available at www.ladwp.com after January 13, 2011.

Written comments are due no later than March 15, 2011 by email to simon.hsu@ladwp.com, or by mail to:

LADWP - Water System
111 N. Hope Street, Room 1460
Los Angeles, CA 90012
Attn: Simon Hsu

For questions, please call Simon Hsu at (213) 367-2970.

As a covered entity under Title II of the Americans with Disabilities Act, the City of Los Angeles does not discriminate on the basis of disability and, upon request, will provide reasonable accommodation to ensure equal access to its programs, service and activities. To ensure availability, such requests should be made 72 hours in advance by calling (213) 367-2970, TDD: 1 (800) 432-7397.

Internet Outreach

Twitter

LADWP News

DATE: February 7, 2011 11:47:39 AM PST

LADWP News

LOS ANGELES DEPARTMENT OF WATER AND POWER
111 North Hope St., Room 1520, Los Angeles, CA. 90012-5701
Phone (213) 367-1361 - After Hours (213) 367-3227
www.ladwp.com

LA DWP Los Angeles Department of Water & Power

FOR IMMEDIATE RELEASE
February 7, 2011

Urban Water Management Plan Workshop this Wednesday at 6pm in Downtown Los Angeles

Help Us Plan LA's Water Future!

WHAT: The public is invited to hear an overview of the LADWP Water System's strategic priorities and preview the draft 2010 Urban Water Management Plan that will outline the City's long-term water resources management strategy. Workshop attendees are invited to share their thoughts during the program.

WHO: LADWP Water System Representatives

WHEN: Wednesday, February 9, 2011
6:00 p.m.

WHERE: LADWP John Ferraro Building
Cafeteria Conference Room
111 N. Hope Street
Los Angeles, CA 9012
Map

WHY: LADWP is currently preparing the 2010 Urban Water Management Plan (UWMP), which will outline the City's long-term water resources management strategy. Public input received from the workshops will be considered for the final 2010 UWMP, to be presented for adoption by the LADWP Board of Commissioners in May 2011.

For more information on the UWMP workshop, click here.

# # #

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I'm Attending

LADWP Draft 2010 Urban Water Management Plan Workshop

Share · Public Event

Time	Thursday, February 3 · 6:00pm - 9:00pm
Location	Van Nuys Service Center 14401 Saticoy Street Van Nuys, CA
Created By	SOCAL ASLA
More Info	http://www.lariver.org/

Wall

Export · Report Event

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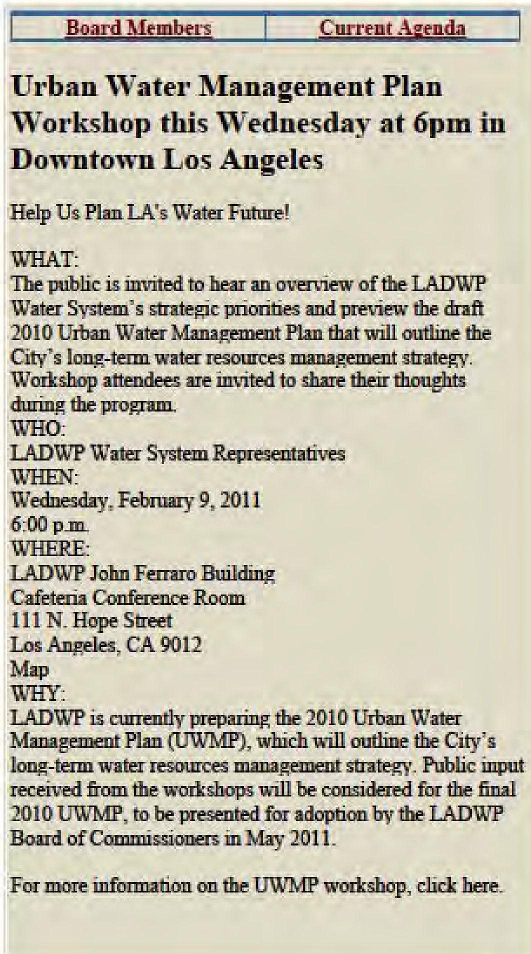
United Neighborhoods (Neighborhood Council) Website



Board Members	Current Agenda

Urban Water Management Plan Workshop this Wednesday at 6pm in Downtown Los Angeles

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LADWP is currently preparing the 2010 Urban Water Management Plan (UWMP), which will outline the City's long-term water resources management strategy. Public input received from the workshops will be considered for the final 2010 UWMP, to be presented for adoption by the LADWP Board of Commissioners in May 2011.

For more information on the UWMP workshop, click here.

Foreign Language Publications Advertisements for February 2011 Public Workshops

Korean Daily

Los Angeles Department of Water & Power

LA 시 수자원의 미래를 지키기 위한 전략 과제

LA 수도전력국의 전략적 우선과제의 개요와 LA 시의 장기적 수자원 관리 전략의 윤곽을 그릴 2010 어반 워터 매니지먼트 플랜 (UWMP)의 초안에 대해 함께 논의하고자 귀하를 초대합니다. 최종 2010 UWMP는 2011년 5월 LA 수도전력국 임원회에서 채택을 발표하게 됩니다.

퍼블릭 워크샵

VAN NUYS

2월 3일 목요일 오후 6시
Van Nuys Service Center
14401 Saticoy Street

DOWNTOWN LOS ANGELES

2월 9일 수요일 오후 6시
LADWP John Ferraro Building, Cafeteria Conference Room
111 N. Hope Street

무료 파킹 제공

2010 UWMP 초안은 www.ladwp.com에서 확인하실 수 있으며
서면으로 된 의견은 2011년 3월 15일까지 아래의 주소나 이메일로 보내주십시오:
LADWP, 111 N. Hope St, Room 1460, Los Angeles, CA 90012,
Attn: Simon Hsu or simon.hsu@ladwp.com

더 자세한 사항은 (213) 367-2970으로 문의하시거나
Simon.hsu@ladwp.com으로 이메일을 보내주시길 바랍니다

As a covered entity under Title II of the Americans with Disabilities Act, the City of Los Angeles does not discriminate on the basis of disability and, upon request, will provide reasonable accommodation to ensure equal access to its programs, service and activities. To ensure availability, such requests should be made 72 hours in advance by calling (213) 367-2970, TDD: 1 (800) 432-7397.

La Opinion

Los Angeles Department of Water & Power

ASEGURANDO EL FUTURO DEL AGUA DE LOS ÁNGELES

El público está invitado para conocer un panorama general de las prioridades estratégicas del Sistema de Agua de LADPW y una vista previa del proyecto Plan de Gestión del Agua 2010 (UWMP, por sus siglas en inglés) que será una idea general de la estrategia para el manejo de recursos del agua de la ciudad a largo plazo. El UWMP 2010 final será presentado para su aprobación por el Concejo de Comisionados de LADWP en mayo de 2011.

Talleres Públicos

VAN NUYS

Jueves 3 de febrero, 6:00 p.m.
Centro de Servicio Van Nuys
14401 Saticoy Street

CENTRO DE LOS ÁNGELES

Miércoles 9 de febrero, 6:00 p.m.
LADWP Edificio John Ferraro
Sala de Conferencias Cafetería
111 N. Hope Street

Estacionamiento Gratuito

El proyecto UWMP 2010 está disponible en www.ladwp.com
Comentarios escritos se reciben hasta el 15 de marzo de 2011 a:
LADWP, 111 N. Hope St, Sala 1460, Los Ángeles, CA 90012,
Attn: Simon Hsu o simon.hsu@ladwp.com

Para más información contactar al (213) 367-2970
o al correo electrónico simon.hsu@ladwp.com

Como una entidad cubierta bajo el Título III de la Ley de Americanos con Discapacidades, la ciudad de Los Ángeles no discrimina por motivos de discapacidad y, previa solicitud, proveerá ajustes razonables para asegurar la igualdad de acceso a su programa, servicios y actividades. Para asegurar la disponibilidad, las solicitudes deberán hacerse con 72 horas de anticipación llamando al (213) 367-2970, TDD 1 (800) 432-7397.

Sing Tao (Chinese)

Los Angeles LA DWP Department of Water & Power

保障洛縣
未來用水

歡迎民眾參加洛縣水電局介紹用水系統的策略重點
及預覽概述城市的長遠用水資源管理戰略的
2010城市用水資源管理計劃(UWMP)草案。
最終的2010城市用水資源管理計劃
將於2011年5月提交洛縣水電局董事會通過。

社區研討會

VAN NUYS

2/3/2011 (星期四) 下午六時
Van Nuys Service Center
14401 Saticoy Street

洛杉磯市中心

2/9/2011 (星期三) 下午六時
LADWP John Ferraro Building, Cafeteria Conference Room
111 N. Hope Street

免費停車

2010城市用水資源管理計劃(UWMP)草案詳情，
請上網至www.ladwp.com
書面意見請於3/15/2011前寄到：
LADWP, 111 N. Hope St, Room 1460, Los Angeles, CA 90012,
Attn: Simon Hsu or simon.hsu@ladwp.com

查詢電話：(213)367–2970或
電郵 simon.hsu@ladwp.com

在美國殘障法案第二條所保障下，洛杉磯市沒有歧視殘障者的基本人權，並且一旦有所要求時，將會提供合理的協助，以確保對洛杉磯市之節目、服務以及活動的公平性。為確保時限有效，任何要求必須在72小時前撥打(213) 367–2970，聽力障礙者專線：1(800) 432–7397。

March 3, 2011

Mr. Sol Blumenfeld
Community Development Director
City of Culver City, Planning Division
9770 Culver Boulevard
Culver City, CA 90232

Dear Mr. Blumenfeld:

Subject: City of Los Angeles 2010 Urban Water Management Plan Public Hearing

The Los Angeles Department of Water and Power (LADWP) is providing this notice of a public hearing for our 2010 Urban Water Management Plan (UWMP). As part of its regularly scheduled meeting on May 3, 2011, the Los Angeles Board of Water and Power Commissioners will hold a public hearing during which members of the public may comment on the adoption of our 2010 UWMP. The hearing will be held on May 3, 2011 at 1:30 p.m. (tentative), 111 N. Hope Street, Room 1555, Los Angeles, CA 90042. Please check the website (http://www.ladwp.com) to confirm the start time.

The 2010 UWMP outlines the City of Los Angeles' (City) long-term water resources management strategy. It is the City's master plan for water supply and resources management. It includes details on LADWP's plans for recycled water, conservation, stormwater capture and other water resource options.

All large California urban water agencies prepare an UWMP every five years. The LADWP's 2010 UWMP is currently available for review on our website at (http://www.ladwp.com) by searching "UWMP."

If you have any questions or comments, please contact Mr. Simon Hsu of my staff at (213) 367-2970, or e-mail him at simon.hsu@ladwp.com.

Sincerely,

Thomas M. Erb

Thomas M. Erb
Director of Water Resources

CR:lsf
c: Mr. Simon Hsu

Department of Water and Power the City of Los Angeles

ANTONIO R. VILLARAIGOSA
Mayor

Commission
THOMAS S. SAYLES, *President*
ERIC HOLOMAN, *Vice-President*
CHRISTINA E. NOONAN
JONATHAN PARFREY
BARBARA E. MOSCHOS, *Secretary*

RONALD O. NICHOLS
General Manager

March 3, 2011

Ms. Gail Farber
Los Angeles County Department of Public Works
900 South Fremont Avenue
Alhambra, CA 91803

Dear Ms. Farber::

Subject: City of Los Angeles 2010 Urban Water Management Plan Public Hearing

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Sincerely,

Thomas M. Erb

Thomas M. Erb
Director of Water Resources

CR:lsf
c: Mr. Simon Hsu

Department of Water and Power the City of Los Angeles

ANTONIO R. VILLARAIGOSA
Mayor

Commission
THOMAS S. SAYLES, *President*
ERIC HOLOMAN, *Vice-President*
CHRISTINA E. NOONAN
JONATHAN PARFREY
BARBARA E. MOSCHOS, *Secretary*

RONALD O. NICHOLS
General Manager

March 3, 2011

Mr. Oscar Delgado, Director
City of West Hollywood
Department of Public Works
8300 Santa Monica Boulevard
West Hollywood, CA 90069

Dear Mr. Delgado:

Subject: City of Los Angeles 2010 Urban Water Management Plan Public Hearing

The Los Angeles Department of Water and Power (LADWP) is providing this notice of a public hearing for our 2010 Urban Water Management Plan (UWMP). As part of its regularly scheduled meeting on May 3, 2011, the Los Angeles Board of Water and Power Commissioners will hold a public hearing during which members of the public may comment on the adoption of our 2010 UWMP. The hearing will be held on May 3, 2011 at 1:30 p.m. (tentative), 111 N. Hope Street, Room 1555, Los Angeles, CA 90042. Please check the website (http://www.ladwp.com) to confirm the start time.

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If you have any questions or comments, please contact Mr. Simon Hsu of my staff at (213) 367-2970, or e-mail him at simon.hsu@ladwp.com.

Sincerely,

Thomas M. Erb
Director of Water Resources

CR:lsf
c: Mr. Simon Hsu

Water and Power Conservation . . . a way of life

111 North Hope Street, Los Angeles, California 90012-2607 *Mailing address:* Box 51111, Los Angeles 90051-5700
Telephone: (213) 367-4211 *Cable address:* DEWAPOLA

60-Day Notification Ads (March 3 and 10, 2011)

La Opinion

TENGA PRESENTE que como parte de su reunión programada para el 3 de mayo de 2011, la Junta de Comisionados de Agua y Energía realizara una audiencia publica durante la cual cualquier mimbre del publico podrá comentar sobre la adopción del Plan de Gestión Urbano del Agua 2011 (UWMP, por sus siglas en inglés).

La audiencia se llevara a cabo a la 1:30 p.m. (tentativamente) el 3 de mayo de 2011, 111 N. Hope Street, Los Angeles, cuarto 1555.

Favor de revisar nuestro sitio en la red en: (http://www.ladwp.com) y buscar en "UWMP"

Los Angeles Department of Water and Power

Metropolitan News

.RATION OF PUBLICATION

STATE OF CALIFORNIA

COUNTY OF LOS ANGELES

KIM HUGHES

DEPT OF WATER AND POWER
GOV'T LEGISLATIVE & PUB AFFAIR
111 N HOPE ST RM 1510
LOS ANGELES CA 90012

NOTICE
2010 URBAN WATER MANAGEMENT PLAN (UWMP)

HEARING/CLOSE/SALE DATE: 05/03/11

The undersigned says:

I am over the age of 18 years and a citizen of the United States. I am not a party to and have no interest in this matter. I am a principal clerk of the METROPOLITAN NEWS-ENTERPRISE*, a newspaper of general circulation in the City of Los Angeles, the Judicial District of Los Angeles, the County of Los Angeles, and the State of California, as adjudicated in Los Angeles Superior Court Case No. 601165. The notice, a printed copy of which appears hereon, was published on the following date(s): Mar 3,10, 2011

I declare under penalty of perjury that the foregoing is true and correct. Executed at Los Angeles, California on 03/10/11.

signature

Metropolitan News-Enterprise
P.O. Box 60859
Los Angeles, Ca 90060

Phone: (213) 346-0033
Fax: (213) 687-3886

Cust. Num.: 012120
Cust. Ref. Num.:
Control Num.: 851942

NOTICE OF PUBLIC HEARING

PLEASE TAKE NOTICE that as part of its regularly scheduled meeting on May 3, 2011, the Board of Water and Power Commissioners will hold a public hearing during which any members of the public may comment on the adoption of the 2010 Urban Water Management Plan (UWMP). The hearing will be held at 1:30 pm (tentative) on May 3, 2011, 111 N. Hope Street, Los Angeles, CA, Room 1555. Please check the website (http://www.ladwp.com) to confirm the start time.

The UWMP is currently accessible for review on our website (http://www.ladwp.com) by searching for "UWMP"

Los Angeles Department of Water and Power.

CN851942 Mar 3,10, 2011

Page 1 of 1

PUBLIC COMMENTS

WORKSHOP PUBLIC COMMENTS

Following is a summary of questions, comments received, as well as LADWP responses at public workshops on the City of Los Angeles Draft 2010 Urban Water Management Plan (UWMP). The first round of public workshops were held on January 12th and 20th, 2010 and then a second round was held on February 3rd and 9th, 2011.

Los Angeles Department of Water and Power

2010 Urban Water Management Plan Public Workshop Comments/Suggestions for What Should be Included in the Plan

INCLUDES LADWP COMMENT RESPONSES

Date:	January 12 and January 20, 2010
Time:	6:00 – 8:30 pm and 5:00 – 7:00 pm (respectively)
Location:	Marvin Braude Constituent Center, 6262 Van Nuys Blvd., Van Nuys, Room 1B Los Angeles River Center, 570 West Avenue 26, Los Feliz Room
Participants:	LADWP (Thomas Erb, David Pettijohn, Simon Hsu, Chris Repp), See Also attached sign-in sheet

Meeting Objective: To present a preliminary summary of the topics to be addressed in the 2010 Urban Water Management Plan (UWMP), and collect comments/suggestions for what should be included in the Plan from the public on these various topics.

If you feel your suggestion is not included, please let us know by e-mailing chris.repp@ladwp.com or calling (213)367-4736.

Links for Workshop Requests

- Plume contamination drawings for the San Fernando Valley, Figures 3-1 to 3-8: http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/3dc283e6c5d6056f88257426007417a2/49aa6d700fbae1988825763200575b46/$FILE/2007_SFV_Report_1_Main.pdf

- Graywater systems for residential buildings from the Dept. of Building and Safety: http://www.ladbs.org/LADBSWeb/LADBS_Forms/InformationBulletins/IB-P-PC2008-012Graywater.pdf

- Summer 2009 Water Main Leak Preliminary Investigation Report (dated November 2009): http://www.ladwpnews.com/posted/1475/Summer_09_Water_Main_Leaks_Prelim_Investigation_Rpt_.398503.pdf

Groundwater

1. **Comment:** The groundwater recharge program should be expanded. The vast majority of the LA River and other stormwater runoff wastefully flows directly to the ocean. Much more of the runoff within the City needs to be captured to recharge our aquifers or supplement other supplies.

   Response: LADWP will be preparing a Stormwater Capture Master Plan which will address the potential of stormwater capture infiltration and distributed stormwater capture projects. The Stormwater Capture Master Plan is covered in Section 7.3 of the draft report.

Stormwater Capture and Graywater

2. **Comment:** Land use should be changed to allow more rainwater harvesting and stormwater capture. If a developer wants to build and consequently use more water, they should be required to provide open space to be used for stormwater capture. The City codes should have more emphasis on promoting stormwater capture.

Response: On December 17, 2010, the L.A. City Council directed the Los Angeles City Attorney to draft language for a Low Impact Development (LID) Ordinance addressing new development.

3. **Comment:** LADWP should communicate more with other City agencies (LA City Bureau of Engineering) on LA River and other watershed issues to increase stormwater capture.

   Response: LADWP is working with other City agencies and the LA County Flood Control District to enhance Stormwater Capture. This is detailed in Chapter 7 and 10, particularly in sections 7.1, 7.3, 7.7, and 10.2. LADWP involvement with the LA River is covered in section 10.2, under *Los Angeles River*, and *Agency Coordination.* A case study on the LA River Revitalization is also included in Chapter 3.

4. **Comment:** A good way to study sustainable use and stormwater capture potential is to get universities and large public facilities involved.

   Response: The Stormwater Capture Master Plan will examine alternative methods to implement Stormwater Capture.

5. **Comment:** In terms of Recycled Water Systems for private family residents, the City should implement incentives for graywater applications (see link on first page), rainbarrels, and cisterns.

   Response: LADWP continually assesses conservation programs. For stormwater capture solutions, the Stormwater Capture Master Plan will review potential incentives. The link to the graywater regulations is provided on the first page (Refer to "Links for Workshop Requests"). The Bureau of Sanitation conducted a pilot study for rain barrel use in the City. It is discussed in Chapter 7 of the draft report as "Case Study: Ballona Creek Watershed Rainwater Harvesting Pilot Program". The Bureau of Sanitation, Watershed Protection Division, began the City's first free Rainwater Harvesting pilot program in July 2009.

6. **Comment:** It would be advantageous if there was an action body or group within the City that the public could work with to speed the development of small scale rainwater capture and graywater applications.

   Response: LADWP will continue to look for ways to work with other agencies and stakeholders in advancing stormwater capture solutions. Implementation of Low Impact Development (LID) will significantly facilitate the development of stormwater capture and graywater applications. The link to the graywater regulation is provided on the first page. The LADWP website is currently being revised and should contain additional information on graywater once complete. See also response number 8.

7. **Comment:** In the UWMP there should be more emphasis on practical examples of stormwater capture and rainwater harvesting. More pamphlet materials would also be helpful.

   Response: Chapter 7 – Watershed Management provides three case studies on neighborhood recharge, rainwater harvesting, and stormwater capture. More information will be available following the completion of the Stormwater Capture Master Plan, as part of public outreach. See also response number 8.

8. **Comment:** The new UWMP plan should have specific guidelines and instructions of how to implement graywater and other water saving systems. This would include how to obtain permits from Building and Safety, and would streamline the entire process.

   Response: The link to the graywater regulations is provided on the first page (above) and Section 3.3.1 of the draft 2010 UWMP. It states that a permit is not required for untreated residential graywater systems using water from clothes washers. Furthermore, The LADWP webpage is currently being revised, and once complete will contain updated information on promoting graywater. The website will familiarize our customers with graywater and promote safe and legal installations of graywater systems. It will include various graywater systems, permits required, water saving estimates, frequently asked questions, and additional information resources. LADWP has obtained International Association of Plumbing and Mechanical Officials (IAPMO) approval to use and modify copyrighted material (i.e. graywater figures) to reflect California State regulations.

Water Recycling

9. **Comment:** There should be an emphasis not only on large scale recycling but also on small scale recycling as in rainwater harvesting and graywater applications.

   Response: Section 7.6, entitled Distributed Stormwater Capture, discusses several types of de-centralized stormwater capture, including rain barrels, cisterns, rain gardens, and several neighborhood recharge projects. Graywater is discussed in the Conservation Chapter in Section 3.3.1 and mentioned in response 8 above.

10. **Comment:** Setting incremental goals for recycled water past 2019 onto 2035 is a positive step in meeting the challenge of dependence on imported water. Increasing the amount of recycled water used not only for environmental use, but to replace potable water, is the right direction for the City.

    Response: Chapter 4, Recycled Water, discusses these very issues, covering LADWP's recycled water program for the next 25 years. It includes plans for groundwater replenishment, along with recycled water "purple pipe" distribution projects to industries and businesses within the City.

Costs

11. **Comment:** There is a concern of the increase of water rates, the costs for planned projects, and the marginal costs of various sources of water supply.

    Response: With the exception of the proposed groundwater remediation efforts in the San Fernando Valley, it is believed all resource initiatives in the 2010 UWMP can be funded with current water rates. The groundwater cleanup project is a very costly large scale project, and will require additional funding. Unit costs of various sources of supply are covered in Chapter 11, Section 11.1.

12. **Comment:** The additional funding from increased water rates should be used to improve the water infrastructure.

    Response: Infrastructure improvements (reliability), compliance with regulatory requirements (safety), increasing local supply, protecting the environment (sustainability) and maintaining competitive water rates are the top water priorities for LADWP.

13. **Comment:** The decision to implement particularly expensive projects throughout the City should be based more upon environmental and economical feasibility than on neighborhood influence. This benefits the greater good of the community.

    Response: When moving forward with expensive water resource projects, LADWP considers environmental and economical feasibility. A good example is that recycled water is favored over seawater desalination mainly because of its more competitive cost and lesser environmental impact.

Los Angeles Department of Water and Power

2010 Urban Water Management Plan Public Workshop Comments/Suggestions for What Should be Included in the Plan

New Developments

14. **Comment:** There should be a link between water supply and community development planning.

    Response: The link between water supply and development planning is explained in Section 11.4, Water Supply Assessments.

15. **Comment:** New developments (particularly those on multi family residences) should bear a greater burden for the costs of acquiring water. The cost of acquiring additional water supply is unjustly being shared by the rate payers.

    Response: This comment will be recorded and included in the appendix of the 2010 UWMP.

16. **Comment:** In terms of conservation, some high-density projects may be beneficial in ways such as allocating more open space that can be used for stormwater capture.

    Response: The City of Los Angeles is close to adopting a low impact development (LID) ordinance requiring stormwater capture for all new development.

Climate Change

17. **Comment:** LADWP needs to educate constituents about the water crisis and the potential effects of dry climate conditions furthering the drought situation. The Department should enlist experts to provide insight into this challenge.

    Response: Chapter 12 is dedicated to the topic of climate change. LADWP is currently conducting a climate change study regarding its impacts on the Eastern Sierra watershed, which provides water to the Los Angeles Aqueduct.

Conservation

18. **Comment:** Some of the lesser known Phase III Water Conservation Ordinance restrictions should not be lifted if they produce a City that is more responsible and efficient.

    Response: Conservation efforts in Los Angeles have proven very successful, and have significantly increased water use efficiency in the City. The Los Angeles City Council ultimately determines whether or not these restrictions are lifted. At this time LADWP does not recommend any changes.

19. **Comment:** LADWP should work with other City departments to ensure maximum public benefit with the incentive programs. Additional fees across departments may discourage the use of these incentives.

    Response: LADWP will keep this in mind to ensure incentive programs are effective. LADWP recently worked with the L.A. Department of Building and Safety (LADBS) to eliminate fees for turf removal in parkways.

20. **Comment:** Conservation alone is not adequate to sustain an increasing population. We will need to introduce additional and/or increased supplies.

    Response: Exhibit 11C of Section 11.2.8, entitled Service Area Reliability Assessment, highlights LADWP's plans to increase our local supplies significantly. This will reduce purchase of imported water from the Metropolitan Water District by approximately 50 percent by 2035.

Los Angeles Department of Water and Power

2010 Urban Water Management Plan Public Workshop Comments/Suggestions for What Should be Included in the Plan

Water Supplies

21. **Comment:** There is concern over the amount of water used for environmental reasons in the Owens Valley as this supply diversion significantly increases our dependence on imported water.

    Response: Annually, LADWP diverts up to 95,000 acre-ft (AF) of Los Angeles Aqueduct water for the Owens Lake Dust Mitigation Project. This is one of the City's many environmental challenges. LADWP is proposing dust mitigation solutions on Owens Lake that will not increase water usage from what is currently used.

22. **Comment:** There is concern about meeting our supplies with an ever growing City population, and an interest in seawater desalination. As costs of various water supplies increase, and technological improvements lower operating cost, it may eventually become economically feasible. However desalination still has its fair share of environmental challenges.

    Response: LADWP has studied seawater desalination and concluded that it presents too many economic and environmental obstacles at this time. LADWP has decided to focus its efforts on water conservation and recycling.

23. **Comment:** It would be beneficial to have a long term vision for eliminating the City's need for water imports.

    Response: See comment number 20.

Miscellaneous

24. **Comment:** There is an interest in the cause of recent water main breaks (See also link on first page); it's relation to the two day water restriction, and the bombardment of overweight trucks.

    Response: The link on the first page shows the Summer 2009 Water Main Leaks Preliminary Investigation Report. In addition, the Conservation chapter shows the most recent Water Conservation Ordinance amendments, which implement revised Phase III restrictions. In the amendments, odd numbered addresses are allowed to water on Monday, Wednesday, or Friday, while even numbered addresses can water only on Tuesday, Thursday, or Sunday. This is designed to prevent large fluctuations of pressure within the water distribution system.

25. **Comment:** The City should set up a forum with blogs where the public can share ideas and comments on water related issues.

    Response: As discussed in comment number 6, the LADWP website is currently being revised. It will include Facebook and Twitter links.

Los Angeles Department of Water and Power

Summary of 2010 Urban Water Management Plan Public Workshops Comments and Suggestions with LADWP Responses

Workshop 1: February 3, 2011, Van Nuys Service Center, 14401 Saticoy St.

Workshop 2: February 9, 2011, LADWP John Ferraro Building, 111 N. Hope St.

Attendees: See attached sign-in sheets

Water Demands

1. **Comment:** How long has the State Department of Water Resources required submittal of Urban Water Management Plans (UWMP)? Historically, how accurate have the projections been?

   Response: The water demand projections and UWMP have been a requirement since the UWMP Act was established in 1984. Historically, LADWP's projections have turned out to be higher than actual use. The 2010 UWMP is the first UWMP where water demand projections are significantly lower than previous versions. Section 2.3 provides a description of the demand forecast methodology.

2. **Comment:** Water demand projections are significantly lower than those developed in the 2005 UWMP. Why is this?

   Response: As stated above, previous projections were higher than what actually occurred. For this UWMP, LADWP devoted a lot of study on projected water demands and developed a new forecasting model. Water efficient practices and numerous regulations effecting water use are much more commonplace than in the past, which are expected to prevent significant increases in water demands.

3. **Comment:** The population increased in the last 30 years but water usage has seemed to decrease. However, LADWP has now projected a continual increase with population and increase in water demand. What is changing this historical trend?

   Response: Today, as compared to the 1970's and 1980's, the City has achieved a much higher level of conservation. This is why our water demand has stayed relatively the same even though the City population has increase by over 1 million since 1970. As the City continues to grow in population, water demand is projected to increase slightly.

4. **Comment:** Why is water use staying relatively the same versus a steady increase of population over time?

   Response: The City's water use has not increased significantly due changes in customer awareness and efficient use of water, more stringent plumbing standards, LADWP incentives and rebates, and requirements such as mandatory restrictions on water use.

5. **Comment:** Twenty five years from now what percentage of our water supply will come from local water supplies?

   Response: According to the UWMP 43 percent of water supplies will come from local sources in 2035. By increasing water conservation, recycled water, and stormwater capture, LADWP is projecting to cut the current average annual amount of MWD purchases in half in 25 years.

6. **Comment:** Through 2050, the Southern California Association of Governments (SCAG) projects the Southern California area to double in size from 15 to 30 million people. How can we meet these water requirements, especially considering that other adjacent cities are far behind LA and have not implemented such aggressive conservation measures?

   Response: The major focus of LADWP's UWMP is the development of increased local water supplies to lessen our dependence on imported water that must be shared with all of Southern California. Many other cities in Southern California are pursuing similar local water resource goals. State Senate Bill X7-7 (SBX7-7), passed by the State Senate in 2010 requires a 20 percent reduction in water use by all water agencies by 2020. This requirement will assist in driving other agencies to meet conservation targets.

7. **Comment:** The presentation shows a slight increase in Los Angeles Aqueduct supplies will increase in 2035. Why?

   Response: The most recent 5-year average Los Angeles Aqueduct deliveries are slightly lower than the historical average. The 2035 projection of Los Angeles Aqueduct deliveries assumes average weather conditions, with a slight decrease due to anticipated climate change impacts.

Water Supplies and MWD

8. **Comment:** Where, how, and when is the connection between the State Water Project and Los Angeles Aqueduct (LAA) going to be built?

   Response: A turnout facility is currently being constructed where the Los Angeles Aqueduct and the California Aqueduct intersect in the Antelope Valley, a few miles west of the 14 freeway. The purpose of the facility is to allow the pumping of water from the California Aqueduct into the Los Angeles Aqueduct and allow LADWP to participate in water transfers from the water market. The turnout facility is currently under construction and should be in service by the summer of 2013.

9. **Comment:** Is there a document that summarizes the structure of water supplies for the City?

   Response: The UWMP is primary water resource planning documents. It is updated every 5 years.

10. **Comment:** Is LADWP planning to purchase more water from the Bay-Delta?

    Response: There are a number of water supply and environmental challenges in the Bay-Delta. As outlined in the UWMP, LADWP is planning on decreasing purchases from MWD, which imports water from the Bay-Delta. The UWMP discusses how local water supplies are being developed and how LADWP is planning to rely less on MWD.

11. **Comment:** MWD has been decreasing its allocations from the Bay-Delta via the State Water Project, and Colorado River storage has been decreasing as is evident in Lake Mead's low levels. The City's water demand will increase while LADWP's supply from MWD seems to decrease. How can LADWP reconcile this difference?

Response: LADWP projects a small increase in water use due to population increases, however the UWMP projects LADWP's reliance on MWD water supplies will be reduced by half; from the current five-year average of 52 percent of total demand to 24 percent by 2035 under average weather conditions. The reliability of MWD's water supplies from both the State Water Project and the Colorado River are discussed in detail in Chapters 8 and 11 of the UWMP.

12. **Comment:** What water will be exchanged when the connection between the California Aqueduct and the Los Angeles Aqueduct is developed?

    Response: LADWP will seek to purchase water from willing sellers, most likely agricultural entities. State Water Project supplies provided to agencies such as MWD will not be a source of these water purchases.

13. **Comment:** Is there a reciprocal agreement between Metropolitan Water District and LADWP on water transfers occurring at the connection of the California Aqueduct and Los Angeles Aqueduct?

    Response: Yes, there is a reciprocal agreement between MWD and LADWP. MWD has the exclusive right to sell State Water Project supplies within its service territory. LADWP has the ability to move non-State Water Project water through the California Aqueduct into LADWP's service territory.

14. **Comment:** Are there salinity problems with Colorado River water?

    Response: Salinity continues to be an issue with Colorado River water supplies. MWD addresses this through water blending. MWD blends Colorado River Aqueduct water with lower salinity State Water Project water.

Water Conservation and Graywater

15. **Comment:** Is the new watering schedule going to decrease the effectiveness of LADWP's outdoor watering conservation efforts?

    Response: The new watering schedule went into effect in late August 2010. Since that time, water savings have been essentially unchanged compared to the period prior to the change. Overall monthly conservation savings continue at approximately 20 percent, with single-family residential savings at approximately 25 percent. LADWP will continue to monitor conservation.

16. **Comment:** LADWP should abandon the Irrigation Association Smart Water Application Technologies (SWAT) testing as a means of evaluating weather based irrigation controllers.

    Response: The SWAT project is an international utility/irrigation industry initiative to achieve landscape water use efficiency through the application of irrigation technology. It includes an independent third party testing protocol for weather based irrigation controllers. LADWP's Water Conservation staff is reviewing this suggestion with the individual who provided it.

17. **Comment:** LADWP should have more information and guides on graywater projects.

    Response: The LADWP website update will contain information on graywater. Included will be information on benefits, available alternative installations, costs and savings, and how to obtain permits.

Water Recycling

18. **Comment:** What are LADWP's plans to use recycled water for environmental enhancement improvements?

    Response: Recycled water is currently being provided for the Sepulveda Basin Japanese Garden, Lake Balboa, the Wildlife Lake, and the Los Angeles River. Those commitments will be maintained as LADWP expands recycled water use.

19. **Comment:** Provide a description of the Recycled Water Master Plan.

    Response: Section 4.4 of the UWMP describes the components of Recycled Water Master Plan. Once complete, the Recycled Water Master Plan will act as a roadmap for how to expand recycled water in the City.

Stormwater Capture

20. **Comment:** Why are the stormwater infiltration goals of 10,000 AF of rainwater harvesting and 15,000 AF of infiltration so low?

    Response: Currently, stormwater infiltrates and replenishes local groundwater basins so LADWP can fully exercise its pumping rights. The UWMP projects that by 2035 there will be a minimum of 15,000 AFY of increased groundwater pumping in the San Fernando Basin due to water supply augmentation through stormwater infiltration. In order to increase groundwater production, it must be determined that not only have groundwater levels recovered to sustain existing safe yield pumping amounts, but documented additional infiltration is occurring that could potentially increase the safe yield. Increasing the safe yield will require concurrence by the Watermaster and the courts to amend the basin judgment. Amending the judgment would be a lengthy process involving all basin pumpers. More studies must be conducted to determine how much more infiltration must be developed to increase the safe yield and groundwater production. The Stormwater Capture Master Plan will identify the potential acre-feet per year quantities available for recharge, and develop an implementation plan to augment the groundwater basin through centralized and decentralized infiltration projects and programs.

21. **Comment:** Provide a description of the Stormwater Capture Master Plan, and what is its cost?

    Response: A Request for Proposal for consulting services to prepare a Stormwater Capture Master Plan has been released. The Master Plan's goal is to study the potential for increased stormwater capture and identify feasible alternatives and estimated costs. The cost of the Master Plan will be determined once proposals are received and reviewed, and a contract negotiated.

22. **Comment:** The City states that it will cost $8 billion for stormwater capture projects. How does the Stormwater Capture Master Plan fit in with this cost?

    Response: While the City has potential obligations for improving stormwater quality, the Stormwater Capture Master Plan's focus is on developing new water supplies. However, the Stormwater Capture Master Plan will include input from other City departments and examine potential alternatives that achieve multiple objectives.

23. **Comment:** Watershed management needs to be evaluated on a regional level.

    Response: LADWP increasing coordinates with other agencies and organizations on watershed issues, including the United States Army Corps of Engineers, the Los Angeles County Flood Control District, the Greater Los Angeles Integrated Regional Water Management Group, the Los Angeles and San Gabriel Rivers Watershed Council, and numerous environmental organizations and stakeholders. LADWP will continue to work with others to improve regional coordination of watershed management.

24. **Comment:** Construction of more subsurface infiltration basins will help counteract the effects of hardscape in the City.

    Response: Agreed. LADWP participated in the Elmer Avenue Neighborhood Retrofit Demonstration Project, the North Hollywood Alley Retrofit Project, and other projects to highlight alternatives to impervious hardscape.

25. **Comment:** Required infiltration from roof gutters on property development should prevent more runoff

    Response: The City's Low Impact Development Ordinance will require stormwater capture and reuse on all new development. Capturing water from roof gutters is one available option to meet the Ordinance requirements.

26. **Comment:** Construction of reservoirs along the Los Angeles River is a good way to enhance infiltration of runoff along the Los Angeles River channel.

    Response: This option may be feasible if available parcels can be identified and obtained.

27. **Comment:** There are some areas in the City that have historically had repeated flooding. What is being done to solve this problem?

    Response: While flood control is not LADWP's primary mission, it is possible that areas prone to flooding may also be candidates for stormwater capture projects. Examples are the Elmer Avenue Neighborhood Retrofit Demonstration Project and the recently approved Woodman Avenue Multi-Beneficial Storm Water Capture Project. LADWP will seek involvement by other City departments during the preparation of the Stormwater Capture Master Plan to explore solutions that have multiple benefits.

28. **Comment:** There should be collaboration with the City Planning Department to regulate the structure of roofs and gutters on parking lots, etc., to promote infiltration and water reuse on new projects.

    Response: LADWP works with other City departments on ordinances to require stormwater capture for all new developments in the City. An example of this is the Low Impact Development (LID) ordinance, currently being drafted by the City Attorney. See Section 7.6.4.

29. **Comment:** How is LADWP working to increase capture of stormwater runoff in urban developments such as parking lots and other hardscape?

    Response: LADWP is currently participating in various stormwater capture demonstration projects in order to develop alternative city-approved construction standards and gather cost data. An example is the Elmer Avenue Neighborhood Retrofit Project. LADWP actively worked on the development of the Low Impact Development

Ordinance currently being drafted, and has begun the process to initiate a Stormwater Capture Master Plan to identify the potential for stormwater capture and identify alternative solutions.

30. **Comment:** Does LADWP partner with other agencies to promote more progressive parking lot strategies and similar approaches to increase stormwater capture?

    Response: LADWP worked with other City departments on the Low Impact Development Ordinance, and continues to work with other departments on the Green Streets Committee and stormwater capture demonstration projects. Increased stormwater capture from parking lots will be explored in the Stormwater Capture Master Plan.

Groundwater

31. **Comment:** What is the percent make-up of the City's local groundwater supply?

    Response: Historically, 15 percent of the City's total water supply has come from local groundwater. However, due to contamination issues in the San Fernando Basin, the City's largest groundwater source, local groundwater currently comprises only 11 percent of overall water supplies.

32. **Comment:** LADWP has not been able to meet groundwater production as stated in previous Urban Water Management Plans. The Department needs to improve their approach to meet the long-range groundwater goals. How will LADWP do this?

    Response: Groundwater contamination has prevented LADWP from pumping its full entitlement. LADWP is conducting a comprehensive analysis of groundwater quality to determine the location and type of treatment necessary to fully clean up the contamination. The analysis will lead to specific groundwater treatment project proposals. With groundwater improvements in place, LADWP expects to meet long-range groundwater pumping goals.

33. **Comment:** Water supply issues in the Bay-Delta could be offset by using advanced treated groundwater. What type of treatment technologies are planned for groundwater cleanup in the San Fernando Basin?

    Response: The analysis of San Fernando Basin contaminants and potential treatment technologies is still being studied. However, potential treatment methods under review include: Air Stripping with Vapor Phase Granular Activated Carbon and Liquid Phase Granular Activated Carbon (for volatile organic compounds), Ion Exchange and/or Biological Treatment (for nitrate and perchlorate), Catalytic Media Filtration (for heavy metals), Ultraviolet Light/Hydrogen Peroxide (for 1,4, dioxane and NDMA), Filtration (for chromium 6), and Reverse Osmosis (for total dissolved solids).

34. **Comment:** Are there groundwater storage opportunities up North in areas outside of the City?

    Response: Yes. The Antelope Valley contains a large groundwater basin that can be used for groundwater storage. In the Antelope Valley, the City of Los Angeles is a party in current litigation to establish an adjudication that will potentially address storage rights. Other groundwater storage opportunities exist in the San Joaquin Valley. While groundwater storage outside of the Los Angeles basin can assist with water supply management, it is not a new water supply and is potentially costly. LADWP will continue to review opportunities for cost-effective groundwater storage outside of the Los Angeles basin.

Costs

35. **Comment:** There is a significant concern over water rates and costs associated with all the projects in the 2010 UWMP.

    Response: The UWMP includes information on the costs of different resource options. With existing revenues for local supply development, LADWP believes we can achieve the water resource goals as stated in the 2010 UWMP, with the exception of the groundwater cleanup effort which will require rate increases. Section 11.1 addresses unit costs and funding.

36. **Comment:** The LADWP Power System is planning to significantly increase energy rates to support green energy sources. How will the Water System deal with the extra cost of the groundwater cleanup alongside the power cost increase?

    Response: All proposed rate increases are reviewed with Neighborhood Councils and the public, and the LADWP Board of Commissioners carefully considers the justification and impact of increased rates prior to making any decision. Also, all LADWP rate revisions require approval by the Los Angeles City Council.

Climate Change

37. **Comment:** To what region does the climate change study apply?

    Response: The climate change study LADWP is conducting is specifically for the Eastern Sierra watershed that feeds the Los Angeles Aqueduct. However, Section 12.1 provides information on projected local climate change impacts.

Miscellaneous

38. **Comment:** There is an interest in ocean desalination. Why is this not a water supply LADWP is pursuing?

    Response: Five years ago, LADWP conducted studies and began planning an ocean desalination pilot project adjacent to the Scattergood Power Generation Facility. However, we found desalination to be too costly and have numerous environmental challenges. LADWP determined that conservation and recycling are more cost effective, easier to implement, and more environmentally friendly.

39. **Comment:** Explain the inconsistency whereby City Planning Department updates to the General Plan are not in line with LADWP's updates for the 2010 UWMP projections.

    Response: The UWMP includes projected population increases provided by demographic projections from Southern California of Governments (SCAG) data. The City's General Plan also uses population forecasts provided by SCAG data; therefore, the UWMP projections are generally consistent with the City's General Plan as both use SCAG projections as their basis. Both of these planning documents are interdependent, however, their updates may not necessarily be on the same schedule.

Summary of 2010 Urban Water Management Plan Public Workshops Comments and Suggestions with LADWP Responses

40. **Comment:** The 2010 UWMP should state that the City's water allotment is based on the preferential rights agreement of the MWD Allocation Plan which is now a fixed number and does not increase with City's demographics or demand projections.

    Response: MWD adopted a Water Supply Allocation Plan in 2008 that is not based on preferential rights. If shortage allocations are required, the calculations established in the Water Supply Allocation Plan equitably allocate available supplies among MWD's member agencies primarily based on need, with adjustments to account for growth, local investments, changes in supply conditions, demand hardening, and water conservation programs.

41. **Comment:** LADWP is doing a good job of projecting demands and implementing conservation, recycling, and stormwater programs; however, LADWP still has a long way to go.

    Response: The 2010 Urban Water Management Plan highlights the significant potential for increased local resources development.

42. **Comment:** Financial incentives, either positive or negative, should be used to modify water use behavior. Rebates and incentives for exceptional conservation or citations for water waste will help encourage conservation and spread the word of efficient water use.

    Response: Since November 2008 the Water Conservation Team (formerly know as Drought Busters) have been enforcing the City's Emergency Water Conservation Ordinance, issuing both warnings and citations for water waste. Also, LADWP continues to offer rebates and incentives for all customer types.

43. **Comment:** Development should be limited and should be required to compensate for additional water needs.

    Response: In December 2009, the High Efficiency Plumbing Ordinance went into effect requiring the next generation of water efficient plumbing fixtures in all new development. Also, the City Attorney is currently drafting the Low Impact Development Ordinance for City Council approval that will require on-site stormwater capture for all new development.

44. **Comment:** In the "Securing L.A.'s Water Future" presentation, under Regulatory Requirements – Other, there are significant proposed expenditures of $337 million. What are these expenditures for?

    Response: The largest portion of these proposed expenditures are for air quality requirements at Owens Lake.

45. **Comment:** Please explain the high number of pipe breaks recently. Is it because of the watering schedule?

    Response: The expert panel formed to examine pipe breaks reviewed possible causes. The panel reviewed whether the 2-day per week watering schedule in place at the time was contributing to the increased frequency of pipe leaks. The 2-day per week watering schedule caused water system pressures to cycle more frequently than prior to watering restrictions. The panel theorized that these pressure cycles increased pipe breaks. In response to that analysis, the City Council modified the watering schedule to 3-days per week watering, with separate watering days for odd and even addresses.

46. **Comment:** Explain the budget for groundwater storage.

    Response: There is $2 million budgeted for groundwater storage in fiscal year 2010-11 to study groundwater storage opportunities outside of the Los Angeles basin.

47. **Comment:** How many miles of riveted steel pipe does LADWP have?

    Response: LADWP has 86.3 miles of riveted steel pipe within the city's water distribution system. In addition, the First Los Angeles Aqueduct contains 13.8 miles of riveted pipe.

48. **Comment:** Describe the power usage of the State Water Project in comparison to the Los Angeles Aqueduct?

    Response*:* As explained in the UWMP's Section 12.2 entitled "Water Energy Nexus", State Water Project supplies are the most energy intensive, ranging from approximately 2,580 kilowatt hours per acre foot (kWh/AF) for the west branch, to 3,236 kwh/AF for the east branch. The Los Angeles Aqueduct water is conveyed from the eastern Sierra Nevada watershed by gravity flow, and does not require pumping as compared to the State Water Project water. Los Angeles Aqueduct water requires no energy for delivery and generates hydroelectric power as it travels from the eastern Sierra Nevada to Los Angeles.

49. **Comment:** What is LADWP doing to install individual meters for multi-family residences?

    Response: LADWP supports efforts to encourage individual meters in new multi-family construction. Studies show that customers who pay individual water bills use water more efficiently.

50. **Comment:** When will electronic meters be used?

    Response: LADWP continues to investigate so-called smart water meters and at this time we do not have an estimate when they will begin to be introduced. Smart water meters allow for more frequent readings and can provide useful water information such as leak detection.

51. **Comment:** What is the current status of the Palos Verdes Reservoir in San Pedro? Is it empty?

    Response: The Palos Verdes Reservoir is owned and operated by MWD. It is in service, but looks empty since a floating cover is installed. This floating cover is one option that we are investigating for some of our own open reservoirs to meet water quality regulations.

52. **Comment:** Is most of the infrastructure work being done going to be performed by LADWP employees or will any of the work be contracted out?

    Response: Major water quality improvement projects, such as reservoir covers will be contracted out. Small diameter pipe replacement is performed by LADWP personnel. For large diameter pipelines, it is estimated that approximately half will be contracted out and half performed by LADWP personnel.

WRITTEN PUBLIC COMMENTS

Following are responses to written correspondences (attached) from Accurate WeatherSet, S.Schron, Edward Saltzberg & Associates Forensic Mechanical Engineers, David Coffin, Phoenix, Aquacell, Heal the Bay, Joyce Dillard, Elmco/Duddy, Environmental Now, TreePeople, and Southern California Watershed Alliance on the City of Los Angeles Draft 2010 Urban Water Management Plan (UWMP).

Responses to Written Questions

Heal the Bay, 3/15/11

Question: Why have water recycling goals decreased from the original target?

Response: Recycled water projections in the UWMP reflect what can be achieved with the existing amount of annual revenue. Receipt of federal or state grants will allow projections to be increased.

Question: LADWP should prioritize stormwater capture projects and set goals for new stormwater capture projects in Los Angeles. When will the Stormwater Capture Master Plan be completed?

Response: The Stormwater Capture Master Plan will address these suggestions. It is projected that the Master Plan will be completed by the fall of 2013.

Joyce Dillard, 3/15/11

Question: You conclude that outdoor water use is estimated at 39% of demand, but the water demand data in Exhibit 2C does not indicate a reason to come to that conclusion.

Response: The projection of outdoor water use is based on estimated water needs for landscape irrigation and an analysis of wastewater system flows compared to total water consumption. Section 2.1 of the UWMP discuss the analysis.

Question: What is the definition of non-revenue water use?

Response: Non-revenue water use is defined as the difference between the total water supplied to the City and total water sales. Non-revenue water consists of water for used for fire fighting, reservoir evaporation, pipeline leaks, meter errors, theft from hydrants, water used for street sweeping and pipeline flushing for water quality purposes.

Environment Now, 3/15/11

Qustion: Why has LADWP been behind on its water recycling targets compared to the original benchmark? Why have the water recycling goals decreased from the original target?

Response: The 2010 UWMP water recycling targets and current progress reflect the current level of revenue. Based on current levels of revenue, LADWP projects they can meet the current water recycling goals. If LADWP is successful in acquiring additional grants, then goals may be increased.

TreePeople, 3/15/11

Question: Page 11-8, Exhibit 11E: Note 1 indicates a loss in the LA Aqueduct at 0.1652% per year due to climate change. There is no indication of loss from MWD (California Aqueduct, and Colorado River Aqueducts) due to climate change. Does this account for MWD's projections?

Response: MWD's recently adopted 2010 Regional Urban Water Management Plan (RUWMP) and their 2010 Integrated Resources Plan (IRP) documents discuss in detail the potential impacts to supplies to the California and

Colorado River Aqueducts due to climate change. LADWP's draft 2010 Urban Water Management Plan (UWMP) makes references to these to MWD documents.

Although MWD's State Water Project (SWP) contract entitlement is 1,911 thousand acre-feet (TAF), projected SWP water deliveries to MWD are expected to be much less than their full entitlement due to many factors. The State's Department of Water Resources (DWR) issued the 2009 draft Reliability Report which identified climate change as one of the significant factors that could reduce future SWP water deliveries. MWD used the DWR's 2009 Reliability Report in reporting its SWP supply projections in its RUWMP, which was the source document for MWD SWP supplies as reported in the LADWP's 2010 UWMP.

The impacts of climate change is also projected to reduce Colorado River supplies, however, it's not expected to impact California as the state has senior water rights on the use of Colorado River water. Under the Seven Party Agreement of 1931 that divided California's share of the Colorado River supplies among the seven major water uses in the state, MWD's full Priority 4 Apportionment of Colorado River water has been consistently delivered and can reasonably be expected to be available in the future as indicated in their RUWMP. This is due in part to the fact that MWD's allocation of Colorado River holds a senior priority right to both Nevada and Arizona. In effect this means that any shortages on the Colorado River from climate change or other causes up to 1 million acre-feet will be born first by Arizona and Nevada before MWD is impacted.

Please note that MWD's SWP and Colorado River supply projections in their RUWMP indicate no reductions in deliveries even during extended dry periods because MWD has made numerous investments in other water supply and storage programs on the Colorado River, which are in addition to MWD's projected base apportionment and entitlement deliveries. MWD's 2010 IRP also establishes goals for a range of potential "buffer" supplies, up to approximately 500,000 acre-feet, to protect the region from possible shortages due to potential climate change and other impacts to its supplies.

Southern California Watershed Alliance (3/28/11)

Question: Regarding Exhibits 2I, 2J, and 2K. While projection of conservation savings go up, the demand seems to rise gradually until 2035. If you take the historic savings in the last few years and combine that with future investments why would demand continue to rise?

Response: Exhibit 2I was found to contain some errors and has been corrected and updated. It now shows that per capita water use consistently decreases. Though per capita water use decreases due to increased conservation efforts, demand will continue to increase in the future due to projected economic growth and population increases.

Question: Why, on page 3-5, did you choose Method 3 for reporting, when you are already at 19% conservation? If the current gallons per capita per day is 124, by taking this approach you are actually looking at a higher per capita into the future.

Response: LADWP reviewed all four available methods for compliance with the State's 20 percent by 2020 water use efficiency mandate and selected Method 3 because it is the most straightforward calculation method which also accounts for the City's past conservation investments.

Responses to Written Comments

Edward Saltzberg & Associates Forensic Mechanical Engineers, 2/28/11

Comment: Have a list of abbreviations on a page that readers can refer to if they are not conversant with all of the acronyms. In the written material, spell out what an abbreviation stands for when it's first used in a section.

Response: LADWP has created a Glossary of Abbreviations and Terms which is included in the final 2010 UWMP, and reviewed the UWMP to spell out abbreviations when first used.

Heal the Bay, 3/15/11

Comment: LADWP should investigate reclaimed water purification as a water supply alternative in the future. LADWP should explore advanced wastewater treatment for future indirect or even direct potable use before exploring seawater desalination as an option for water supply.

Response: The UWMP outlines plans for groundwater replenishment of advanced treated recycled water in the San Fernando Valley. The current Recycled Water Master Plan is reviewing the long-term potential of advanced treated water from the Hyperion Wastewater Treatment Plant for groundwater replenishment as well as potential direct potable use.

Comment: LADWP should provide further support for Los Angeles Unified School District (LAUSD) to achieve the goals set forth in the LAUSD Water Savings Resolution. In addition to providing financial incentives for retrofits and for new zero-water urinal and high efficiency toilets used in a new construction project, LADWP should provide incentives for new fixtures in redevelopment and retrofit projects as well. In addition to these rebates, LADWP should consider expanding the purple pipe system to LAUSD schools.

Response: LADWP does provide conservation rebates and incentives for redevelopment and retrofit projects, in fact, these rebate amounts are significantly more than those for new construction. Some LAUSD schools are currently receiving recycled water. The Recycled Water Master Plan will identify expansion of purple pipe projects to reach additional schools.

Mr. David Coffin, 3/7/11

Comment: Water supply projections published in previous UWMP's between 1990 and 2005 have been much higher than actual water supply.

Response: It is true that previous UWMP water supply projections turned out to be higher than actual demands. However, it is important to point out that projections of supply reflect what can be produced and delivered if necessary to meet projected demands. If actual demands do not materialize at projected levels, then less supply is produced and delivered to meet those demands.

In previous UWMP's, LADWP anticipated that demands would gradually increase over time. This has not been the case for several reasons. The City has been successful in implementing one of the country's most aggressive water conservation programs. Additionally, demand forecasts could not foresee events such as economic recession, environmental and regulatory restrictions on Delta exports, and the recent multiple dry year conditions throughout California and the Southwest. All of these factors have lead to changes in customer water use behavior resulting in both increased water use efficiency and decreased demands.

The net effect of these changes were that LADWP produced and purchased less water to meet actual demands than was envisioned in previous UWMP's between 1990 and 2005.

Comment: UWMP's between 1990 and 2005 seriously miscalculated future groundwater supply projections.

Response: We agree that previous UWMP's contained groundwater projections that were significantly higher than the actual groundwater yield. There are several reasons for this over projection. For instance, previous UWMP's groundwater projections envisioned groundwater replenishment with recycled water which would increase groundwater yield. However, previous plans to replenish the groundwater basin with recycled water were halted following public opposition.

In addition, starting in the mid 1980's, LADWP significantly decreased groundwater pumping in order to minimize the migration of a contamination plume toward active wells in the San Fernando Groundwater Basin (SFB). Contamination issues in the SFB continue to adversely affect groundwater pumping. To restore LADWP's full groundwater pumping rights in the SFB, the 2010 UWMP incorporates plans for construction of groundwater contamination treatment facilities. Additionally, the 2010 UWMP includes increases in groundwater pumping due to groundwater replenishment with advanced treated recycled water as well as increased stormwater capture.

Comment: Water Supply Assessments should cite the UWMP and not the City's General Plan when assessing the proposed water demand for a project.

Response: LADWP does cite the UWMP in water supply assessments in accordance with Water Code Section 10910.

UWMP Section 11.4 Water Supply Assessments states that LADWP's UWMP uses anticipated growth as provided by demographic projections from Southern California of Governments (SCAG) data, re-allocated by MWD into LADWP's service area. The City's General Plan uses population forecasts as provided by SCAG data as well; therefore, the UWMP projections are consistent with the City's General Plan as both use SCAG projections as their basis.

In preparing water supply assessments, LADWP works with the Planning Department to confirm that all proposed projects conform to the City's General Plan.

Comment: The City's allocation of water from the Metropolitan Water District is based on property tax assessments and the value of the investments it has made with MWD infrastructure projects.

Response: The City's preferential rights to purchase water from MWD, as defined in Section 135 of the MWD Act, was not included in the development of MWD's Water Supply Allocation Plan (WSAP). While it is correct that the City may have this entitlement, no member agency, including the City, has historically ever invoked this entitlement during an allocation of water by MWD.

The WSAP is discussed in the UWMP, Section 11.2.6, entitled "MWD Imported Supplies". LADWP, along with other member agencies, worked collaboratively with MWD in developing the WSAP to equitably allocate water supplies during periods of a regional shortage by taking into account many factors including demands, growth, local investments, changes in supply conditions, and water conservation programs. Preferential entitlement was not a factor in developing the WSAP, which is fundamentally a needs-based allocation plan.

Joyce Dillard, 3/15/11

Comment: 2035 water demand projections for most customer service sectors exceed the 2005-2010 average water usage. You need to compare the projections with baseline per capita use to see if 20 percent by 2020 compliance can be obtained.

Response: Although water use in some customer sectors is projected in to increase, expanded water conservation and water recycling will offset this increase water use. LADWP projects we will be in compliance with 20 by 2020 requirements.

Comment: Recycled water cannot be sold to water down dust on horse ranches, yet you consider irrigation usage.

Response: The California Department of Public Health and Los Angeles Regional Water Quality Control Board recently provided approval for use of recycled water for dust control subject to certain conditions. LADWP recycled water staff will be working with interested customers to comply with the new regulations so recycled water use can be expanded.

Comment: Non-adjudicated groundwater basins such as the Santa Monica Basin and the Hollywood Basin are not addressed.

Response: Chapter 6 of the UWMP was amended to mention these unadjudicated basins, and LADWP's plans to revisit previous studies to determine the current potential for expanded groundwater supplies.

TreePeople, 3/15/11

Comment: Page 2-9 Exhibit 2I – Although we applaud LADWP's leadership in water conservation, we believe much greater water savings can be obtained and will be necessary to meet future local water needs. We believe that LADWP should continue to lead by setting conservation targets that well exceed the minimum 20 x 2020 state mandated goals. Exhibit 2I appears to assume no new innovation or transformation will take place beyond 2015.

Response: Exhibit 2I was based on a preliminary demand forecast model and contained erroneous data. It has now been corrected and updated.

Comment: Page 3-26: Identify next steps necessary for incorporating graywater systems into LADWP conservation programs.

Response: The section on graywater in Chapter 3 was amended to state that LADWP is reviewing the concept of assisting in the creation of ad hoc committees to develop a standard for graywater systems.

Comment: Page 7-10 references "Exhibit 7D" which "summarizes the potential water yield and average unit cost of the different resources available to increase localized capture and infiltration of runoff" is missing from the document, or is this referencing the cost table "Exhibit 7H"?

Response: The exhibit reference was corrected. Also, Exhibit 7H has now been revised to Exhibit 7G.

Comment: Page 7-17 and Exhibit 7H: Update cost table with new figures.

Response: Updates have been incorporated into the final 2010 UWMP. Exhibit 7H has been renamed to Exhibit 7G.

Comment: Replace "drought tolerant" with "climate appropriate" throughout the document. Climate appropriate is becoming the more accepted description for landscape transformation.

Response: This change has been made throughout the final 2010 UWMP.

Comment: Page 7-22, Section 7.6.5 Future Distributed Stormwater Programs: Add rain gardens to the list of potential rebates (TreePeople is beginning a pilot rain garden rebate program with the Watershed Management Group).

Response: A reference to rain gardens have been added to section 7.6.5.

Comment: Page 7-24 (revise language): "Furthermore, distributed stormwater capture projects yield additional benefits to the public outside of water supply generation such as flood control, restored native habitat, community beautification, public right of way improvements, water conservation, as well as private residence safety and aesthetic improvements."

Response: This suggested change has been made.

Comment: Chapter 7 General: Revisit the projected stormwater capture estimates as the Stormwater Capture Master Plan is finalized and projects come online. We believe that more than 25,000 acre feet per year can be captured by 2035.

Response: The Stormwater Capture Master Plan will comprehensively evaluate stormwater capture potential within the City. Once the Master Plan is complete, LADWP will be able to reevaluate its future stormwater capture goals.

Comment: Chapter 11, Exhibits 11E to 11L: Targets for stormwater capture stay consistent at 25,000 AF for both dry and normal years.

Response: The 15,000 AFY of increased groundwater production due to stormwater capture is anticipated to be available in every year. The 10,000 AFY of increased conservation due to stormwater capture and reuse will need further analysis in the Stormwater Capture Master Plan.

Southern California Watershed Alliance, 3/28/11

Comment: Given that the UWMP does not include desalination as a projected supply, the historical list of past planning on the issue is confusing and leads one to believe that there are plans to move forward.

Response: At this time LADWP has no plans to pursue ocean desalination as a supply.

FROM: Andrew Davis
Accurate WeatherSet

Simon,

In the DRAFT 2010 URBAN WATER MANAGEMENT PLAN, I see page 11-15 section 4 (1) that it states

(1) must have approved weather-based irrigation controllers registered with LADWP (eligible weather- based irrigation controllers are those approved by MWD or the Irrigation Association Smart Water Application Technologies (SWAT) initiative

MWD uses only controller that passed the SWAT testing. So the statement of "approved by MWD or the Irrigation Association Smart Water Application Technologies (SWAT) initiative are equivalent.

SWAT testing a is bad requirement. SWAT testing is meaningless because:
1) SWAT testing is done in laboratory under highly technical conditions and not in the field with homeowners and contractors;
2) SWAT tests only one controller from each manufacturer which is programmed by the technical staff of the manufacturer;
3) test results cover only 30 days;
4) manufacturers may suppress bad results, pay another $3500 testing fee, reprogram their controller and resubmit for another test until the manufacturers get the results that they want.

Below are the published results from SWAT laboratory testing. All ten controllers scored identically on Irrigation Adequacy. All ten controllers scored nearly identically on Irrigation Excess. These nearly identical results were achieved even though their technologies differ widely. From these nearly identical SWAT results, you would expect all controllers to deliver the same water savings.

The results of SWAT testing by some manufacturers have varied over the years as manufactures have suppressed unfavorable results. These manufacturers have reprogrammed and resubmitted their controller for SWAT testing until they get nearly perfect results. Such tests are rigged by manufacturers and meaningless when measuring water conservation in the hands of homeowners and contractors in the field. Because of these flaws, Accurate WeatherSet has NOT submitted its controllers for testing at SWAT.

While SWAT testing "proves" that all controllers are nearly identical, field tests show that is NOT true.The most meaningful test of weather-based irrigation controllers in the field is the 309-page report submitted by MWD and EBMUD to Cal DWR. That engineering field-study was performed by Aquacraft and can be downloaded at http://www.aquacraft.com/Download_Reports/Evaluation_of_California_Smart_Controller_Programs_-_Final_Report.pdf

This most significant table in that 309-page, multi-year report of 1,000s of controllers shows water savings by manufacturer. Note the we, Accurate WeatherSet, saved MUCH MORE water than any of the other controllers AND our water saving ARE STATISTICALLY SIGNIFICANT and we have the lowest retail price. Look at column labeled **Avg.%Change in Outdoor Use for** water savings that are very different from SWAT testing.
This report shows that Accurate WeatherSet is the lowest cost (see Retail Price column) with the HIGHEST WATER SAVINGS (see **Avg.%Change in Outdoor Use**). Lowest cost with greatest water savings should be highest on your list of controllers to include and is another reason the use 309-page report and reject SWAT testing as your criteria. By achieving 33% outdoor water savings, our controller by itself can reduce water consumption nearly 20% water since 60% to 70% of all water that goes thru a residential meter is used on lawns. This is another reason to include our controller in LA's URBAN WATER MANAGEMENT PLAN.

Please note that the **95% Conf Interval**. Since standard deviation in the chart above was greater than the water savings for most controllers, most controllers did NOT save significant water. This report covers nearly 600 controllers installed in LADWP's service area (see Table ES.3) on page xix. One hundred of the controllers were from Accurate WeatherSet. So the water savings of ALL controllers was not statistically significant because our statistically significant water savings of our controllers was buried by the wide variation in water savings/excess of the other manufacturers.

This 309-page report contains the result of 1,000s of controllers, purchased, installed and programmed by homeowners and contractors. This is real-world testing, not testing in for 30 days in the a laboratory.

This report show the real results that you will have from weather-based irrigation controllers when purchased, installed and programmed by homeowners and contractors and should be used for LA's URBAN WATER MANAGEMENT PLAN to assure success.

Search thru the 309 page report for "SWAT" and see that the report also states that SWAT testing is not designed to measure water conservation.

If you use the 309-page, multi-year field report instead of SWAT testing, you will include my company. A happy feature of including us in your approved list of weather-based irrigation controllers is that you will include/help a company located in the City of Los Angeles in the neighborhood called Winnetka in the west San Fernando Valley. I understand that city agencies are dedicated to encouraging businesses to stay in LA.

Also, I suggest that you talk to Al Pinnaro in LA City Parks & Rec. Last year, he completed a 5-year field study of all the weather-based irrigation controllers and found MANY problems, except with ours. He has ordered controllers from us for installation in LA City parks. You may reach him at 213-216-7351. If you want to give irrigation problems to LA residences and business, then ignore Al Pinnaro and use the SWAT laboratory results. If you want to give well-tested controllers, the listen to Pinnaor's experience over 5 years and eliminate some of the controllers based on his experience AND include us.

LA and California have led the country in science-based standards. Science-based water conservation is the next challenge. Please use the 309 page report and the experience of Al Pinnaro to determine which controllers to include in LA's URBAN WATER MANAGEMENT PLAN.

Will there be anymore public meetings?

Andrew Davis

From: ****@***.com

Sent: Sunday, January 30, 2011 10:30 AM

To: Hsu, Chiun-Gwo (Simon)

Subject: COMMENT/SUGGESTION

Evaporation of water from swimming pools during the summer time can be greatly reduced with the use of pool covers/blankets. I would like the DWP to offer some sort of REBATE for homeowners who invest in
pool covers/blankets. thank you, S. Schron

Edward Saltzberg & Associates
Forensic Mechanical Engineers
14733 Oxnard Street
Van Nuys, California 91411
818.994.2613
Fax.818.782.7792
Ed@ESaltzberg.com

February 28, 2011

LADWP-Water System

111 North Hope Street, Room #1460

Los Angeles, California 90012

Attn: Simon Hsu

RE: Urban Water management Plan

Dear Mr. Hsu:

I thought the publication of the water management plan was very good. However, I have a few suggestions to make it better.

1. Have a list of abbreviations on a page that readers can refer to if they are not conversant with all of the acronyms.

2. In the written material spelled out what an abbreviation stands for when its first used in a section.

3. Make sure that all graphs and charts are properly labeled as to what the units of the chart are. For example exh. 5B, are the units on the left acre feet? There are a few others where the units are not labeled or the title of the chart or graph does not clarify what the chart or graph represents.

I hope that these suggestions help improve the management plan.

Very truly yours,

Edward Saltzberg & Associates

Edward Saltzberg PE, CPD, FASPE

Pres.

COMMENTS TO THE LOS ANGELES DEPARTMENT OF WATER AND POWER 2010 DRAFT URBAN WATER MANAGEMENT PLAN

March 7, 2011

Simon Hsu
Los Angeles Department of Water and Power
111 N. Hope St., Room 1460
Los Angeles, CA 90012

Thank you for the opportunity to comment on the LADWP draft 2010 Urban Water Management Plan ("UWMP" or "water plan").

Missing from past water plans published from 1990 through today has been a review of past water plans. Deliberation and adoption of a new water plan should be done with an understanding of how well the city has met stated goals in previous plans. Did they meet their targets and goals? Did they fall short? What lessons have been learned? Will the 2010 UWMP follow the same pattern as water plans before it?

Sections 1 and 2 provide an overview of the past water projections and how well the city met those projections.

1. **PROJECTED VERSUS ACTUAL WATER SUPPLY - A REVIEW OF PAST WATER PLANS**
   a. Water plans published between 1990 and 2005 seriously miscalculated future water supply projections (Figure 1). In one example the 1990 UWMP overstated the 2010 water supply projection by 41 percent.
   b. In every projection cited by UWMP's published between 1990 and 2010, records show that that the city's actual supply failed to meet expectations by a large amount.
   c. UWMP's routinely cited water supplies over 700,000 AF and as much as 799,000 AF, yet records show the city has never received more than 699,000 AF of water since 1986.

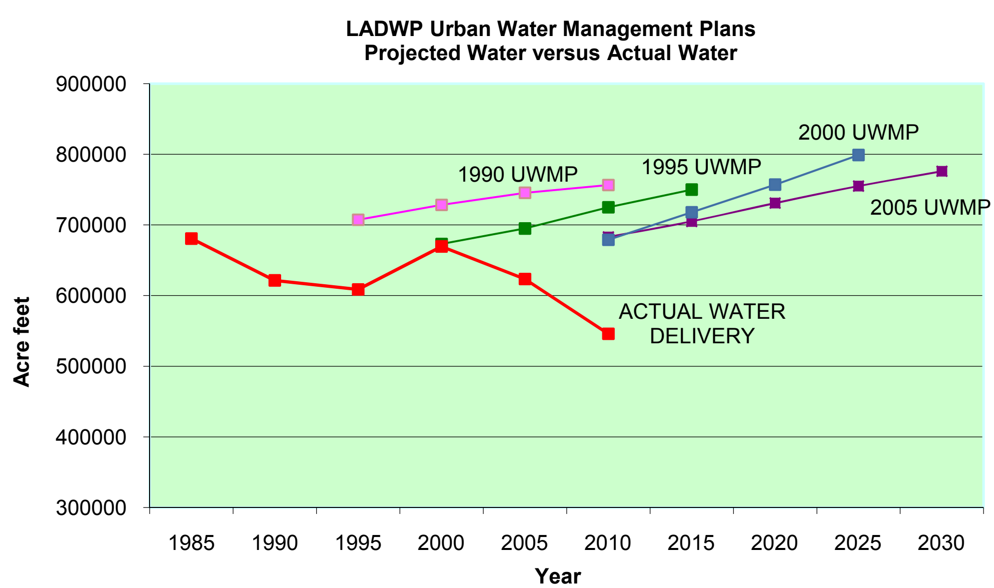

Figure 1 – This chart plots the overstated projections of the past four urban water management plans (1990 through 2005) and compares them with actual water amount received by the LADWP. The 1990 UWMP over-projected water supply by 41 percent for 2010, enough for 146,000 single family housing units.

Given the failure to meet nearly every past projection since 1990, At what point should UWMP's stop projecting supplies in excess of 700,000 AF when it is an historical fact that the DWP has never been able break through that level?

Twenty years of seriously overstated projections have lead city officials to believe that sufficient water supplies existed when they were faced with assessing infrastructure impacts of large developments seeking city permits. A total of 65 major projects were approved using the projected figures in the 2000 and 2005 UWMP. Records show that not one of the water supply projections used by these assessments were ever met by the city. The approvals of such projects and subsequent failure to meet these projections have led to water supply shortfalls and today's permanent drought conditions in the area served by LADWP.

2. **PROJECTED VERSUS ACTUAL GROUND WATER SUPPLY - A REVIEW OF PAST WATER PLANS**
   a. Water plans between 1990 and 2005 seriously miscalculated future groundwater supply projections. In some years as high as 195 percent. (See Figure 2)
   b. The city has not met groundwater supply projections anytime in water plans between 1990 and 2010.
   c. All water plans from 1990 through 2010 routinely projected groundwater pumping well above 100,000 AF annually though the actual amount received annually between 1990 and 2010 averaged just 83,582 AF.
   d. The 1995 UWMP over-projected groundwater pumping for 2005 by 178%. Likewise, the 2000 water plan overstated the 2005 projection by 195%.

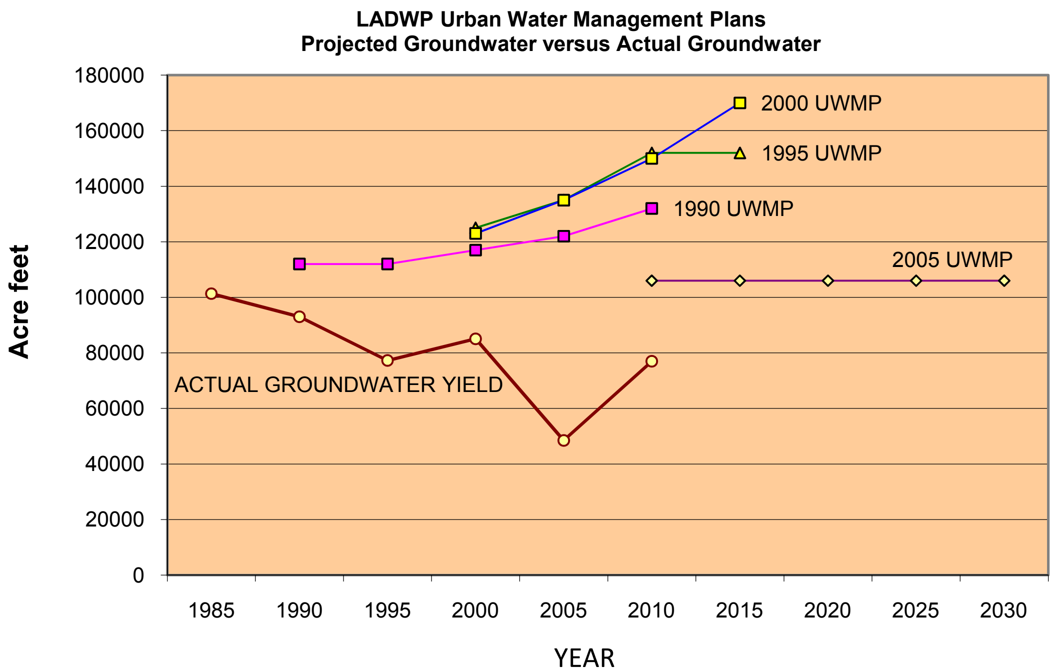

Figure 2 – This chart summarizes the groundwater projections from the past four urban water management plans (1990 through 2005) and compares them with actual groundwater pumped by the LADWP. The 1990 UWMP over-projected water supply by 51 percent for 2010, enough for 150,000 single family housing units.

3. **WATER SUPPLY ASSESSMENTS (Sec 11.4) – A SERIOUS DEPARTURE FROM THE PAST**
   a. The 2010 draft urban water management plan cites that *"If the land use of the proposed development is consistent with the City's General Plan, the projected water demand of the development is considered to be accounted for in the most recently adopted UWMP."*

   In this section the 2010 draft UWMP is inconsistent with Section 10910 (c)(1), (2) & (3) of the California Water Code. Section 10910 requires a city or county to cite the "most recently adopted urban water management plan", not the General Plan as stated above when assessing the proposed water demand of a project.

> ***Section 10910**(c)*
> *(1) The city or county, at the time it makes the determination required under Section 21080.1 of the Public Resources Code, shall request each public water system identified pursuant to subdivision (b) to determine whether the projected water demand associated with a proposed project was included as part of the **most recently adopted urban water management plan** adopted pursuant to Part 2.6 (commencing with Section **10610**).*
> *(2) If the projected water demand associated with the proposed project was accounted for **in the most recently adopted urban water management plan,** the public water system may incorporate the requested information **from the urban water management plan** in preparing the elements of the assessment required to comply with subdivisions (d), (e), (f), and (g).*
> *(3) **If the projected water demand associated with the proposed project was not accounted for in the most recently adopted urban water management plan**, or the public water system has no urban water management plan, the water supply assessment for the project shall include a discussion with regard to whether the public water system's total projected water supplies available during normal, single dry, and multiple dry water years during a 20-year projection will meet the projected water demand associated with the proposed project, in addition to the public water system's existing and planned future uses, including agricultural and manufacturing uses.*

This section in the 2010 UWMP is a serious departure of past water assessments (See figure 3). If left in place, all new water supply assessments performed over the next five years (or until a new general plan is adopted) will be referencing a water plan that is no longer the most recent plan, and a plan that seriously overstates the city's water supply.

Findings

The proposed Bundy Village and Medical Park Draft Project is estimated to increase water demand within the site by 170 acre-feet annually based on review of information submitted by the City Planning Department.

The 170 acre-feet increase falls within the available and projected water supplies for normal, single-dry, and multiple-dry years through the year 2030 as described in LADWP's year 2005 UWMP. LADWP finds that it will be able to meet the water demand of the Bundy Village and Medical Park Draft Project as well as existing and planned future water demands of its service area.

Figure 3 – Typical finding found in water assessments for developments within the LADWP service area.

b. The 2010 draft states that "The water demand forecast model in the UWMP was developed using LADWP total water use, including the water served by LADWP for use outside of the City."

Given that demand has exceeded supply since the 1985 UWMP, the 'demand forecast' is no longer a useful model since it encourages drought conditions. The demand is based on population projections provided by the Southern California Association of Governments (SCAG) that encourage growth with reckless disregard to water supply. This model should be replaced with an annual water 'supply forecast' model that manages growth to avoid costly and damaging droughts.

4. METROPOLITAN WATER DISTRICT (MWD)

a. The 2010 LADWP UWMP notes that *"An important part of the water planning process is for LADWP to work collaboratively with MWD to ensure that anticipated water demands are incorporated into MWD's long-term water resources development plan and water supply allocation plan. The City's allotment of MWD water supplies under MWD's water supply allocation plan is based on the City's total water demand which includes services to areas outside the City."*

The City's allotment of MWD water is not based on the city's total water demand but instead on property tax assessments and the value of the investments it has with MWD infrastructure projects. Combined, those investments have earned LADWP the rights to about 20.8 percent of MWD water. The rest is split up among the MWD's twenty-five other member agencies.

The City's full contractual allotment of water from MWD would be approximately 511,000 AF of water annually which is about 20.8 percent of MWD's total annual inventory[1].

However, the city's water annual allocation has been substantially limited because of *a)* legal restrictions caused by environmental over-commitment (damage caused to other regions of the state)[2], *b)* the rights of other member agencies, agricultural interests, and the rights of other states[3].

In 2007 the city received approximately 421,000 AF of water and in 2010 the city received only 262,538 despite increased demands.

David Coffin
8430 Truxton Ave.
Westchester, CA 90045

[1] Includes 1.91 million AF from State Water Project and 550,000 AF of Colorado River Aqueduct

[2] Sacramento Delta restrictions (Wanger 2007); LA/Inyo Long Term Water Agreement; State Water Resources Control Board issues decision 1631; 1997 LORP MOU Provisions.

[3] Sacramento Delta restrictions (Wanger 2007) and State of Arizona v. State of California 2006 Consolidated Decree.

March 9, 2011

Mr. Ronald Nichols
General Manager and Chief Engineer
Los Angeles Department of Water and Power
111 North Hope Street, Room 1550
Los Angeles, CA 90012

Dear Mr. Nichols:

Decentralized greywater and blackwater recycling have made a significant impact on the water supply in Sydney, Australia. Sydney Water, in collaboration with the state of New South Wales, has defined a goal to recycle 18 billion gallons of water per year by 2015 in the greater Sydney area. As of today, 78 greywater and blackwater projects are recycling and saving 8 billion gallons a year. Aside from the water savings, imagine the implications on the city's water and sewer systems – nothing short of dramatic.

The key ingredient to the progress in Sydney is the broad scale effort by Sydney Water. The utility recognized the potential for onsite greywater and blackwater recycling and has not only embraced, but encouraged the practice. Instead of leaving the green building movement to initiate comprehensive water conservation, Sydney Water decided to address water conservation at the source – their organization. Sydney Water understands they cannot do it alone and that promoting private decentralized recycling will make a more immediate impact on the water supply. I believe Los Angeles has the potential to make a similar impact with greywater and blackwater recycling – an impact that would serve current and future generations.

Upon reading the 2010 Los Angeles Urban Water Management Plan I find that it improperly addresses the potential for greywater and blackwater recycling. These topics should be a priority for the LADWP and I write this letter to ask that the Plan be revised to include funding dollars towards greywater and blackwater onsite reuse programs.

I also support the creation of ad hoc committees made up of manufacturers, consultants, engineers and experts in the field of onsite water recycling to begin work towards developing a standard for greywater and blackwater recycling in Los Angeles. Regulators and policymakers need to discuss and understand the benefits and challenges associated to implementing these solutions. For instance, where can this non-potable effluent make the most impact on water demands? Cooling towers, surface irrigation and toilet flushing are typically the heaviest water users and this is where the technology should be applied. Officials will also need to address the risks associated with onsite water recycling and this is where my firm can add significant value to the conversation.

My company, PHOENIX Process Equipment Co, has partnered with Aquacell, an industry leader in onsite water recycling in Australia, to usher in a safe and reliable solution for water recycling in the United States. Based on an integrated approach which includes consulting, installation, project management and operations of greywater and blackwater systems, Aquacell has a remarkable track record and serves as a great example how to properly implement this practice. Aquacell's success illustrates that if employed with care and risk management in mind, onsite water recycling can be safe and effective – all while providing the inhabitants of the building something to be proud of. I should also testify that as of today, Aquacell has no reported health incidents as a result of their systems.

I hope you will consider the accounts outlined above as an impetus to engage greywater and blackwater recycling more seriously at LADWP. Please let me know if I can be of any service to LADWP as you begin to research and adopt this practice. PHOENIX and Aquacell would be delighted to partner and/or assist LADWP at any level deemed appropriate.

Sincerely,

Mark Meredith
Product Manager, Aquacell

cc:
James McDaniel
Simon Hsu

14 March 2011

Mr. Ronald Nichols
General Manager and Chief Engineer
Los Angeles Department of Water and Power
111 North Hope Street, Room 1550
Los Angeles, CA 90012

Re: 2010 LA Urban Water Management Plan

Dear Mr. Nichols,

I have read the 2010 Los Angeles Urban Water Management Plan and I believe it should be a priority to allocate more funding dollars towards greywater and blackwater onsite reuse programs in the plan. As green building initiatives such as LEED drive the building movement towards a more sustainable built environment, I believe LADWP has an opportunity to play a critical role in building a sustainable Los Angeles. By developing policies and a framework for onsite greywater and blackwater recycling, LADWP can take ownership of this significant water conservation measure and promote the use of these technologies to make a remarkable impact on the region's water supplies. A water crisis in Los Angeles will ultimately fall on the shoulders of LADWP, therefore I believe it is in the organization's best interest to promote water conservation measures such as onsite recycling to mitigate risks.

I support the creation of ad hoc committees made up of manufacturers, consultants, engineers and experts in the field of onsite water recycling to discuss the parameters and scope for developing a standard for greywater and blackwater recycling in Los Angeles.

My company, Aquacell, builds and operates water recycling plants for business, industry and government. Our focus is on non-potable (non-drinking) water for use in a variety of applications including surface irrigation, cooling tower makeup, clothes washing and toilet flushing. Aquacell's plants recycle greywater which is water discharged from showers, baths, basins and washing machines; and blackwater which is any water that has been contaminated with water discharged from a toilet.

Aquacell takes an integrated approach to water recycling plants including consulting, installation and project management for commercial and new residential developments. It also offers ongoing operations and maintenance agreements.

Aquacell staff has many years experience in the water industry and are very knowledgeable about each Australian state and territory's regulatory requirements. Our experience in Australia is that a properly structured regulatory framework can safely ensure decentralised recycled water systems, such as those we install in buildings and neighbourhoods can contribute in a major way to saving water and reducing hydraulic loading on water and sewer systems.

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With such a depth of knowledge and successful track record implementing onsite water recycling, Aquacell would be eager to partner with LADWP and contribute to the development of a viable approach to recycling water in Los Angeles.

Yours sincerely,

Colin Fisher
Managing Director

cc:
James McDaniel
Simon Hsu

aquacell
water recycling solutions

14th March 2011

Mr. Ron Nichols
General Manager & Chief Engineer
Los Angeles Department of Water and Power
111 North Hope Street, Room 1550
Los Angeles, CA 90012

Dear Mr Nichols,

RE: 2010 LA URBAN WATER MANAGEMENT PLAN

I understand from reading the 2010 Los Angeles Urban Water Management Plan (LAUWMP) that the City of LA wants to establish a Water Management Framework that aims to reduce overall water demands for the city and improve Water Security. Obviously this will be a multi-prong approach given that water is primarily sourced from Los Angeles aqueducts, groundwater, and is imported with supplemental water purchases from MWD. We understand that Recycle water currently only contributes <1% of the total water supply.

The LAUWMP appears to look at Water Conservation mainly through pricing incentive schemes, improved water efficiency fixtures, and domestic graywater reuse, but hasn't realised the full potential that decentralised commercial graywater and blackwater systems can contribute to the City of LA's water management objectives.

Despite large scale recycling schemes being in place in LA since 1979 (when water was delivered to the Department of Recreation and Parks for irrigation of areas in Griffith), such centralised reuse schemes are limited to where they can be utilised by physical infrastructure constraints. Centralised systems typically only benefit very large scale water users (e.g. golf course, freeway irrigation), and then only those users who are also located directly next to where the distribution piping is built. Whilst significantly contributing to the city's overall Water security, developments that are located outside of the central recycled water distribution network are precluded from accessing the water saving benefits that a centralised reuse scheme provides.

Medium scale decentralised Plants (e.g. 15,000 – 100,000 gallons / day Plants) have an opportunity to afford a high level of flexibility to implement reuse schemes across a wider area of LA City than what current or future centralised systems offers, whilst being large enough to meet the costs associated with maintaining and demonstrating that public health risks are appropriately managed. Broadly speaking, decentralised graywater systems that manage the total water balance of a site can reduce on-site water demand/wastewater production by 30-50%, and blackwater reuse system can reduce on-site water demand/wastewater production by 70-90%. Developments that currently have significant water demands either through surface irrigation (e.g. any development with a sports fields, city or precinct gardens) or cooling towers are major candidates for decentralised systems because of their localised high water demands.

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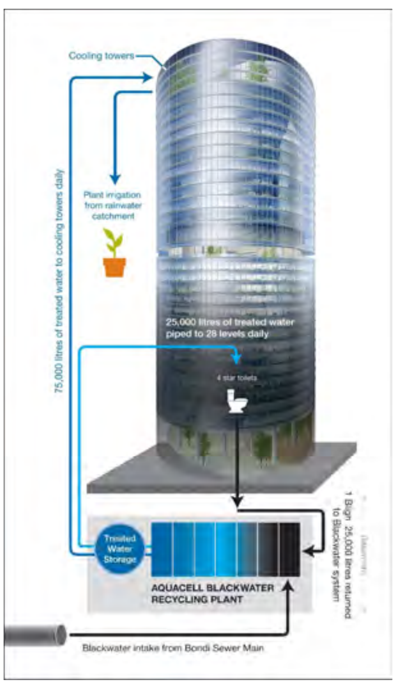
Aquacell is an Australian company that specialises in commercial graywater and blackwater reuse systems. We have both blackwater and greywater systems which have been operating for a number of years that can demonstrate what can be achieved. With more and more decentralised schemes coming on line in Australia, reuse ius becoming more widely accepted and consequently the interest is growing. The main project drivers why facilities look at decentralised reuse schemes cover a range of reasons, including: regulatory or development approval requirements, sourcing alternative water sources (e.g. to add to available water sources), green or environmental marketing, infrastructure solutions (either no sewer or sewer at limited capacity).

To demonstrate what can be done with decentralised schemes, I have attached an Aquacell case study of a 25,000 gallon a day blackwater reuse Plant that we have had operational for the last 5 years at a sports club in Western Sydney. The site treats blackwater generated from the site and uses it for surface irrigation of the sports fields. In addition to water saving measures, the site has also reduced fertiliser use by 30-50% due to the available nutrients in the effluent – another non-water environmental benefit. Note that nutrient removal can be done at other sites if required.

In addition to this, I show some schematically pictures below of a Blackwater to cooling tower system that Aquacell is in the final stages of project implementation – practical completion due May 2011. In this project, we are collecting 100% of the blackwater from a CBD building in Sydney (6,600 gal/day), plus drawing in an extra 25,000 gallon per day from the main Sydney sewer to reuse the effluent in the buildings cooling tower. Although technology for such schemes has existed for a number of years, the reason why this project can be considered in Sydney is because the regulatory framework is in place to allow it to legally occur.



We see that the key to tapping into the very significant potential that decentralised reuse Plants can offer, starts with the development of a LA city blueprint standard for graywater and blackwater reuse. It is important that this standard gets the right balance between protecting public health and also being commercially realistic. In Australia, Aquacell has seen a range of regulatory positions; some being too lax that let systems get through the cracks which perhaps havn't been fully scrutinised, while other regulations are driven too much by bureaucrats and academics and have subsequently imposed such unrealistic expectations on reuse systems that they become commercially inhibitive below any scheme less than 250,000 gallon per day. It therefore is important that when Standards for blackwater and graywater reuse are developed for LA City, they are done so by an ad hoc committee that is able to bring a range of expertise and perspectives to the table. This should not only include law makers, but also public health experts, commercial representatives that could benefit from implementing these systems (e.g. developers or facility owners), consultants and people with prior experience in operating decentralised reuse schemes.

I would be more than happy to share our experience in Australia with LA City to ensure that it steps forward with a pragmatic and protective Standard, which establishes a template for effectively and safely implementing reuse opportunities throughout the city of LA. Please don't hesitate to call or email if you require further information.

Sincerely

I Kikkert

Ian Kikkert
Business Development Engineer
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Heal the Bay

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March 15, 2010

Attn: Simon Hsu
LADWP--Water System
111 N. Hope St. Room 1460
Los Angeles, CA 90012

Re: Draft 2010 Urban Water Management Plan

Dear Mr. Simon Hsu:

On behalf of Heal the Bay, we submit these comments regarding the City of Los Angeles Department of Water and Power Draft 2010 Urban Water Management Plan ("Plan" or "Draft UWMP"). We appreciate the opportunity to provide these comments.

There are many aspects of the Draft UWMP that we support. For instance, we agree with LADWP's prioritization of expanded water conservation and water recycling over the use of desalination to provide additional water supply. Heal the Bay supports the expansion of LADWP's recycled water system and the commitment to move towards a more sustainable water supply. However, we do have a few concerns with the Plan as drafted. LADWP should revert to a more ambitious goal for expanding recycled water use, provide additional support for stormwater capture, and investigate direct and indirect potable use of advanced treated water as a supply alternative. These and other concerns and suggestions are expressed below.

LADWP should set more aggressive goals for water recycling.

The goals the Draft UWMP sets for expanding recycled water use are not ambitious enough given the present condition of our current water supply and the available source water from POTWs. In fact, the goals provided are a major step backwards from previously set goals. The Draft UWMP states that LADWP has the goal of replacing 50,000 AFY of potable water with recycled water by 2029. When Heal the Bay began participation on the Recycled Water Advisory Task Force in 2009, the stated goal was "to produce 50,000 acre-feet of recycled water by 2019." Another stated action was to "pursue options to maximize recycling beyond 50,000 AFY." Of note, several members of RWAG held that we should look beyond this goal and increase the new recycling opportunities to 100,000 AFY by 2019. The revised goal stated in the Draft UWMP takes a major step backwards. Compounding this concern is the fact that LADWP has not met the goals set in the 2005 Urban Water Management Plan for recycled water usage, as noted in the Draft UWMP.

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LADWP should prioritize expanding demand and delivery of recycled water. The four major treatment plants operated by Los Angeles BOS produce enough treated water to allow for much more aggressive recycled water goals than are presented within this document. According to the draft, Los Angeles used approximately 550,000 acre-feet of water last year, and around half of that volume was imported through MWD (Draft UWMP Exhibit 1F). Los Angeles-Glendale, Donald C. Tillman, Terminal Island, and Hyperion Water Reclamation Plants combined produce an average of around 460,000 AFY. Utilizing recycled water in our region to the fullest extend could greatly reduce our reliance on imported water in Los Angeles. This is a crucial step toward a sustainable water future. It is critical that we use local reliable water, such as recycled water that would otherwise be discharged to the ocean, to offset the demand for imported water supplies as soon as possible. Thus, the Draft UWMP should be modified to, at a minimum, return to the more ambitious goal of 50,000 AFY of new recycled water usage by 2019. We urge LADWP to look beyond this initial goal and plan for 100,000 AFY by 2019.

LADWP should prioritize stormwater capture projects and set goals for new stormwater capture projects in Los Angeles.

Stormwater must be used as a resource in order for Los Angeles to achieve a sustainable water supply. Using stormwater as a water source requires less energy and results in far fewer environmental impacts than many other sources of water such as desalination and water importation. Stormwater proves to be a much more sustainable, cost-effective local water resource than desalinated water, yet no incentives are provided in the Draft UWMP for its capture and use throughout the region. We strongly encourage LADWP to create a policy that provides economic incentives for stormwater recharge and reuse projects. Further, the Plan should establish a goal for increased stormwater capture in Los Angeles. At a minimum, LADWP should set a goal of an additional 50,000 AFY by 2020 for stormwater capture projects. The Tujunga Spreading Grounds alone currently capture 8,000 AFY, with plans to expand to 16,000 AFY and the potential to capture 50,000 AFY, so we believe this is a realistic goal.

There are also opportunities for stormwater capture at the individual lot scale. In Section 7.6 (Distributed Stormwater Capture), the Draft UWMP highlights that "Installation of rain barrels at residences throughout Los Angeles… could potentially capture 6,400 AFY…" As you know, the City of Los Angeles had a very successful rain barrel pilot project. This would be a great program for LADWP to help fund and take city-wide. We also urge LADWP's continued support for the Low Impact Development Ordinance, which the City of Los Angeles is in the process of adopting. This ordinance will go a long way in using stormwater as a resource.

The Draft UWMP mentions that LADWP is partnering with Los Angeles City Department of Public Works, Los Angeles County Department of Public Works, and Treepeople Inc. to draft a Stormwater Capture Master Plan. When will the Stormwater Capture Master Plan be completed? Will it be released to the public for review? The Draft UWMP should discuss these goals in more detail and involve additional stakeholders in this effort.

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LADWP should actively increase water conservation measures

In the Draft UWMP, LADWP sets a water conservation goal of 50,000 AFY by 2019. In terms of conservation, the City has moved in the right direction, but there is more that can be done to provide conservation incentives. In addition to the measures mentioned in the Plan, LADWP should require that all public buildings get retrofitted with waterless urinals and other ultra-efficient conservation devices. New high-use visitor-serving commercial properties should be required to install these devices as well. In addition, LADWP should offer incentives for graywater treatment and reuse systems. Also, LADWP should push for the city to develop a landscape conservation ordinance that weans Los Angeles off of the use of thirsty non-native plants and requires the use of natives or xeriscape plants. Finally, water pricing needs to be more equitable city-wide and provide greater incentives to conserve.

LADWP should investigate reclaimed water purification as a water supply alternative in the future.

The Draft UWMP mentions that in 2002 LADWP identified Scattergood Generating Station as a potential site for a seawater desalination plant. While we support the fact that LADWP's current water resource strategy does not include seawater desalination as water supply due to environmental and cost considerations, we are concerned that this option is still being considered for future supply while there are still water saving projects that are "lower-hanging fruit". Before exploring seawater desalination as an option for water supply, LADWP should aggressively explore stormwater capture and water recycling as discussed above. In addition, LADWP should explore advanced wastewater treatment for future indirect or even direct potable use. Hyperion Treatment Plant, for example, produces nearly 360,000 AFY, most of which is discharged directly to the ocean. If this water were utilized, it would offset a significant portion of the freshwater needed in Los Angeles. Wastewater purification takes about a quarter of the energy that seawater desalination requires, strictly looking at thermodynamic considerations, and would not have as many negative environmental impacts as seawater desalination. This type of project has seen great success in other areas. The benefits and constraints of advanced wastewater treatment through reverse osmosis and microfiltration should be considered in the Draft UWMP.

If LADWP does pursue research of seawater desalination as a potential water supply, LADWP should focus on the least environmentally harmful types of desalination, such as subsurface cooling intakes, desalination of brackish water, or desalting Hyperion effluent in order to avoid some of the negative impacts of seawater desalination on marine life and energy usage. Several desalination proposals in California rely on co-locating with once-through cooled power plants, causing impingement and entrainment of marine life. Researching alternative forms of desalination to co-location with once-through cooled power plants would help inform future water supply technologies that pose a lower threat to marine life and are less energy intensive.

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LADWP should provide further support for LAUSD to achieve the goals set forth in the LAUSD Water Savings Resolution.

Los Angeles Unified School District (LAUSD) is one of the largest water consumers in the county. This past December, the LAUSD School Board passed a Water Savings Resolution with extremely ambitious goals for water conservation, water efficiency, and the offset of potable water with recycled water resources. LAUSD resolved to utilize recycled water, where available within one-half mile from the local utility distribution source, for irrigation and in urinals and toilets. In addition to providing financial incentives for every retrofit and for every new zero-water urinal and high efficiency toilet used in a new construction project, LADWP should provide incentives for new fixtures in redevelopment and retrofit projects as well. In addition to these rebates, LADWP should consider expanding the purple pipe system to LAUSD schools.

To summarize, LADWP should should set more aggressive goals for water recycling and stormwater capture, provide more support for widespread implementation of LID and Stormwater capture projects throughout Los Angeles, investigate reclaimed water purification for future as a water supply alternative, and provide further support for LAUSD to achieve the goals set forth in the LAUSD Water Savings Resolution. Thank you for your consideration of these comments. If you have any questions, please contact us at (310) 451-1500.

Sincerely,

Kirsten James

Kirsten James, MESM
Water Quality Director

W. Santilena

W. Susie Santilena, MS, E.I.T.
Water Quality Scientist

Comments to LADWP Draft 2010 Urban Water Management Plan due 3.15.2011

The **Population, Housing** and **Employment** history (1980) and projected (2035) shows increases of the following:

Total Population: 1,497,560 or 50.42%
Total Housing: 543,947 or 49.45%
Total Employment: 320,664 or 18.95%

In reference to "**Securing L.A.'s Water Supply**," you state:

"By 2028, the Plan envisioned a six-fold increase in recycled water supplies to a total of 50,000 AFY.

Similarly, by 2030, an increase of 50,000 AFY was planned for conservation. As described in the Plan, this aggressive approach included: investments in state-of-the-art technology; a combination of rebates and incentives; efficient clothes washers, and urinals; and long-term measures such as expansion of water recycling and remediating contaminated groundwater supplies. . A multi-faceted approach to developing a locally sustainable water supply was developed incorporating the following key short-term and long-term strategies:

Short-Term Conservation Strategies

- Enforcing prohibited uses of water
- Expanding prohibited uses of water
- Extending outreach efforts
- Encouraging regional conservation measures

- Long-Term Strategies
- Increasing water conservation through reduction of outdoor water use and new technology
- Maximizing water recycling
- Enhancing stormwater capture
- Accelerating groundwater basin clean-up
- Expanding groundwater storage
- Green Building Initiatives (added subsequent to the release of the Plan)"

Land Use, on the other hand is:

Single Family Dwellings: 121,470 acres of 40.2%

Other including specific plans, transportation, freeways, rights of way and other miscellaneous uses that are not zoned: 52,806 or 17.48%

Open Space/Parks: 40,263 acres or 13.32%

Multi-Family Dwellings: 34,189 acres or 11.31%

Commercial includes public facilities, libraries, public schools and government facilities: 30,083 acres or 9.96%

Manufacturing: 23,353 acres or 7.73%

Historical Water Demand has been **reduced**, on average from the 1986-1990 to the 2005-2010 periods:

Single Family Dwellings: 2,094 AF or 0.88%

Multifamily Dwellings: 17,033 AF or 8.63%

Commercial: 16,369 AF or 13.27%

Industrial: 7,301 AF or 23.94%

Government: 438 AF or 1.01%

Non-Revenue: 20,901 AF or 39.56%

Overall: 64,136 AF or 9.35%

You conclude that **outdoor water use** is estimated at 39% of demand, yet the usage above does not indicate a reason to come to that conclusion. In fact, non-revenue almost matches that 30% outdoor demand. What is the definition of non-revenue, city usage?

Your **2035 estimates** exceed the **2005-2010 Average usage** except in Industrial passive, Industrial passive and active; and Commercial/Government passive and active:

Single Family:

2005-2010: 236,154 AF
2035 Passive: 259,904 AF
2035 Passive and Active: 247,655 AF

Multifamily:

2005-2010: 180,279 AF
2035 Passive: 221.912 AF
2035 Passive and Active: 218,762 AF

Commercial/Government:

2005-2010: 149,895 AF
2035 Passive: 160,049 AF
2035 Passive and Active: 120,420 AF

Industrial:

2005-2010: 23,201 AF
2035 Passive: 19,852 AF
2035 Passive and Active: 10,513 AF

Non-Revenue:

2005-2010: 31,929 AF
2035 Passive: 49,042 AF
2035 Passive and Active: 44,272 AF

You need to compare these with the Baseline Per Capita Use to see if compliance can be obtained for the 20 X 2020. Those calculations are not included in this draft.

Conservation should not be used as a category of source. It is a method of reduction, so 9.05% needs to be replaced by source usage.

Industrial and **Manufacturing** bases need to be placed in reality. Is there an overall reduction of businesses with no future growth, or is growth planned in the manufacturing arena with more demand to be placed.

This plan needs to be overlaid with the LA Power Plan for consistency of forecasting. Both plans need to be consistent with the General Plan.

Recycled Water

You state:

"These include expanding the recycled water distribution system for Non-Potable Reuse (NPR) such as for irrigation and industrial use, along with replenishment of groundwater basins with highly purified recycled water. Beyond 50,000 AFY, LADWP expects to increase recycled water use by approximately 1,500 AFY annually, bringing the total to 59,000 AFY by 2035."

There are several problems here.

Recycled water needs to be treated for use. So far, these water cannot be sold to water down dust on horse ranches, yet you only consider irrigation usage.

Purple pipe is a capital expense limited to age of existing infrastructure, homes and subject to gravity for delivery.

Tanks and underground storage need to be addressed. There are legal issues with underground storage of groundwater in an adjudicated basin. Nothing is mentioned of the lawsuit against the **Water Replenishment District** regarding groundwater rights extraction and the Storage Framework in the Central Basin. The Storage Framework was not allowed.

Nothing is mentioned of West Basin and recycled water processing or of **CeLAC** Central Los Angeles County Regional Recycled Water Project.

Nothing is mentioned of the **2009-2010 Grand Jury Report** or the County's answer. There has been no City of Los Angeles response. The Grand Jury notes discrepancies with charts supplied.

Storm water runoff and **urban water runoff** is under the jurisdiction of the County of Los Angeles and the Los Angeles County Flood Control District. Runoff is not an asset of the City, the Bureau of Sanitation or the LADWP. We are attaching the United States Court of Appeals Ninth Circuit Opinion No. 10-56017 in a recent case involving the County of Los Angeles ETAL.

The assumption in this document is that the Bureau of Sanitation can partner with LADWP. Only LADWP can have possession, management and control of water and water rights, lands and facilities and can capture, transport, distribute and deliver water for the benefit of the City, its inhabitants and its customers.

Non adjudicated groundwater basins such as the Santa Monica Basin and the Hollywood Basin are not addressed. There are no groundwater extraction rights and storage would probably be applicable to the individual property owner.

Groundwater replenishments projects in the San Fernando Valley are part of the Greater Los Angeles County Integrated Regional Water Management Plan under the jurisdiction of the State Department of Water Resources.

Greater Los Angeles County Integrated Regional Water Management Plan shows the Metropolitan Water District Integrated Resource Plan Supply Targets and proportion of targets. There is no reconciliation in this report to the LADWP portion of those targets in all categories.

Overall, this report touches on aspects of water, but does not address the complexities of supply and demand in a realistic sense. Growth is evident without supply considerations and cost (demand). Green Building is so minimal, it should not even be considered as a method. Recycled water is not a reliable source at this point in time.

Capital costs and operation and maintenance funding are not addressed properly.

This leaves the inhabitants and customers in the City of Los Angeles at risk financially, in public health and safety issues and quality of life issues.

Joyce Dillard
P.O. Box 31377
Los Angeles, CA 90031

Attachment: Opinion No. 10-56017

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9750 Birch Canyon Place, San Diego, CA 92126 858/437-0112 Fax/437-0117

March 13, 2011

To: Ronald O. Nichols, General Mgr. & Chief Engineer WP

First, let me congratulate you on your appointment as General Manager of the DWP. I, along with my fellow ASPE members look forward to your aggressive and far reaching plans for the City of Los Angeles.

I have had the opportunity to attend several DWP workshops in regards to the proposed 2010 Urban Water Management Plan and I applaud the efforts of the DWP to address the upcoming water shortage issues that face the Southern California region.

It goes without exception that we are facing issues that mirror the energy crisis that was addressed decades ago. That crisis forced the public and the industry to address fuel economy and most recently alternative power sources.

In reviewing the proposed plan, the issues of Graywater, Rainwater Harvesting and Stormwater Management I feel are areas that can be readily obtainable and cost effective. There are already Graywater systems being used not only worldwide, in particular Australia, but in the City of New York there is an existing commercial/residential application installed. The technology for Graywater, Rainwater Harvesting already exist meaning that the "wheel doesn't have to be re-invented" There are major Universities involved with these technologies, in particular UCLA and UC Davis.

The Water Purveyors and Utility Companies such as LADWP should develop a strategic plan to convince policy makers and building officials to accept these types of technological innovations which already have a successful track record in Australia.

Like any game changing effort, this will be a herculean task. That being said, rather than grinding slowly toward a solution, I propose that an ad-hoc committee be formed consisting of engineers, manufactures, contractors, university experts and DWP personnel to add to the Urban Plan specifically in these three areas with the mandate that a workable plan and technologies to go with it be presented for DWP review within the next 180 days. As a member of the industry that addresses these issues, I would be happy to serve on such a committee.

The recent tragedy in Japan is an example of how a catastrophe can affect both the water and power delivery when it is most needed.

I am enclosing separate sheets of industry professional signatures that likewise share my enthusiasm and concern for this task at hand. They represent members of the Los Angeles Chapter of ASPE.

Sincerely,

Bob Pehrson

elmco duddy

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cc: James B Mc Daniel, Simon Hsu, Ms. Lorraine Paskett, Thomas Gackstetter, Thomas Erb, Dr. Parekh Pankaj, Amir Tabakh, Michael Benisek

March 15, 2010

Attn: Simon Hsu
LADWP – Water System
111 N. Hope St, Room 1460
Los Angeles, CA 90012

Re. Recommended Amendments to Urban Water Management Plan 2010: Chapter Four

Dear Mr. Hsu:

Environment Now submits the following comments to Los Angeles Department of Water & Power (LADWP) on its 2010 Urban Water Management Plan (UWMP). Environment Now (EN) is an independent, non-partisan, non-profit organization, founded in 1989. EN's mission is to be an active leader in creating measurably effective environmental programs to protect and restore California's environment.

Thank you for this opportunity to comment on the UWMP. California's water supply is becoming increasingly vulnerable as our population grows and landscape dries. To meet the challenges of our heightened demands and diminished supply, EN has supported the diversification of water supplies. EN has worked with water providers and clean water advocates to establish regulations that will bring millions of acre-feet of recycled water on-line —including reclaimed wastewater, captured stormwater, and recharged groundwater basins.

EN has been committed to helping LADWP reach water re-use targets since 2006. We formed partnerships between LADWP staff and community leaders to promote reclaimed water by addressing permitting concerns. In 2007, we formed the State Water Resources Control Board's stakeholder group including LADWP staff to draft the state's first "Recycled Water Policy." In 2008, we also worked with LADWP to host community workshops in order to allay concerns about the "toilet to tap" campaign. In 2009, we worked with LADWP to reconcile their Recycled Water Master Plan with 2005 and 2008 benchmarks. In 2010, we participated in the Recycled Water Advisory Group and supported the staff's plans to reach benchmarks with ongoing rate dedication to "environmental" projects such as recycled water.

The commitment to reclaimed water from community leaders and LADWP staff has been unwavering. For this reason, we are surprised to see rollbacks in the 2010 UWMP water re-use benchmarks. In its 2005 UWMP, LADWP forecasted 16,000 AFY by 2010 and 30,000 AFY by 2030. In 2008 the City of LA promised 50,000 AFY of reclaimed water by 2019 and 100,000 AFY by 2030. Unfortunately, LADWP appears to be plagued with rollbacks. Regardless of the community support and staff expertise, the agency has only met half its original benchmark with 8,000 AFY of reclaimed water on-line today. Now the 2010 UWMP projects a total of 59,000 AFY by 2035. This is considerably below its 2005 and 2008 benchmarks.

LADWP has considerable resources on which to draw for increased reclaimed water supplies. In addition to upgrading the Tillman Plant by 15,000 AFY, the Terminal Island plant could be expanded to 12,000 AFY with an additional 20,000 AFY transferred for treatment from Hyperion. Further, the L.A.-Glendale Plant tertiary water could be distributed for irrigation use rather than discharged into the LA River. Moreover, Hyperion remains a tremendous resource for nearly half-a-million AFY of reclaimed water if only it were upgraded. Even without Hyperion, the potential capacity for existing reclamation facilities is higher than the 2010 UWMP benchmark.

EN has provided comments regarding commitments and financing for reclaimed water on many occasions. Most recently, we provided verbal comments to General Manager, Ron Nichols, and staff on February 10, 2010. We do not see our comments reflected in your recent comment responses (published at: https://www.piersystem.com/go/doc/1643/992207/) To secure our comments are included and addressed, we are submitting these written comments.

Thank you again for this opportunity to comment on LADWP's 2010 UWMP. We look forward to working with the LADWP staff to implement these important reclaimed water plans and, ultimately, make the City of Los Angeles' water supply more reliable. If we can provide further research or comments please do not hesitate to contact us, cmandelbaum@environmentnow.org, 310-829-5568*241

Sincerely,

Caryn Mandelbaum
Freshwater Program Director

TreePeople

March 15, 2011

Los Angeles Department of Water and Power
111 N. Hope St
Los Angeles, CA 90012

To: Chris Repp, and Simon Hsu
Cc: Thomas Erb
RE: Urban Water Management Plan, 2010 Comments

Thank you for the opportunity to submit comments on the LADWP Draft Urban Water Management Plan, 2010. Should you have any questions about our comments and recommendations, feel free to call or email.

Sincerely,

Rebecca Drayse

Rebecca Drayse
Director, Natural Urban Systems Group

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Printed with soy ink on chlorine-free, acid-free 100% post-consumer recycled paper

TreePeople comments and recommendations on the Draft 2010 Urban Water Management Plan dated January 14, 2011

Chapter 2

- **2-9, Exhibit 2I -** Although we applaud LADWP's leadership in water conservation, we believe much greater water savings can be obtained and will be necessary to meet future local water needs. We believe that LADWP should continue to lead by setting conservation targets that well exceed the minimum 20 x 2020 state mandated goals. Exhibit 2I appears to assume no new innovation or transformation will take place beyond 2015.

Chapter 3

- **3-16 to 3-18:** As residential outdoor water use (for irrigation needs) accounts for the bulk of water use, LADWP should create a stronger and more concerted public campaign focused on landscape transformation (turf to native, or climate appropriate landscaping). Most of the conservation savings have so far been seen in incorporating efficient technologies, however a greater savings can be had in embracing a new landscape ethic.

- **3-22, final paragraph –** Revise sentence to better reflect Watershed Council's leadership in the Elmer Avenue project. Suggested language: "**Most recently TreePeople, LADWP, and other state and federal agencies partnered on an effort led by the Los Angeles and San Gabriel Rivers Watershed Council, to retrofit an entire residential block on Elmer Avenue in Sun Valley.**"

- **3-26:** Identify next steps necessary for incorporating graywater systems into LADWP conservation programs.

Chapter 6

- **6-1, Section 6.1:** Explore opportunities to receive credit for additional stormwater recharge in the San Fernando Basin, particularly if large scale decentralized stormwater infiltration strategies are employed.

Chapter 7

- **7-10** references **"Exhibit 7D"** which "summarizes the potential water yield and average unit cost of the different resources available to increase localized capture and infiltration of runoff". It is missing from the document. Is the cost table in **"Exhibit 7H"** the proper reference here?

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- **7-17 and Exhibit 7H:** We recommend updating cost table (Exhibit H) according to the new figures TreePeople provided for internal review under separate cover. Update text in 7-17 to reflect new figures in Exhibit H.

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- **7-22, Section 7.6.5 Future Distributed Stormwater Programs:** Add rain gardens to the list of potential rebates (TreePeople is beginning a pilot rain garden rebate program with the Watershed Management Group).

- **From 7-24 (revise language):** "Furthermore, distributed stormwater capture projects yield additional benefits to the public outside of water supply generation such as **flood control, restored native habitat,** community beautification, public right of way improvements, **water conservation,** as well as private residence safety and aesthetic improvements."

- **General:** Revisit the projected stormwater capture estimates as the Stormwater Master Plan is finalized and new targets are established. We believe that significantly more than **25,000 acre feet per year** can be captured by **2035.**

Chapter 11

- **11-8, Exhibit 11E:** Note 1 indicates a loss in the LA Aqueduct at 0.1652% per year due to climate change. There is no indication of loss from MWD (California Aqueduct, and Colorado River Aqueducts) due to climate change. Does this account for MWD's projections?

- **Chapter 11, Exhibits 11E to 11L:** Targets for stormwater capture stay consistent at 25,000 AF for both dry and normal years. Can this be revised?

General

- Coordinate and package conservation, rainwater harvesting, low impact development, and graywater incentive programs to customers who implement these strategies. This will decrease implementation costs for these programs and increase consumer awareness of steps they can take to manage water supply.

- Replace "**drought tolerant**" with "**climate appropriate**" throughout the document. Climate appropriate is becoming the more accepted description for landscape transformation.

- Please replace "**Tree People**" with "**TreePeople**" (without a space) where referenced including the Table of Contents.

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Comments on 2010 Urban Water Management Plan

From: Conner Everts
Southern California Watershed Alliance

To: Tom Urb, Simon Hsu
LADWP

After reviewing your draft 2010 Urban Water Management Plan, attending your public workshops while making comments there, I just have a few final thoughts that I hope you will accept.

While I find this Urban Water Management Plan a vast improvement over past plans that I have commented on there are a couple of places where I think you do not give yourself enough credit. That is specifically the projections of per capita water use into the future, which is expressed in household use in Exhibit 21 on page 2-9 and Exhibit 2J with CII worked in and finally Exhibit 2K. While projection of conservation savings go up the demand seems to rise gradually until 2035. If you take the historic savings in the last few years and combine that with future investments why would demand continue to drop? La has that history and population has not been shown to 1) Be equal to SCAG or Department of Finance numbers or 2) mean increases of consumption.

This leads me to question why, on page 3-5, you chose Method 3 for reporting, when you are already at 19%. If current gpd is 124 by taking this approach you are actually looking at a higher per capita into the future. Other cities are taking a more aggressive approach, like Long Beach, which is about to reach 100 gpd, and therefore assuring the city of a full allocation under MWD's water shortage plan which then comes a real reliability factor. I believe that this should be discussed, as required, at a separate workshop.

There is an opportunity to make this a real planning tool for future water supply and inclusion of greywater, watershed management with stormwater, the City of LA's IRP make this plan very different. Inclusion and reference of LID and smart streets and the River Project's Tujunga Watershed plan would be helpful. Given that the 2020 Water Supply Plan does not list desalination, the historical list of past planning on the issue is confusing and leads one to believe that there are plans to move forward.

I wanted to attend the SCWC workshop last Friday at MWD and got this language:

10608.26. (a) In complying with this part, an urban retail water supplier shall conduct at least one public hearing to accomplish all of the following:
(1) Allow community input regarding the urban retail water supplier's implementation plan for complying with this part.
(2) Consider the economic impacts of the urban retail water supplier's implementation plan for complying with this part.
(3) Adopt a method, pursuant to subdivision (b) of Section 10608.20,

for determining its urban water use target.

We just interpreted this to mean that this public input should take place prior to when the UWMP is finalized, otherwise, if the public input takes place at the same time the plan is adopted, that input is pretty meaningless.

On another note, my fellow environmentalists and I have concerns with the direction and facilitation of the RWAG. We will attend the public workshops in support, like San Pedro this week but would like to talk about how we move forward. Lastly, the movement of AB 1180 is causing greater concern.

Again, thanks for your consideration and I am available if you want to talk about it.

Conner Everts

Urban Water Management Plan

Appendix E

References

Urban Water Management Plan for the Los Angeles Department of Water and Power

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Urban Water Management Plan

Appendix F

Groundwater Basin Adjudications

- San Fernando Basin – Judgment 650079
- Sylmar Basin – Judgment 650079
- Eagle Rock Basin – Judgment 650079
- West Coast Basin – Judgment 506806
- Central Basin – Judgment 786656

SUPERIOR COURT OF THE STATE OF CALIFORNIA

FOR THE COUNTY OF LOS ANGELES

THE CITY OF LOS ANGELES, Plaintiff,	)	No. 650079
vs.	)	JUDGMENT
CITY OF SAN FERNANDO, ET AL. Defendants.	)	

There follows by consecutive paging Recitals (page 1), Definitions and List of Attachments (pages 1 to 6), Designation of Parties (page 6), Declaration re Geology and Hydrology (pages 6 to 12), Declaration of Rights (pages 12 to 21), Injunctions (pages 21 to 22), Continuing Jurisdiction (page 23), Watermaster (pages 23 to 29), Physical Solution (pages 29 to 34), and Miscellaneous Provisions (pages 34 to 35), and Attachments (pages 36 to 46). Each and all of said several parts constitute a single integrated Judgment herein.

1. RECITALS

This matter was originally tried before the Honorable Edmund M. Moor, without jury, commencing on March 1, 1966, and concluding with entry of Findings, Conclusions and Judgment on March 14, 1968, after more than 181 trial days. Los Angeles appealed from said judgment and the California Supreme Court, by unanimous opinion, (14 Cal. 3d 199) reversed and remanded the case; after trial of some remaining issues on remand, and consistent with the opinion of the Supreme Court, and pursuant to stipulations, the Court signed and filed Findings of Fact and Conclusions of Law. Good cause thereby appearing,

IT IS ORDERED, ADJUDGED AND DECREED:

2. DEFINITIONS AND ATTACHMENTS

2.1 Definitions of Terms. As used in this Judgment, the following terms shall have the meanings herein set forth:

[1] Basin or Ground Water Basin -- A subsurface geologic formation with defined boundary conditions, containing a ground water reservoir, which is capable of yielding a significant quantity of ground water.

[2] Burbank -- Defendant City of Burbank.

[3] Crescenta Valley -- Defendant Crescenta Valley County Water district.

[4] Colorado Aqueduct -- The aqueduct facilities and system owned and operated by MWD for the importation of water from the Colorado River to its service area.

[5] Deep Rock -- Defendant Evelyn M. Pendleton, dba Deep Rock Artesian Water Company.

[6] Delivered Water -- Water utilized in a water supply distribution system, including reclaimed water.

[7] Eagle Rock Basin -- The separate ground water basin underlying the area shown as such on Attachment “A”.

[8] Extract or Extraction -- To produce ground water, or its production, by pumping or any other means.

[9] Fiscal Year -- July 1 through June 30 of the following calendar year.

[10] Foremost -- Defendant Foremost Foods Company, successor to defendant Sparkletts Drinking Water Corp.

[11] Forest Lawn -- Collectively, defendants Forest Lawn Cemetery Association, Forest Lawn Company, Forest Lawn Memorial-Park Association, and American Security and Fidelity Corporation.

[12] Gage F-57 -- The surface stream gaging station operated by Los Angeles County Flood Control District and situated in Los Angeles Narrows immediately upstream from the intersection of the Los Angeles River and Arroyo Seco, at which point the surface outflow from ULARA is measured.

[13] Glendale -- Defendant City of Glendale.

[14] Ground Water -- Water beneath the surface of the ground and within the zone of saturation.

[15] Hersch & Plumb -- Defendants David and Eleanor A. Hersch and Gerald B. and Lucille Plumb, successors to Wellesley and Duckworth defendants.

[16] Import Return Water -- Ground water derived from percolation attributable to delivered imported water.

[17] Imported Water -- Water used within ULARA, which is derived from sources outside said watershed. Said term does not include inter-basin transfers wholly within ULARA.

[18] In Lieu Storage -- The act of accumulating ground water in a basin by intentional reduction of extractions of ground water which a party has a right to extract.

[19] Lockheed -- Defendant Lockheed Aircraft Corporation.

[20] Los Angeles -- Plaintiff City of Los Angeles, acting by and through its Department of Water and Power.

[21] Los Angeles Narrows -- The physiographic area northerly of Gage F-57 bounded on the east by the San Rafael and Repetto Hills and on the west by the Elysian Hills, through which all natural outflow of the San Fernando Basin and the Los Angeles River flow en route to the Pacific Ocean.

[22] MWD -- The Metropolitan Water District of Southern California, a pubic agency of the State of California.

[23] Native Safe Yield -- That portion of the safe yield of a basin derived from native waters.

[24] Native Waters -- Surface and ground waters derived from precipitation within ULARA.

[25] Overdraft -- A condition which exists when the total annual extractions of ground water from a basin exceed its safe yield, and when any temporary surplus has been removed.

[26] Owens-Mono Aqueduct -- The aqueduct facilities owned and operated by Los Angeles for importation to ULARA water from the Owens River and Mono Basin watersheds easterly of the Sierra-Nevada in Central California.

[27] Private Defendants -- Collectively, all of those defendants who are parties, other than Glendale, Burbank, San Fernando and Crescenta Valley.

[28] Reclaimed Water -- Water which, as a result of processing of waste water, is made suitable for and used for a controlled beneficial use.

[29] Regulatory Storage Capacity -- The volume of storage capacity of San Fernando Basin which is required to regulate the safe yield of the basin, without significant loss, during any long-term base period of water supply.

[30] Rising Water -- The effluent from a ground water basin which appears as surface flow.

[31] Rising Water Outflow -- The quantity of rising water which occurs within a ground water basin and does not rejoin the ground water body or is not captured prior to flowing past a point of discharge from the basin.

[32] Safe Yield – The maximum quantity of water which can be extracted annually from a ground water basin under a given set of cultural conditions and extraction patterns, based on the long-term supply, without causing a continuing reduction of water in storage.

[33] San Fernando -- Defendant City of San Fernando.

[34] San Fernando Basin -- The separate ground water basin underlying the area shown as such on Attachment "A".

[35] Sportsman's Lodge -- Defendant Sportsman's Lodge Banquet Association.

[36] Stored Water -- Ground water in a basin consisting of either (1) imported or reclaimed water which is intentionally spread, or (2) safe yield water which is allowed to accumulate by In Lieu Storage. Said ground waters are distinguished and separately accounted for in a ground water basin, notwithstanding that the same may be physically commingled with other waters in the basin.

[37] Sylmar Basin -- The separate ground water basin underlying the area indicated as such on Attachment "A".

[38] Temporary Surplus – The amount of ground water which would be required to be removed from a basin in order to avoid waste under safe yield operation.

[39] Toluca Lake -- Defendant Toluca Lake Property Owners Association.

[40] ULARA or Upper Los Angeles River Area – The Upper Los Angeles River watershed, being the surface drainage area of the Los Angeles River tributary to Gage F-57.

[41] Underlying Pueblo Waters -- Native ground waters in the San Fernando Basin which underlie safe yield and stored waters.

[42] Valhalla -- Collectively, Valhalla Properties, Valhalla Memorial Park, Valhalla Mausoleum Park.

[43] Van de Kamp -- Defendant Van de Kamp's Holland Dutch Bakers, Inc.

[44] Verdugo Basin -- The separate ground water basin underlying the area shown as such on Attachment "A".

[45] Water Year -- October 1 through September 30 of the following calendar year.

Geographic Names, not herein specifically defined, are used to refer to the places and locations thereof as shown on Attachment "A".

2.2 List of Attachments. There are attached hereto the following documents, which are by this reference incorporated in this Judgment and specifically referred to in the text hereof:

"A" -- Map entitled "Upper Los Angeles River Area", showing Separate Basins therein.

"B" -- List of "Dismissed Parties".

"C" -- List of "Defaulted Parties".

"D" -- List of "Disclaiming Parties".

"E" -- List of "Prior Stipulated Judgments."

"F" -- List of "Stipulated Non-Consumptive or Minimal-Consumptive Use Practices."

"G" -- Map entitled "Place of Use and Service Area of Private Defendants."

"H" -- Map entitled "Public Agency Water Service Areas."

[Attachments B-H are available upon request from LADWP – UWMP Note 2005]

3. PARTIES

3.1 Defaulting and Disclaiming Defendants. Each of the defendants listed on Attachment "C" and Attachment "D" is without any right, title or interest in, or to any claim to extract ground water from ULARA or any of the separate ground water basins therein.

3.2 No Rights Other Than as Herein Declared. No party to this action has any rights in or to the waters of ULARA except to the extent declared herein.

4. DECLARATION RE GEOLOGY AND HYDROLOGY

4.1 Geology.

4.1.1 ULARA. ULARA (or Upper Los Angeles River Area), is the watershed or surface drainage area tributary to the Los Angeles River at Gage F-57. Said watershed contains a total of 329,000 acres, consisting of approximately 123,000 acres of valley fill area and 206,000 acres of hill and mountain area, located primarily in the County of Los Angeles, with a small portion in the County of Ventura. Its boundaries are shown on Attachment "A". The San Gabriel Mountains form the northerly portion of the watershed, and from them two major washes--the Pacoima and the Tujunga--discharge southerly. Tujunga Wash traverses the valley fill in a southerly direction and joins the Los Angeles River, which follows an easterly course along the base of the Santa Monica Mountains before it turns south through the Los Narrows. The waters of Pacoima Wash as and when they flow out of Sylmar Basin are tributary to San Fernando Basin. Lesser tributary washes run from the Simi Hills and the Santa Susana Mountains in the westerly portion of the watershed. Other minor washes, including Verdugo Wash, drain the easterly portion of the watershed which consists of the Verdugo Mountains, the Elysian, San Rafael and Repetto Hills. Each of said washes is a non-perennial stream whose flood flows and rising waters are naturally tributary to the Los Angeles River. The Los Angeles River within ULARA and most of said tributary natural washes have been replaced, and in some instances relocated, by concrete-lined flood control channels. There are 85.3 miles of such channels within ULARA, 62% of which have lined concrete bottoms.

4.1.2 San Fernando Basin. San Fernando Basin is the major ground water basin in ULARA. It underlies 112,047 acres and is located in the area shown as such on Attachment "A". Boundary conditions of the San Fernando Basin consist on the east and northeast of alluvial contacts with non-waterbearing series along the San Rafael Hills and Verdugo Mountains and the Santa Susana Mountains and Simi Hills on the northwest and west and the Santa Monica Mountains on the south. Water-bearing material in said basin extends to at least 1000 feet below the surface. Rising water outflow from the San Fernando Basin passes its downstream and southerly boundary in the vicinity of Gage F-57, which is located in Los Angeles Narrows about 300 feet upstream from the Figueroa Street (Dayton Street) Bridge. The San Fernando Basin is separated from the Sylmar Basin on the north by the eroded south limb of the Little Tujunga Syncline which causes a break in the ground water surface of about 40 to 50 feet.

4.1.3 Sylmar Basin. Sylmar Basin underlies 5,565 acres and is located in the area shown as such on Attachment "A". Water-bearing material in said basin extends to depths in excess of 12,000 feet below the surface. Boundary conditions of Sylmar Basin consist of the San Gabriel Mountains on the north, a topographic divide in the valley fill between the Mission Hills and San Gabriel Mountains on the west, the Mission Hills on the southwest, Upper Lopez Canyon Saugus Formation on the east, along the east bank of Pacoima Wash, and the eroded south limb of the Little Tujunga Syncline on the south.

4.1.4 Verdugo Basin. Verdugo Basin underlies 4,400 acres and is located in the area shown as such on Attachment "A". Boundary conditions of Verdugo Basin consist of the San Gabriel Mountains on the north, the Verdugo Mountains on the south and southwest, the San

Rafael Hills on the southeast and the topographic divide on the east between the drainage area that is tributary to the Tujunga Wash to the west and Verdugo Wash to the east, the ground water divide on the west between Monk Hill-Raymond Basin and the Verdugo Basin on the east and a submerged dam constructed at the mouth of Verdugo Canyon on the south.

4.1.5 Eagle Rock Basin. Eagle Rock Basin underlies 807 acres and is located in the area shown as such on Attachment "A". Boundary conditions of Eagle Rock Basin consist of the San Rafael Hills on the north and west and the Repetto Hills on the east and south with a small alluvial area to the southwest consisting of a topographic divide.

4.2 Hydrology.

4.2.1 Water Supply. The water supply of ULARA consists of native waters, derived from precipitation on the valley floor and runoff from the hill and mountain areas, and of imported water from outside the watershed. The major source of imported water has been from the Owens-Mono Aqueduct, but additional supplies have been and are now being imported through MWD from its Colorado Aqueduct and the State Aqueduct.

4.2.2 Ground Water Movement. The major water-bearing formation in ULARA is the valley fill material bounded by hills and mountains which surround it. Topographically, the valley-fill area has a generally uniform grade in a southerly and easterly direction with the slope gradually decreasing from the base of the hills and mountains to the surface drainage outlet at Gage F-57. The valley fill material is a heterogeneous mixture of clays, silts, sand and gravel laid down as alluvium. The valley fill is of greatest permeability along and easterly of Pacoima and Tujunga Washes and generally throughout the eastern portion of the valley fill area, except in the vicinity of Glendale where it is of lesser permeability. Ground water occurs mainly within the valley fill, with only negligible amounts occurring in hill and mountain areas. There is no significant ground water movement from the hill and mountain formations into the valley fill. Available geologic data do not indicate that there are any sources of native ground water other than those derived from precipitation. Ground water movement in the valley fill generally follows the surface topography and drainage except where geologic or man-made impediments occur or where the natural flow has been modified by extensive pumping.

4.2.3 Separate Ground Water Basins. The physical and geologic characteristics of each of the ground water basins, Eagle rock, Sylmar, Verdugo and San Fernando, cause impediments to inter-basin ground water flow whereby there is created separate underground reservoirs. Each of said basins contains a common source of water supply to parties extracting ground water from each of said basins. The amount of underflow from Sylmar Basin, Verdugo Basin and Eagle Rock Basin to San Fernando Basin is relatively small, and on the average has been approximately 540 acre feet per year from the Sylmar Basin; 80 acre feet per year from Verdugo Basin; and 50 acre feet per year from Eagle Rock Basin. Each has physiographic, geologic and hydrologic differences, one from the other, and each meets the hydrologic definition of "basin". The extractions of water in the respective basins affect the other water users within that basin but do not significantly or materially affect the ground water levels in any of the other basins. The underground reservoirs of Eagle Rock, Verdugo and Sylmar Basins are independent of one another and of the San Fernando Basin.

4.2.4 Safe Yield and Native Safe Yield. The safe yield and native safe yield, stated in acre feet, of the three largest basins for the year 1964-65 was as follows:

Basin	Safe Yield	Native Safe Yield
San Fernando	90,680	43,660
Sylmar	6,210	3,850
Verdugo	7,150	3,590

The safe yield of Eagle Rock Basin is derived from imported water delivered by Los Angeles. There is no measurable native safe yield.

4.2.5 Separate Basins -- Separate Rights. The rights of the parties to extract ground water within ULARA are separate and distinct as within each of the several ground water basins within said watershed.

4.2.6 Hydrologic Condition of Basins. The several basins within ULARA are in varying hydrologic conditions, which result in different legal consequences.

4.2.6.1 San Fernando Basin. The first full year of overdraft in San Fernando Basin was 1954-55. It remained in overdraft continuously until 1968, when an injunction herein became effective. Thereafter, the basin was placed on safe yield operation. There is no surplus ground water available for appropriation or overlying use from San Fernando Basin.

4.2.6.2 Sylmar Basin. Sylmar Basin is not in overdraft. There remains safe yield over and above the present reasonable beneficial overlying uses, from which safe yield the appropriative rights of Los Angeles and San Fernando may be and have been exercised.

4.2.6.3 Verdugo Basin. Verdugo Basin was in overdraft for more than five consecutive years prior to 1968. Said basin is not currently in overdraft, due to decreased extractions by Glendale and Crescenta Valley on account of poor water quality. However, the combined appropriative and prescriptive rights of Glendale and Crescenta Valley are equivalent to the safe yield of the Basin. No private overlying or appropriative rights exist in Verdugo Basin.

4.2.6.4 Eagle Rock Basin. The only measure water supply to Eagle Rock Basin is import return water by reason of importations by Los Angeles. Extractions by Foremost and Deep Rock under the prior stipulated judgments have utilized the safe yield of Eagle Rock Basin, and have maintained hydrologic equilibrium therein.

5. DECLARATION OF RIGHTS

5.1 Right to Native Waters.

5.1.1 Los Angeles River and San Fernando Basin.

5.1.1.1 Los Angeles' Pueblo Right. Los Angeles, as the successor to all rights, claims and powers of the Spanish Pueblo de Los Angeles in regard to water rights, is the owner of a prior and paramount pueblo right to the surface waters of the Los Angeles River and the native ground waters of San Fernando Basin to meet its reasonable beneficial needs and for its inhabitants.

5.1.1.2 Extent of Pueblo Right. Pursuant to said pueblo right, Los Angeles is entitled to satisfy its needs and those of its inhabitants within its boundaries as from time to time modified. Water which is in fact used for pueblo right purposes is and shall be deemed needed for such purposes.

5.1.1.3 Pueblo Right -- Nature and Priority of Exercise. The pueblo right of Los Angeles is a prior and paramount right to all of the surface waters of the Los Angeles River, and native ground water in San Fernando Basin, to the extent of the reasonable needs and uses of Los Angeles and its inhabitants throughout the corporate area of Los Angeles, as its boundaries may exist from time to time. To the extent that the Basin contains native waters and imported waters, it is presumed that the first water extracted by Los Angeles in any water year is pursuant to its pueblo right, up to the amount of the native safe yield. The next extractions by Los Angeles in any year are deemed to be from import return water, followed by stored water, to the full extent of Los Angeles' right to such import return water and stored water. In the event of need to meet water requirements of its inhabitants, Los Angeles has the additional right, pursuant to its pueblo right, withdraw temporarily from storage Underlying Pueblo Waters, subject to an obligation to replace such water as soon as practical.

5.1.1.4 Rights of Other Parties. No other party to this action has any right in or to the surface waters of the Los Angeles River or the native safe yield of the San Fernando Basin.

5.1.2 Sylmar Basin Rights.

5.1.2.1 No Pueblo Rights. The pueblo right of Los Angeles does not extend to or include ground waters in Sylmar Basin.

5.1.2.2 Overlying Rights. Defendants Moordigian and Hersch & Plumb own lands overlying Sylmar Basin and have a prior correlative right to extract native waters from said Basin for reasonable beneficial uses on their said overlying lands. Said right is appurtenant to said overlying lands and water extracted pursuant thereto may not be exported from said lands nor can said right be transferred or assigned separate and apart from said overlying lands.

5.1.2.3 Appropriative Rights of San Fernando and Los Angeles. San Fernando and Los Angeles own appropriative rights, of equal priority, to extract and put to reasonable beneficial use for the needs of said cities and their inhabitants, native waters of the Sylmar Basin in excess of the exercised reasonable beneficial needs of overlying users. Said appropriative rights are:

San Fernando	3,580 acre feet
Los Angeles	1,560 acre feet.

5.1.2.4 No Prescription. The Sylmar Basin is not presently in a state of overdraft and no rights by prescription exist in said Basin against any overlying or appropriative water user.

5.1.2.5 Other Parties. No other party to this action owns or possesses any right to extract native ground waters from the Sylmar Basin.

5.1.3 Verdugo Basin Rights.

5.1.3.1 No Pueblo Rights. The pueblo right of Los Angeles does not extend to or include ground water in Verdugo Basin.

5.1.3.2 Prescriptive Rights of Glendale and Crescenta Valley. Glendale and Crescenta Valley own prescriptive rights as against each other and against all private overlying or appropriative parties in the Verdugo Basin to extract, with equal priority, the following quantities of water from the combined safe yield of native and imported waters in Verdugo Basin:

Glendale	3,856 acre feet
Crescenta Valley	3,294 acre feet.

5.1.3.3 Other Parties. No other party to this action owns or possesses any right to extract native ground waters from the Verdugo Basin.

5.1.4 Eagle Rock Basin Rights.

5.1.4.1 No Pueblo Rights. The pueblo right of Los Angeles does not extend to or include ground water in Eagle Rock Basin.

5.1.4.2 No Rights in Native Waters. The Eagle Rock Basin has no significant or measurable native safe yield and no parties have or assert any right or claim to native waters in said Basin.

5.2 Rights to Imported Waters.

5.2.1 San Fernando Basin Rights.

5.2.1.1 Rights to Recapture Import Return Water. Los Angeles, Glendale, Burbank and San Fernando have each caused imported waters to be brought into ULARA and to be delivered to lands overlying the San Fernando Basin, with the result that percolation and return flow of such delivered water has caused imported waters to become a part of the safe yield of San Fernando Basin. Each of said parties has a right to extract from San Fernando Basin that portion of the safe yield of the Basin attributable to such import return waters.

5.2.1.2 Rights to Store and Recapture Stored Water. Los Angeles has heretofore spread imported water directly in San Fernando Basin. Los Angeles, Glendale, Burbank and San Fernando each have rights to store water in San Fernando Basin by direct spreading or in lieu practices. To the extent of any future spreading or in lieu storage of import water or reclaimed water by Los Angeles, Glendale, Burbank or San Fernando, the party causing said water to be so stored shall have a right to extract an equivalent amount of ground water from San Fernando Basin. The right to extract waters attributable to such storage practices is an undivided right to a quantity of water in San Fernando Basin equal to the amount of such Stored Water to the credit of any party, as reflected in Watermaster records.

5.2.1.3 Calculation of Import Return Water and Stored Water Credits. The extraction rights of Los Angeles, Glendale, Burbank and San Fernando in San Fernando Basin in any year, insofar as such rights are based upon import return water, shall only extend to the amount of any accumulated import return water credit of such party by reason of imported water delivered after September 30, 1977. The annual credit for such import return water shall be calculated by Watermaster based upon the amount of delivered water during the preceding water year, as follows:

Los Angeles:	20.8% of all delivered water (including reclaimed water) to valley fill lands of San Fernando Basin.
San Fernando:	26.3% of all imported and reclaimed water delivered to valley-fill lands of San Fernando Basin.
Burbank:	20.0% of all delivered water (including reclaimed water) to San Fernando Basin and its tributary hill and mountain areas.
Glendale:	20.0% of all delivered water (including reclaimed water) to San Fernando Basin and its tributary hill and mountain areas (i.e., total delivered water, [including reclaimed water], less 105% of total sales by Glendale in Verdugo Basin and its tributary hills).

In calculating Stored Water credit, by reason of direct spreading of imported or reclaimed water, Watermaster shall assume that 100% of such spread water reached the ground water in the year spread.

5.2.1.4 Cumulative Import Return Water Credits. Any import return water which is not extracted in a given water year shall be carried over, separately accounted for, and maintained as a cumulative credit for purposes of future extractions.

5.2.1.5 Overextractions. In addition to extractions of stored water, Glendale, Burbank or San Fernando may, in any water year, extract from San Fernando Basin an amount not exceeding 10% of such party's last annual credit for import return water, subject, however, to an obligation to replace such overextraction by reduced extractions during the next succeeding water year. Any such overextraction which is not so replaced shall constitute physical solution water, which shall be deemed to have been extracted in said subsequent water year.

5.2.1.6 Private Defendant. No private defendant is entitled to extract water from the San Fernando Basin on account of the importation of water thereto by overlying public entities.

5.2.2 Sylmar Basin Rights.

5.2.2.1 Rights to Recapture Import Return Waters. Los Angeles and San Fernando have caused imported waters to be brought into ULARA and delivered to lands overlying the Sylmar Basin with the result that percolation and return flow of such delivered water has caused imported waters to become a part of the safe yield of Sylmar Basin. Los Angeles and San Fernando are entitled to recover from Sylmar Basin such imported return waters. In calculating the annual entitlement to recapture such import return water, Los Angeles and San Fernando shall be entitled to 35.7% of the preceding water year's imported water delivered by such party to lands overlying Sylmar Basin. Thus, by way of example, in 1976-77, Los Angeles was entitled to extract 2370 acre feet of ground water from Sylmar Basin, based on delivery to lands overlying said Basin of 6640 acre feet during 1975-76. The quantity of San Fernando's imported water to, and the return flow therefrom, in the Sylmar Basin in the past has been of such minimal quantities that it has not been calculated.

5.2.2.2 Rights to Store and Recapture Stored Water. Los Angeles and San Fernando each have the right to store water in Sylmar Basin equivalent to their rights in San Fernando Basin under paragraph 5.2.1.2 hereof.

5.2.2.3 Carry Over. Said right to recapture stored water, import return water and other safe yield waters to which a party is entitled, if not exercised in a given year, can be carried over for not to exceed five years, if the underflow through Sylmar Notch does not exceed 400 acre feet per year.

5.2.2.4 Private Defendants. No private defendant is entitled to extract water from within the Sylmar Basin on account of the importation of water thereto by overlying public entities.

5.2.3 Verdugo Basin Rights.

5.2.3.1 Glendale and Crescenta Valley. Glendale and Crescenta Valley own appropriative and prescriptive rights in and to the total safe yield of Verdugo Basin, without regard as to the portions thereof derived from native water and from delivered imported waters, notwithstanding that both of said parties have caused waters to be imported and delivered on lands overlying Verdugo Basin. Said aggregate rights are as declared in Paragraph 5.1.3.2 of these Conclusions.

5.2.3.2 Los Angeles. Los Angeles may have a right to recapture its import return waters by reason of delivered import water in the Basin, based upon imports during and after water year 1977-78, upon application to Watermaster not later than the year following such import and on subsequent order after hearing by the Court.

5.2.3.3 Private Defendants. No private defendant, as such, is entitled to extract water from within the Verdugo Basin on account of the importation of water thereto by overlying public entities.

5.2.4 Eagle Rock Basin Rights.

5.2.4.1 Los Angeles. Los Angeles has caused imported water to be delivered for use on lands overlying Eagle Rock Basin and return flow from said delivered imported water constitutes the entire safe yield of Eagle Rock Basin. Los Angeles has the right to extract or cause to be extracted the entire safe yield of Eagle Rock Basin.

5.2.4.2 Private Defendants. No private defendants have a right to extract water from within Eagle Rock Basin, except pursuant to the physical solution herein.

6. INJUNCTIONS

Each of the parties named or referred to in this Part 6, its officers, agents, employees and officials is, and they are, hereby ENJOINED and RESTRAINED from doing or causing to be done any of the acts herein specified:

6.1 Each and Every Defendant -- from diverting the surface waters of the Los Angeles River or extracting the native waters of SAN FERNANDO BASIN, or in any manner interfering with the prior and paramount pueblo right of Los Angeles in and to such waters, except pursuant to the physical solution herein decreed.

6.2 Each and Every Private Defendant -- from extracting ground water from the SAN FERNANDO, VERDUGO, or EAGLE ROCK BASINS, except pursuant to physical solution provisions hereof.

6.3 Defaulting and Disclaiming Parties (listed in Attachments "C" and "D") -- from diverting or extracting water within ULARA, except pursuant to the physical solution herein decreed.

6.4 Glendale -- from extracting ground water from SAN FERNANDO BASIN in any water year in quantities exceeding its import return water credit and any stored water credit, except pursuant to the physical solution; and from extracting water from VERDUGO BASIN n excess of its appropriative and prescriptive right declared herein.

6.5 Burbank -- from extracting ground water from SAN FERNANDO BASIN in any water year in quantities exceeding its import return water credit and any stored water credit, except pursuant to the physical solution decreed herein.

6.6 San Fernando -- from extracting ground water from SAN FERNANDO BASIN in any water year in quantities exceeding its import return water credit and any stored water credit, except pursuant to the physical solution herein decreed.

6.7 Crescenta Valley -- from extracting ground water from VERDUGO BASIN in any year in excess of its appropriative and prescriptive right declared herein.

6.8 Los Angeles -- from extracting ground water from SAN FERNANDO BASIN in any year in excess of the native safe yield, plus any import return water credit and stored water credit of said city; provided, that where the needs of Los Angeles require the extraction of Underlying Pueblo Waters, Los Angeles may extract such water subject to an obligation to replace such excess as soon as practical; and from extracting ground water from VERDUGO BASIN in excess of any credit for import return water which Los Angeles may acquire by reason of delivery of imported water for use overlying said basin, as hereinafter confirmed on application to Watermaster and by subsequent order of the Court.

6.9 Non-consumptive and Minimal Consumptive Use Parties. The parties listed in Attachment "F" are enjoined from extracting water from San Fernando Basin, except in accordance with practices specified in Attachment "F", or pursuant to the physical solution herein decreed.

7. CONTINUING JURISDICTION

7.1 Jurisdiction Reserved. Full jurisdiction, power and authority are retained by and reserved to the Court for purposes of enabling the Court upon application of any party or of the Watermaster by motion and upon at least 30 days' notice thereof, and after hearing thereon, to make such further or supplemental orders or directions as may be necessary or appropriate, for interpretation, enforcement or carrying out of this Judgment, and to modify, amend or amplify any of the provisions of this Judgment or to add to the provisions thereof consistent with the rights herein decreed; provided, however, that no such modification, amendment or amplification shall result in a change in the provisions of Section 5.2.1.3 or 9.2.1 hereof.

8. WATERMASTER

8.1 Designation and Appointment.

8.1.1 Watermaster Qualification and Appointment. A qualified hydrologist, acceptable to all active public agency parties hereto, will be appointed by subsequent order of the Court to assist the Court in its administration and enforcement of the provisions of this Judgment and any subsequent orders of the Court entered pursuant to the Court's continuing jurisdiction. Such Watermaster shall serve at the pleasure of the Court, but may be removed or replaced on motion of any party after hearing and showing of good cause.

8.2 Powers and Duties.

8.2.1 Scope. Subject to the continuing supervision and control of the Court, Watermaster shall exercise the express powers, and shall perform the duties, as provided in this Judgment or hereafter ordered or authorized by the Court in the exercise of the Court's continuing jurisdiction.

8.2.2 Requirement for Reports, Information and Records. Watermaster may require any party to furnish such reports, information and records as may be reasonably necessary to determine compliance or lack of compliance by any party with the provisions of this Judgment.

8.2.3 Requirement of Measuring Devices. Watermaster shall require all parties owning or operating any facilities for extraction of ground water from ULARA to install and maintain at all times in good working order, at such party's own expense, appropriate meters or other measuring devices satisfactory to the Watermaster.

8.2.4 Inspection by Watermaster. Watermaster shall make inspections of (a) ground water extraction facilities and measuring devices of any party, and (b) water use practices by any party under physical solution conditions, at such times and as often as may be reasonable under the circumstances to verify reported data and practices of such party. Watermaster shall also identify and report on any new or proposed new ground water extractions by any party or non-party.

8.2.5 Policies and Procedures. Watermaster shall, with the advice and consent of the Administrative Committee, adopt and amend from time to time Policies and Procedures as may be reasonably necessary to guide Watermaster in performance of its duties, powers and responsibilities under the provisions of this judgment.

8.2.6 Data Collection. Watermaster shall collect and verify data relative to conditions of ULARA and its ground water basins from the parties and one or more other governmental agencies. Where necessary, and upon approval of the Administrative Committee, Watermaster may develop supplemental data.

8.2.7 Cooperation With Other Agencies. Watermaster may act jointly or cooperate with agencies of the United States and the State of California or any political subdivisions, municipalities or districts (including any party) to secure or exchange data to the end that the purpose of this Judgment, including its physical solution, may be fully and economically carried out.

8.2.8 Accounting for Non-consumptive Use. Watermaster shall calculate and report annually the non-consumptive and consumptive uses of extracted ground water by each party listed in Attachment "F".

8.2.9 Accounting for Accumulated Import Return Water and Stored Water. Watermaster shall record and verify additions, extractions and losses and maintain an annual and cumulative account of all (a) stored water and (b) import return water in San Fernando Basin. Calculation of losses attributable to Stored Water shall be approved by the Administrative Committee or by subsequent order of the Court. For purposes of such accounting, extractions in any water year by Glendale, Burbank or San Fernando shall be assumed to be first from accumulated import return water, second from stored water, and finally pursuant to physical solution; provided, that any such city may, by written notice of intent to Watermaster, alter said priority of extractions as between import return water and stored water.

8.2.10 Recalculation of Safe Yield. Upon request of the Administrative Committee, or on motion of any party and subsequent Court order, Watermaster shall recalculate safe yield of any basin within ULARA. If there has been a material long-term change in storage over a base period (excluding any effects of stored water) in San Fernando Basin the safe yield shall be adjusted by making a corresponding change in native safe yield of the Basin.

8.2.11 Watermaster Report. Watermaster shall prepare annually and (after review and approval by Administrative Committee) cause to be served on all active parties, on or before May 1, a report of hydrologic conditions and Watermaster activities within ULARA during the preceding water year. Watermaster's annual report shall contain such information as may be requested by the Administrative Committee, required by Watermaster Policies and Procedures or specified by subsequent order of this Court.

8.2.12 Active Party List. Watermaster shall maintain at all times a current list of active parties and their addresses.

8.3 Administrative Committee.

8.3.1 Committee to be Formed. An Administrative Committee shall be formed to advise with, request or consent to, and review actions of Watermaster. Said Administrative Committee shall be composed of one representative of each party having a right to extract ground water from ULARA, apart from the physical solution. Any such party not desiring to participate in such committee shall so advise Watermaster in writing.

8.3.2 Organization and Voting. The Administrative Committee shall organize and adopt appropriate rules and regulations to be included in Watermaster Policies and Procedures. Action of the Administrative Committee shall be by unanimous vote of its members, or of the members affected in the case of an action which affects one or more basins but less than all of ULARA. In the event of inability of the Committee to reach a unanimous position, the matter may, at the request of Watermaster or any party, be referred to the Court for resolution by subsequent order after notice and hearing.

8.3.3 Function and Powers. The Administrative Committee shall be consulted by Watermaster and shall request or approve all discretionary Watermaster determinations. In the event of disagreement between Watermaster and the Administrative Committee, the matter shall be submitted to the Court for review and resolution.

8.4 Watermaster Budget and Assessments.

8.4.1 Watermaster's Proposed Budget. Watermaster shall, on or before May 1, prepare and submit to the Administrative Committee a budget for the ensuing water year. The budget shall be determined for each basin separately and allocated between the separate ground water basins. The total for each basin shall be allocated between the public agencies in proportion to their use of ground water from such basin during the preceding water year.

8.4.2 Objections and Review. Any party who objects to the proposed budget, or to such party's allocable share thereof, may apply to the Court within thirty (30) days of receipt of the proposed budget from Watermaster for review and modification. Any such objection shall be duly noticed to all interested parties and heard within thirty (30) days of notice.

8.4.3 Notice of Assessment. After thirty (30) days from delivery of Watermaster's proposed budget, or after the order of Court settling any objections thereto, Watermaster shall serve notice on all parties to be assessed of the amount of assessment and the required payment schedule.

8.4.4 Payment. All assessments for Watermaster expenses shall be payable on the dates designated in the notice of assessment.

8.5 Review of Watermaster Activities.

8.5.1 Review Procedures. All actions of Watermaster (other than budget and assessment matters, which are provided for in Paragraph 8.4.2) shall be subject to review by the Court on its own motion or on motion by any party, as follows:

8.5.1.1 Noticed Motion. Any party may, by a regularly noticed motion, apply to the court for review of any Watermaster's action. Notice of such motion shall be served personally or mailed to Watermaster and to all active parties.

8.5.1.2 De Novo Nature of Proceedings. Upon the filing of any such motion, the Court shall require the moving party to notify the active parties of a date for taking evidence and argument, and on the date so designated shall review de novo the question at issue. Watermaster's findings or decision, if any, may be received in evidence at said hearing, but shall not constitute presumptive or prima facie proof of any fact in issue.

8.5.1.3 Decision. The decision of the Court in such proceeding shall be an appealable supplemental order in this case. When the same is final, it shall be binding upon the Watermaster and all parties.

9. PHYSICAL SOLUTION

9.1 Circumstances Indicating Need for Physical Solution. During the period between 1913 and 1955, when there existed temporary surplus waters in the San Fernando Basin, overlying cities and private overlying landowners undertook to install and operate water extraction, storage and transmission facilities to utilize such temporary surplus waters. If the injunction against interference with the prior and paramount rights of Los Angeles to the waters of the San Fernando and Eagle Rock Basins were strictly enforced, the value and utility of those water systems and facilities would be lost or impaired. It is appropriate to allow continued limited extraction from the San Fernando and Eagle Rock Basins by parties other than Los Angeles, subject to assurance that Los Angeles will be compensated for any cost, expense or loss incurred as a result thereof.

9.2 Prior Stipulated Judgments. Several defendants heretofore entered into separate stipulated judgments herein, during the period June, 1958 to November, 1965, each of which judgments was subject to the court's continuing jurisdiction. Without modification of the substantive terms of said prior judgments, the same are categorized and merged into this judgment and superseded hereby in the exercise of the Court's continuing jurisdiction, as follows:

9.2.1 Eagle Rock Basin Parties. Stipulating defendants Foremost and Deep Rock have extracted water from Eagle Rock Basin, whose entire safe yield consist of import return waters of Los Angeles. Said parties may continue to extract water from Eagle Rock Basin to supply their bottled drinking water requirements upon filing all required reports on said extraction with Watermaster and Los Angeles and paying Los Angeles annually an amount equal to $21.78 per acre foot for the first 200 acre feet, and $39.20 per acre foot for any additional water extracted in any water year.

9.2.2 Non-consumptive or Minimal-consumptive Operations. Certain stipulating defendants extract water from San Fernando Basin for uses which are either non-consumptive or have a minimal consumptive impact. Each of said defendants who have a minimal consumptive impact has a connection to the City of Los Angeles water system and purchases annually an amount of water at least equivalent to the consumptive loss of extracted ground water. Said defendants are:

Non-Consumptive

Walt Disney Productions

Sears, Roebuck & Co.

Minimal-Consumptive

Conrock Co., for itself and as successor to California Materials Co.; Constance Ray White and Lee L. White; Mary L. Akmadzich and Peter J. Akmadzich

Livingston Rock & Gravel, for itself and as successor to Los Angeles Land & Water Co.

The nature of each said defendant's water use practices is described in Attachment "F". Subject to required reports to and inspections by Watermaster, each said defendant may continue extractions for said purposes so long as in any year such party continues such non-consumptive or minimal-consumptive use practices.

9.2.3 Abandoned Operations. The following stipulating defendants have ceased extracting water from San Fernando Basin and no further need exists for physical solution in their behalf:

Knickerbocker Plastic Company, Inc.

Carnation Company

Hidden Hills Mutual Water Company

Southern Pacific Railroad Co.

Pacific Fruit Express Co.

9.3 Private Defendants. There are private defendants who installed during the years of temporary surplus relatively substantial facilities to extract and utilize ground waters of San Fernando Basin. Said defendants may continue their extractions for consumptive use up to the indicated annual quantities upon payment of compensation to the appropriate city wherein their use of water is principally located, on the basis of the following physical solution:

9.3.1 Private Defendants and Appropriate Cities. Said private defendants and the cities to which their said extractions shall be charged and to which physical solution payment shall be made are:

		Annual Quantities (acre feet)
Los Angeles	- Toluca Lake	100
	Sportsman's Lodge	25
	Van de Kamp	120
Glendale	- Forest Lawn	400
	Southern Service Co.	75
Burbank	- Valhalla	300
	Lockheed	25

Provided that said private defendants shall not develop, install or operate new wells or other facilities which will increase existing extraction capacities.

9.3.2 Reports and Accounting. All extractions pursuant to this physical solution shall be subject to such reasonable reports and inspection as may be required by Watermaster.

9.3.3 Payment. Water extracted pursuant hereto shall be compensated for by annual payment to Los Angeles, and as agreed upon pursuant to paragraph 9.3.3.2 to Glendale and Burbank, thirty days from day of notice by Watermaster, on the following basis:

9.3.3.1 Los Angeles. An amount equal to what such party would have paid had water been delivered from the distribution system of Los Angeles, less the average energy cost of extraction of ground water by Los Angeles from San Fernando.

9.3.3.2 Glendale or Burbank. An amount equal to the sum of the amount payable to Los Angeles under paragraph 9.4 hereof and any additional charges or conditions agreed upon by either such city and any private defendant.

9.4 Glendale and Burbank. Glendale and Burbank have each installed, during said years of temporary surplus, substantial facilities to extract and utilize waters of the San Fernando Basin. In addition to the use of such facilities to recover import return water, the distribution facilities of such cities can be most efficiently utilized by relying upon the San Fernando Basin for peaking supplies in order to reduce the need for extensive new surface storage. Glendale and Burbank may extract annual quantities of ground water from the San Fernando Basin, in addition to their rights to import return water or stored water, as heretofore declared, in quantities up to:

Glendale	5,500 acre feet
Burbank	4,200 acre feet;

provided, that said cities shall compensate Los Angeles annually for any such excess extractions over and above their declared rights at a rate per acre foot equal to the average MWD price for municipal and industrial water delivered to Los Angeles during the fiscal year, less the average energy cost of extraction of ground water by Los Angeles from San Fernando Basin during the preceding fiscal year. Provided, further, that ground water extracted by Forest Lawn and Southern Service Co. shall be included in the amount taken by Glendale, and the amount extracted by Valhalla and Lockheed shall be included in the amount taken by Burbank. All water taken by Glendale or Burbank pursuant hereto shall be charged against Los Angeles' rights in the year of such extractions.

In the event of emergency, and upon stipulation or motion and subsequent order of the Court, said quantities may be enlarged in any year.

9.5 San Fernando. San Fernando delivers imported water on lands overlying the San Fernando Basin, by reason of which said city has a right to recover import return water. San Fernando does not have water extraction facilities in the San Fernando Basin, nor would it be economically or hydrologically useful for such facilities to be installed. Both San Fernando and Los Angeles have decreed appropriative rights and extraction facilities in the Sylmar Basin. San Fernando may extract ground water from the Sylmar Basin in a quantity sufficient to utilize its San Fernando Basin import return water credit, and Los Angeles shall reduce its Sylmar Basin extractions by an equivalent amount and receive an offsetting entitlement for additional San Fernando Basin extractions.

9.6 Effective Date. This physical solution shall be effective on October 1, 1978, based upon extractions during water year 1978-79.

10. MISCELLANEOUS PROVISIONS

10.1 Designation of Address for Notice and Service. Each party shall designate the name and address to be used for purposes of all subsequent notices and service herein by a separate designation to be filed with Watermaster within thirty (30) days after Notice of Entry of Judgment has been served. Said designation may be changed from time to time by filing a written notice of such change with the Watermaster. Any party desiring to be relieved of receiving notices of Watermaster activity may file a waiver of notice on a form to be provided by Watermaster. Thereafter such party shall be removed from the Active Party list. For purposes of service on any party or active party by the Watermaster, by any other party, or by the Court, of any item required to be served upon or delivered to such party or active party under or pursuant to the Judgment, such service shall be made personally or by deposit in the United States mail, first class, postage prepaid, addressed to the designee and at the address in the latest designation filed by such party or active party.

10.2 Notice of Change in Hydrologic Condition -- Sylmar Basin. If Sylmar Basin shall hereafter be in a condition of overdraft due to increased or concurrent appropriations by Los Angeles and San Fernando, Watermaster shall so notify the Court and parties concerned, and notice of such overdraft and the adverse effect thereof on private overlying rights shall be given by said cities as prescribed by subsequent order of the Court, after notice and hearing.

10.3 Judgment Binding on Successors. This Judgment and all provisions thereof are applicable to and binding upon not only the parties to this action, but also upon their respective heirs, executors, administrators, successors, assigns, lessees and licensees and upon the agents, employees and attorneys in fact of all such persons.

10.4 Costs. Ordinary court costs shall be borne by each party, and reference costs shall be borne as heretofore allocated and paid.

DATED: _______________, 1979.

____
Judge of the Superior Court

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Attorneys for Defendant,
Dominguez Water Corporation

SUPERIOR COURT OF THE STATE OF CALIFORNIA
FOR THE COUNTY OF LOS ANGELES

CALIFORNIA WATER SERVICE COMPANY, et al., Plaintiff, vs. CITY OF COMPTON, et al., Defendants.	No. 506,806 AMENDED JUDGMENT (DECLARING AND ESTABLISHING WATER RIGHTS IN THE WEST COAST BASIN, IMPOSING A PHYSICAL SOLUTION THEREIN AND ENJOINING EXTRACTIONS THEREFROM IN EXCESS OF SPECIFIED QUANTITIES.)

SB 257081 v1: 06774.0096

INTRODUCTION

The above - entitled matter came on regularly for further trial before the Honorable George Francis, Judge of the Superior Court of the State of California, assigned by the Chairman of the Judicial Council to sit in this case on Friday the 21st day of July, 1961. Thereupon plaintiffs filed a dismissal of the action as to certain defendants named in the Complaint and in the Amended Complaint herein who are not mentioned or referred to in Paragraph III of this Judgment, and the further trial of the action proceeded in respect to the remaining parties.

The objections to the Report of Referee and to all supplemental Reports thereto, having been considered upon exceptions thereto filed with the Clerk of the Court in the manner of and within the time allowed by law, were overruled.

Oral and documentary evidence was introduced, and the matter was submitted to the Court for decision. Findings of Fact, Conclusions of Law and Judgment herein have heretofore been signed and filed.

Pursuant to the reserved and continuing jurisdiction of the Court under the Judgment herein, certain amendments to said Judgment and temporary Orders have heretofore been made and entered.

Continuing jurisdiction of the Court under said Judgment is currently assigned to the HONORABLE JULIUS M. TITLE.

The motion of defendant herein, DOMINGUEZ WATER CORPORATION, for further amendments to the Judgment, notice thereof and of the hearing thereon having been duly and regularly given to all parties, came on for hearing in Department 48 of the above-entitled Court on March 21, 1980, at 1:30 o'clock P.M., before said HONORABLE JULIUS M. TITLE. Defendant, DOMINGUEZ WATER CORPORATION, was represented by its attorneys, Helm, Budinger & Lemieux, and Ralph B. Helm. Various other parties were represented by counsel of record appearing on the Clerk's records. Hearing thereon was concluded on that date. The within "Amended Judgment" incorporates amendments and orders heretofore made to the extent presently operable and amendments pursuant to said last mentioned motion. To the extent this Amended Judgment is a restatement of the Judgment as heretofore amended, it is for convenience in incorporating all matters in one document, it is not a readjudication of such matters and is not intended to reopen any such matters. As used hereinafter the word "Judgment" shall include the original Judgment as amended to date.

NOW, THEREFORE, IT IS HEREBY ORDERED, ADJUDGED AND DECREED AS FOLLOWS:

I.

Existence of Basin and Boundaries Thereof.

There exists in the County of Los Angeles, State of California, an underground water basin or reservoir known and hereinafter referred to as "West Coast Basin", "West Basin" or the "Basin", and the boundaries thereof are described as follows:

Commencing at a point in the Baldwin Hills about 1300 feet north and about 100 feet west of the intersection of Marvale Drive and

Northridge Drive; thence through a point about 200 feet northeasterly along Northridge Drive from the intersection of Marvale and Northridge Drives to the base of the escarpment of the Potrero fault; thence along the base of the escarpment of the Potrero fault in a straight line passing through a point about 200 feet south of the intersection of Century and Crenshaw Boulevards and extending about 2650 feet beyond this point to the southerly end of the Potrero escarpment; thence from the southerly end of the Potrero escarpment in a line passing about 700 feet south of the intersection of Western Avenue and Imperial Boulevard and about 400 feet north of the intersection of El Segundo Boulevard and Vermont Avenue and about 1700 feet south of the intersection of El Segundo Boulevard and Figueroa Street to the northerly end of the escarpment of the Avalon-Compton fault at a point on said fault about 700 feet west of the intersection of Avalon Boulevard and Rosecrans Avenue; thence along the escarpment of the Avalon-Compton fault to a point in the Dominguez Hills located about 1300 feet north and about 850 feet west of the intersection of Central Avenue and Victoria Street; thence along the crest of the Dominguez Hills in a straight line to a point on Alameda Street about 2900 feet north of Del Amo Boulevard as measured along Alameda Street; thence in a straight line extending through a point located on Del Amo Boulevard about 900 feet west of the Pacific Electric Railway to a point about 100 feet north and west of the intersection of Bixby Road and Del Mar Avenue; thence in a straight line to a point located about 750 feet west and about 730 feet south of the intersection of Wardlow Road and Long Beach Boulevard at the escarpment of the Cherry Hill fault; thence along the escarpment of the Cherry Hill fault through the intersection of Orange Avenue and Willow Street to a point about 400 feet east of the intersection of Walnut and Creston Avenues; thence to a point on Pacific Coast Highway about 300 feet west of its intersection with Obispo Avenue; thence along Pacific Coast Highway easterly to a point located about 650 feet west of the intersection of the center line of said Pacific Coast Highway with the intersection of the center line of Lakewood Boulevard; thence along the escarpment of the Reservoir Hill fault to a point about 650 feet north and about 700 feet east of the intersection of Anaheim Street and Ximeno Avenue; thence along the trace of said Reservoir Hill fault to a point on the Los Angeles - Orange County line about 1700 feet northeast of the Long Beach City limit measured along the County line; thence along said Los Angeles - Orange County line in a southwesterly direction to the shore line of the Pacific Ocean; thence in a northerly and westerly direction along the shore line of the Pacific Ocean to the intersection of said shore line with the southerly end of the drainage divide of the Palos Verdes Hills; thence along the drainage divide of the Palos Verdes Hills to the intersection of the northerly end of said drainage divide with the shore line of the Pacific Ocean; thence northerly along the shore line of the Pacific Ocean to the intersection of said shore line with the westerly projection of the crest of the Ballona escarpment; thence easterly along the crest of the Ballona escarpment to the mouth of Centinela Creek; thence easterly from the mouth of Centinela Creek across the Baldwin Hills in a line encompassing the entire watershed of Centinela Creek to the point of beginning.

All streets, railways and boundaries of Cities and Counties herinabove referred to are as the same existed at 12:00 o'clock noon on August 20, 1961.

The area included within the foregoing boundaries is approximately 101,000 acres in extent.

II.

Definitions:

1. Basin, West Coast Basin and West Basin, as these terms are interchangeably used herein, mean the ground water basin underlying the area described in Paragraph I hereof.
2. A fiscal year, as that term is used herein, is a twelve month period beginning July 1 and ending June 30.
3. A water purveyor, as that term is used in Paragraph XII hereof, means a party which sells water to the public, whether a regulated public utility, mutual water company or public entity, which has a connection or connections for the taking of imported water through The Metropolitan Water District of Southern California, through West Basin Municipal Water District, or access to such imported water through such connection, and which normally supplies at

least a part of its customers' water needs with such imported water.

4. A water year, as that term is used herein, is a twelve month period beginning October 1 and ending September 30, until it is changed to a "fiscal year," as provided in Paragraph XVI hereof.

III.

Declaration of Rights - Water Rights Adjudicated.

Certain of the parties to this action have no right to extract water from the Basin. The name of each of said parties is listed below with a zero following his name, and the absence of such right in said parties is hereby established and declared. Certain of the parties to this action and/or their successors in interest (through September 30, 1978) are the owners of rights to extract water from the Basin, which rights are of the same legal force and effect and without priority with reference to each other, and the amount of such rights, stated in acre-feet per year, hereinafter referred to as "Adjudicated Rights" is listed below following such parties' names, and the rights of the last-mentioned parties are hereby declared and established accordingly. Provided, however, that the Adjudicated Rights so declared and established shall be subject to the condition that the water, when used, shall be put to beneficial use through reasonable methods of use and reasonable methods of diversion; and provided further that the exercise of all of said Rights shall be subject to a pro rata reduction, if such reduction is required, to preserve said Basin as a common source of water supply.

PARTY AND SUCCESSOR, IF ANY		ADJUDICATED RIGHT IN ACRE FEET, ANNUALLY
LERMENS, EVELYN (Formerly Alfred Lermens)		0.7
LENZINER, EMMA L. sued as Mrs. E.L. Leuziner		1.4
LINDERMAN, ABRAHAM		0
Second West Coast Basin Judgment		
LISTON, LAWRENCE	0.7	0
Sold to R. Harris and L. Harris	-0.7	
LITTLE, WILLIAM	0.1	0
Sold to Watt Industrial Properties	-0.1	
LIZZA, PAT		0
LOCHMAN, ERNEST C.		0
LOCHMAN, WALTER		
Second West Coast Basin Judgment		
LONG, BEN		0
Persilla Long, sued as Pricilla Long		
LONG, JOHN		0
LONG BEACH, CITY OF		0.7
LOPEZ, FRANK		3.7
LOPEZ, MANUEL		0
one Rudolph E. Lopez		
LOS ANGELES, CITY OF		1503.0
LOS ANGELES CITY SCHOOL DISTRICT		0
LOS ANGELES COUNTY (ALONDRA PARK)	28.7	67.7
Successor to Los Angeles County Flood Control District	39.0	

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SUPERIOR COURT OF THE STATE OF CALIFORNIA

FOR THE COUNTY OF LOS ANGELES

CENTRAL AND WEST BASIN WATER REPLENISHMENT DISTRICT, etc., Plaintiff, v. CHARLES E. ADAMS, et al., Defendants. CITY OF LAKEWOOD, a municipal corporation, Cross-Complaint, v. CHARLES E. ADAMS, et al., Cross-Defendants.	No. 786,656 SECOND AMENDED JUDGMENT (Declaring and establishing water rights in Central Basin and enjoining extractions therefrom in excess of specified quantities.)

The above-entitled matter duly and regularly came on for trial in Department 73 of the above-entitled Court (having been transferred thereto from Department 75 by order of the presiding Judge), before the Honorable Edmund M. Moor, specially assigned Judge, on May 17, 1965, at 10:00 a.m. Plaintiff was represented by its attorneys BEWLEY, KNOOP,

LASSLEBEN & WHELAN, MARTIN E. WHELAN, JR., and EDWIN H. VAIL, JR., and cross-complainant was represented by its attorney JOHN S. TODD. Various defendants and cross-defendants were also represented at the trial. Evidence both oral and documentary was introduced. The trial continued from day to day on May 17, 18, 19, 20, 21 and 24, 1965, at which time it was continued by order of Court for further trial on August 25, 1965, at 10:00 a.m. in Department 73 of the above-entitled Court; whereupon, having then been transferred to Department 74, trial was resumed in Department 74 on August 25, 1965, and then continued to August 27, 1965 at 10:00 a.m. in the same Department. On the latter date, trial was concluded and the matter submitted. Findings of fact and conclu-sions of law have heretofore been signed and filed. Pursuant to the reserved and continuing jurisdiction of the court under the judgment herein, certain amendments to said judgment and temporary orders have heretofore been made and entered. Continuing jurisdiction of the court for this action is currently assigned to HON. FLORENCE T. PICKARD. Motion of Plaintiff herein for further amendments to the judgment, notice thereof and of the hearing thereon having been duly and regularly given to all parties, came on for hearing in Department 38 of the above-entitled court on MAY 6, 1991 at 8:45 a.m. before said HONORABLE PICKARD. Plaintiff was represented by its attorneys LAGERLOF, SENECAL, DRESCHER & SWIFT, by William F. Kruse. Various defendants were represented by counsel of record appearing on the Clerk's records. Hearing thereon was concluded on that date. The within "Second Amended Judgment" incorporates amendments and orders heretofore made to the extent presently operable and amendments pursuant to said last mentioned motion. To the extent this Amended judgment is a restatement of the judgment as heretofore amended, it is for convenience in incorporating all matters in one document, is not a readjudication of such matters and is not intended to reopen any such matters. As used hereinafter the word "judgment" shall include the original judgment as amended to date. In connection with the following judgment, the following terms, words, phrases and clauses are used by the Court with the following meanings:

"Administrative Year" means the water year until operation under the judgment is converted to a fiscal year pursuant to Paragraph 4, Part I, p. 53 hereof, whereupon it shall mean a fiscal year, including the initial 'short fiscal year' therein provided.

"Allowed Pumping Allocation" is that quantity in acre feet which the Court adjudges to be the maximum quantity which a party should be allowed to extract annually from Central Basin as set forth in part I hereof, which constitutes 80% of such party's Total Water Right.

"Allowed Pumping Allocation for a particular Administra- tive year" and "Allowed Pumping Allocation in the following Administrative year" and similar clauses, mean the Allowed Pumping Allocation as increased in a particular Administrative year by an authorized carryovers pursuant to Part III, Subpart A of this judgment and as reduced by reason of any over-extractions in a previous Administrative year.

"Artificial Replenishment" is the replenishment of Central Basin achieved through the spreading of imported or reclaimed water for percolation thereof into Central Basin by a governmental agency.

"Base Water Right" is the highest continuous extractions of water by a party from Central Basin for a beneficial use in any period of five consecutive years after the commencement of over-draft in Central Basin and prior to the commencement of this action, as to which there has been no cessation of use by that party during any subsequent period of five consecutive years. As employed in the above definition, the words "extractions of water by a party" and "cessation of use by that party" include such extractions and cessations by any predecessor or predecessors in interest.

"Calendar Year" is the twelve month period commencing January 1 of each year and ending December 31 of each year.

"Central Basin" is the underground water basin or reservoir underlying Central Basin Area, the exterior boundaries of which Central Basin are the same as the exterior boundaries of Central Basin Area.

"Central Basin Area" is the territory described in Appendix "1" to this judgment, and is a segment of the territory comprising Plaintiff District.

"Declared water emergency" shall mean a period commencing with the adoption of a resolution of the Board of Directors of the Central and West Basin Water Replenishment District declaring that conditions within the Central Basin relating to natural and imported supplies of water are such that, without implementation of the water emergency provision of this Judgment, the water resources of the Central Basin risk degradation. In making such declaration, the Board of Directors shall consider any information and requests provided by water producers, purveyors and other affected entities and may, for that purpose, hold a public hearing in advance of such declaration. A Declared Water Emergency shall extend for one (1) year following such resolution, unless sooner ended by similar resolution.

"Extraction", "extractions", "extracting", "extracted", and other variations of the same noun and verb, mean pumping, taking, diverting or withdrawing ground water by any manner or means whatsoever from Central Basin.

"Fiscal year" is the twelve (12) month period July 1 through June 30 following.

"Imported Water" means water brought into Central Basin Area from a non-tributary source by a party and any predecessors in interest, either through purchase directly from The Metropolitan Water District of Southern California or by direct purchase from a member agency thereof, and additionally as to the Department of Water and Power of the City of Los Angeles, water brought into Central Basin area by that party by means of the Owens River Aqueduct.

"Imported Water Use Credit" is the annual amount, computed on a calendar year basis, of imported water which any party and any predecessors in interest, who have timely made the required filings under Water Code Section 1005.1, have imported into Central Basin Area in any calendar year and subsequent to July 9, 1951, for beneficial use therein, but not exceeding the amount by which that party and any predecessors in interest reduces his or their extractions of ground water from Central Basin in that calendar year from the level of his or their extractions in the preceding calendar year, or in any prior calendar year not earlier than the calendar year 1950, whichever is the greater.

"Natural Replenishment" means and includes all processes other than "Artificial Replenishment" by which water may become a part of the ground water supply of Central Basin.

"Natural Safe Yield" is the maximum quantity of ground water, not in excess of the long term average annual quantity of Natural Replenishment, which may be extracted annually from Central Basin without eventual depletion thereof or without otherwise causing eventual permanent damage to Central Basin as a source of ground water for beneficial use, said maximum quantity being determined without reference to Artificial Replenishment.

"Overdraft" is that condition of a ground water basin resulting from extractions in any given annual period or periods in excess of the long term average annual quantity of Natural Replenishment, or in excess of that quantity which may be extracted annually without otherwise causing eventual permanent damage to the basin.

"Party" means a party to this action. Whenever the term "party" is used in connection with a quantitative water right, or any quantitative right, privilege or obligation, or in connection with the assessment for the budget of the Watermaster, it shall be deemed to refer collectively to those parties to whom are attributed a Total Water Right in Part I of this judgment.

"Person" or "persons" include individuals, partner-ships, associations, governmental agencies and corporations, and any and all types of entities.

"Total Water Right" is the quantity arrived at in the same manner as in the computation of "Base Water Right", but including as if extracted in any particular year the Imported Water Use Credit, if any, to which a particular party may be entitled.

"Water" includes only non-saline water, which is that having less than 1,000 parts of chlorides to 1,000,000 parts of water.

"Water Year" is the 12-month period commencing October 1 of each year and ending September 30th of the following year.

In those instances where any of the above-defined words, terms, phrases or clauses are utilized in the definition of any of the other above-defined words, terms, phrases and clauses, such use is with the same meaning as is above set forth.

NOW THEREFORE, IT IS ORDERED, DECLARED, ADJUDGED AND DECREED WITH RESPECT TO THE ACTION AND CROSS-ACTION AS FOLLOWS:

I. DECLARATION AND DETERMINATION OF WATER RIGHTS OF PARTIES; RESTRICTION ON THE EXERCISE THEREOF.[1]

1. Determination of Rights of Parties.

(a) Each party, except defendants, The City of Los Angeles and Department of Water and Power of the City of Los Angeles, whose name is hereinafter set forth in the tabulation at the conclusion of Subpart 3 of Part 1, and after whose name there appears under the column "Total Water Right" a figure other than "0", was the owner of and had the right to extract annually groundwater from Central Basin for beneficial use in the quantity set forth after that party's name under said column "Total Water Right" pursuant to the Judgment as originally entered herein. Attached hereto as Appendix "2" and by this reference made a part hereof as though fully set forth are the water rights of parties and successors in interest as they existed as

[1]headings in the judgment are for purposes of reference and the language of said headings do not constitute, other than for such purpose, a portion of this judgment.

of the close of the water year ending September 30, 1978 in accordance with the Watermaster Reports on file with this Court and the records of the Plaintiff. This tabulation does not take into account additions or subtractions from any Allowed Pumping Allocation of a producer for the 1978-79 water year, nor other adjustments not representing change in fee title to water rights, such as leases of water rights, nor does it include the names of lessees of landowners where the lessees are exercising the water rights. The exercise of all water rights is subject, however, to the provisions of this Judgment is hereinafter contained. All of said rights are of the same legal force and effect and are without priority with reference to each other. Each party whose name is hereinafter set forth in the tabulation set forth in Appendix "2" of this judgment, and after whose name there appears under the column "Total Water Right" the figure "0" owns no rights to extract any ground water from Central Basin, and has no right to extract any ground water from Central Basin.

(b) Defendant The City of Los Angeles is the owner of the right to extract fifteen thousand (15,000) acre feet per annum of ground water from Central Basin. Defendant Department of Water and Power of the City of Los Angeles has no right to extract ground water from Central Basin except insofar as it has the right, power, duty or obligation on behalf of defendant The City of Los Angeles to exercise the water rights in Central Basin of defendant The City of Los Angeles. The exercise of said rights are subject, however, to the provisions of this judgment hereafter contained, including but not limited to, sharing with other parties in any subsequent decreases or increases in the quantity of extractions permitted from Central Basin, pursuant to continuing jurisdiction of the Court, on the basis that fifteen thousand (15,000) acre feet bears to the Allowed Pumping Allocations of the other parties.

(c) No party to this action is the owner of or has any right to extract ground water from Central Basin except as herein affirmatively determined.

2. Parties Enjoined as Regards Quantities of Extractions.

(a) Each party, other than The State of California and The City of Los Angeles and Department of Water and Power of The City of Los Angeles, is enjoined and restrained in any Administrative year commencing after the date this judgment becomes final from extracting from Central Basin any quantity of Water greater than the party's Allowed Pumping Allocation as hereinafter set forth next to the name of the party in the tabulation appearing in Appendix 2 at the end of this Judgment, subject to further provisions of this judgment. Subject to such further provisions, the officials, agents and employees of The State of California are enjoined and restrained in any such Administrative year from extracting from Central Basin collectively any quantity of water greater than the Allowed Pumping Allocation of The State of California as hereinafter set forth next to the name of that party in the same tabulation. Each party adjudged and declared above not to be the owner of and not to have the right to extract ground water from Central Basin is enjoined and restrained in any Administrative year commencing after the date this judgment becomes final from extracting any ground water from Central Basin, except as may be hereinafter permitted to any such party under the Exchange Pool provisions of this judgment.

(b) Defendant The City of Los Angeles is enjoined and restrained in any Administrative year commencing after the date this judgment becomes final from extracting from Central Basin any quantity of water greater than fifteen thousand (15,000) acre feet, subject to further provisions of this judgment, including but not limited to, sharing with other parties in any subsequent decreases or increases in the quantity of extractions permitted from Central Basin by parties, pursuant to continuing jurisdiction of the Court, on the basis that fifteen thousand (15,000) acre feet bears to the Allowed Pumping Allocations of the other parties. Defendant Department of Water and Power of The City of Los Angeles is enjoined and restrained in any Administrative year commencing after the date this judgment becomes final from extracting from Central Basin any quantity of water other than such as it may extract on behalf of defendant The City of Los Angeles, and which extractions, along with any extractions by said City, shall not exceed that quantity permitted by this judgment to that City in any Administrative year. Whenever in this judgment the term "Allowed Pumping Allocation" appears, it shall be deemed to mean as to defendant The City of Los Angeles the quantity of fifteen thousand (15,000) acre feet.

10. Effect of this Amended Judgment on Orders Filed Herein. This Second Amended Judgment shall not abrogate such rights of additional carry-over of unused water rights as may otherwise exist pursuant to orders herein filed June 2, 1977 and September 29, 1977.

THE CLERK WILL ENTER THIS SECOND AMENDED JUDGMENT FORTHWITH.

DATED: May 6, 1991

/s/ Florence T. Packard
Judge of the Superior Court

Urban Water Management Plan
Appendix G

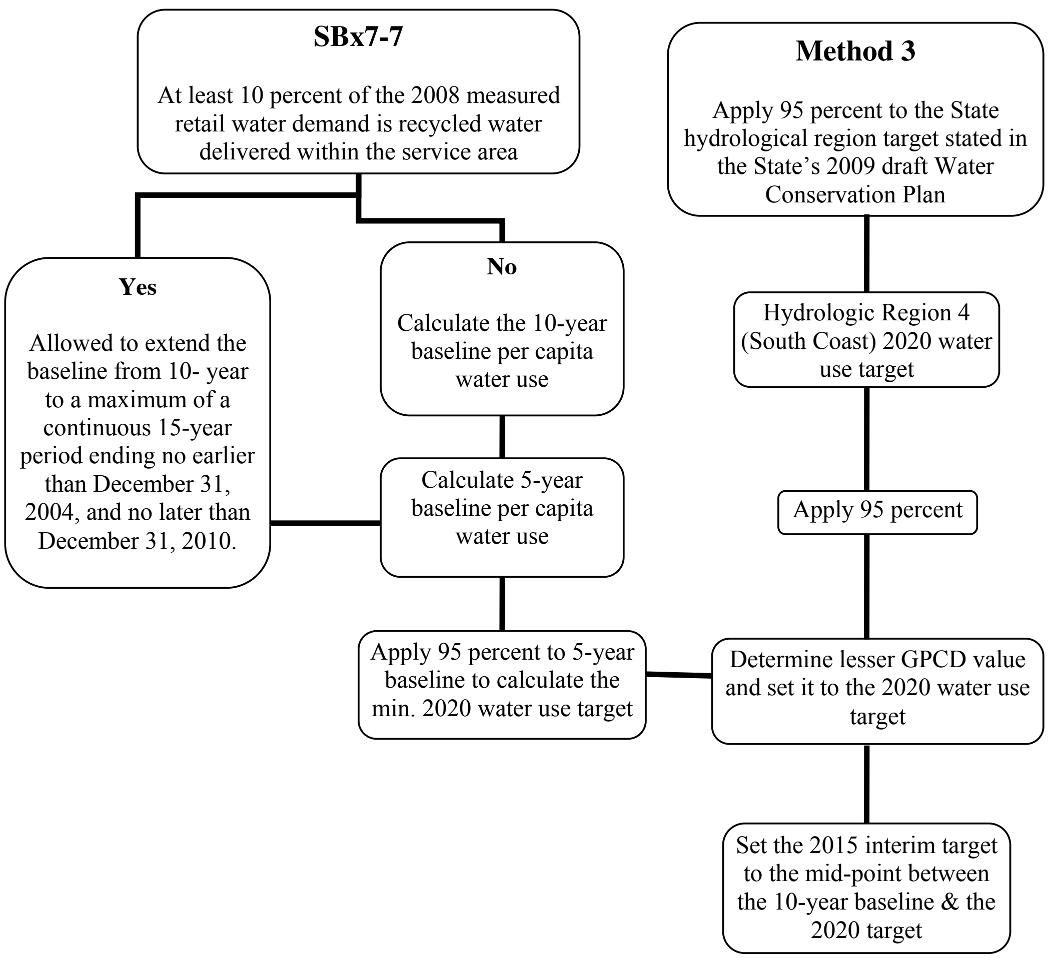
Calculating LADWP's 2020 Water Use Target

Calculating LADWP's Baseline and Compliance Urban Per Capita Water Use

Introduction of Method 3

As an urban retail water supplier, LADWP is required to calculate and report the 2020 water use target and the 2015 interim target in the Urban Water Management Plan. Four methods are stipulated for calculating the 2020 water use target in the Water Conservation Act of 2009, SBX7-7, which is also incorporated in the California Water Code.

LADWP selected Method 3 for the calculation. Using Method 3, 95 percent of the applicable state hydrologic region target, as stated in the State's draft 20x2020 Water Conservation Plan dated April 30, 2009, is set as the 2020 water use target. However, according to California Water Code Section 10608.22, the 2020 water use target shall be no less than 5 percent of the urban retail water supplier's 5-year base daily per capita water use (baseline) if this 5-year baseline is greater than 100 gallons per capita per day (GPCD). The 2015 interim target is the mid-point between the 10- or 15-year baseline and the 2020 water use target. The following flow chart illustrates how to determine the 2020 target and 2015 interim target with Method 3.



Determination of Hydrologic Region Water Use Target for LADWP

LADWP's service area is entirely located in the California State Hydrologic Region 4 – South Coast. As set forth in Table 8 of the State's draft 20x2020 Water Conservation Plan dated April 30, 2009, the 2020 water use target of Hydrologic Region 4 is 149 GPCD. LADWP's hydrologic region target is 142 GPCD or 95 percent of 149 GPCD.

Hydrologic Region Interim Target (2015)	165 GPCD
Hydrologic Region Target (2020)	149 GPCD
95% of the Hydrologic Region 4 Target	142 GPCD

LADWP's Base Daily Per Capita Water Use (Baseline)

As defined in California Water Code Section 10608.12 (b), the baseline is the average gross water use expressed in GPCD and calculated over a continuous, multiyear base period. The 10- or 15-year baseline shall be a continuous period ending no earlier than December 31, 2004, and no later than December 31, 2010.

For an urban retail water supplier that meets at least 10 percent of its 2008 measured retail water demand through recycled water, it has the option of using a 10-year period plus up to an additional 5 years to a maximum of 15-year period for baseline calculation. LADWP can only use the 10-year baseline since it does not meet this requirement.

The 5-year baseline is also calculated for determining the minimum water use reduction requirement if the 5-year baseline is greater than 100 GPCD per Section 10608.22. The 5-year baseline shall be a continuous period ending no earlier than December 31, 2007, and no later than December 31, 2010.

Gross Water Use

As defined in Section 10608.12 (g), LADWP's gross water use is the total volume of water entering the distribution system excluding the recycled water. All 4 LADWP's water sources: Los Angeles Aqueduct, local groundwater, MWD water, and recycled water, are metered before entering the distribution system.

Gross Water Use = LAA deliveries + Local Groundwater + MWD Water

or Total Water Supplies – Recycled Water

Service Area Population

LADWP's service area population is based on the city-level population estimates published by State of California, Department of Finance (DOF) in *E-8 Historical Population and Housing Estimates for Cities, Counties and the State, 1990-2000, August 2007 and E-4 Population Estimates for Cities, Counties and the State, 2001-2010, with 2000 Benchmark, May 2010.* The service area population is adjusted from the City population by adding approximately 28,000 persons who live outside the City limits but within LADWP's service area, and reducing approximately 2,000 persons who live within the City limits but outside LADWP's service area.

Service Area Population = City Population (DOF) + 28,000 – 2,000

LADWP's 10-Year Baseline

LADWP's 10-year baseline is calculated at 152 GPCD for the 10-year period beginning July 1, 1995 and ending June 30, 2005. It is used to determine the minimum water use reduction requirement per Section

10608.22. The following table shows the source data and the calculated annual GPCD for the 10-year period.

Fiscal Year Ending June 30	Total Water Supply (Acre-Feet) [1]	Recycled Water (Acre-Feet) [1]	Gross Water Use	City Population per DOF[2]	Service Area Population [3]	GPCD
1996	612,164	2,020	610,144	3,542,651	3,568,651	153
1997	630,013	1,747	628,265	3,558,227	3,584,227	156
1998	588,847	1,449	587,398	3,587,170	3,613,170	145
1999	621,063	1,596	619,467	3,627,878	3,653,878	151
2000	661,106	1,984	659,121	3,679,600	3,705,600	159
2001	659,955	2,082	675,873	3,744,806	3,770,806	156
2002	669,051	1,907	667,145	3,803,677	3,829,677	156
2003	652,299	1,635	650,664	3,855,069	3,881,069	150
2004	690,266	2,053	688,213	3,899,129	3,925,129	157
2005	615,572	1,500	614,072	3,929,022	3,955,022	139

[1] Operation records are based on meter reads.
[2] Per DOF *E-8 Historical Population and Housing Estimates for Cities, Counties and the State, 1990-2000, August 2007 and E-4 Population Estimates for Cities, Counties and the State, 2001-2010, with 2000 Benchmark, May 2010.*
[3] Adjustments made to reflect the addition of approximately 28,000 persons who live outside City limits but within Water System service area, and the reduction of approximately 2,000 persons who live within the City limits but outside LADWP's service area.

10-Year Baseline between FYE 1996-2005	152 GPCD

LADWP's 5-Year Baseline

The 5-year baseline is calculated at 145 GPCD for the 5-year period beginning July 1, 2004 and ending June 30, 2008. It is used to determine the minimum water use reduction requirement per Section 10608.22. The following table shows the source data and the calculated annual GPCD for the 5-year period.

Fiscal Year Ending June 30	Total Water Supply (Acre-Feet) [1]	Recycled Water (Acre-Feet) [1]	Gross Water Use	City Population per DOF[2]	Service Area Population [3]	GPCD
2004	690,266	2,053	688,213	3,899,129	3,925,129	157
2005	615,572	1,500	614,072	3,929,022	3,955,022	139
2006	627,612	1,417	626,194	3,960,385	3,986,385	140
2007	670,181	5,151	665,030	3,980,145	4,006,145	148
2008	649,822	4,181	645,641	4,016,085	4,042,085	143

[1] Operation records are based on meter reads.
[2] Per DOF *E-8 Historical Population and Housing Estimates for Cities, Counties and the State, 1990-2000, August 2007 and E-4 Population Estimates for Cities, Counties and the State, 2001-2010, with 2000 Benchmark, May 2010.*
[3] Adjustments made to reflect the addition of approximately 28,000 persons who live outside City limits but within Water System service area, and the reduction of approximately 2,000 persons who live within the City limits but outside LADWP's service area.

5-Year Baseline between FYE 2004-2008	145 GPCD

The 2020 Water Use Target and the 2015 Interim Water Use Target

According to California Water Code Section 10608.22, LADWP's 2020 water use target of 142 GPCD based on 95 percent of the hydrologic region target, shall be no less than 5 percent of the 5-year baseline of 145 GPCD, which is 138 GPCD. Therefore, LADWP's 2020 water use target shall be 138 GPCD. The 2015 interim target is the mid-point between the 10-year baseline of 152 GPCD and the 2020 water use target of 138 GPCD and is calculated at 145 GPCD per Section 10608.12 (j).

95% of the Hydrologic Region 4 Target	142 GPCD
95% of 5-Year Baseline	138 GPCD
2020 Target = the lesser of the two above	***138 GPCD***
10-Year Baseline	152 GPCD
2015 Interim Target = the midpoint between 10-Year Baseline & 2020 Target	***145 GPCD***

Urban Water Management Plan

Appendix H

CUWCC Biennal Reports

BMP Coverage Status Report 2007-2008

BMP 1 Coverage Requirement Status

Reporting Unit ID 152

Rep Unit Name: Los Angeles Dept. of Water and Power

Date MOU Signed: 9/12/1991

Reporting Period: 07-08

Rep Unit Category: Retail Only

RU indicated "At least as effective as" implementation during report period: No

RU filed an exemption for this BMP during report period: No exemption request filed

If exemption filed, type:

Exhibit 1 Coverage Requirement

An agency must meet three conditions to satisfy strict compliance for BMP 1.

Condition 1: Adopt survey targeting and marketing strategy on time
Condition 2: Offer surveys to 20% of SF accounts and 20% of MF units during report period
Condition 3: Be on track to survey 15% of SF accounts and 15% of MF units within 10 years of implementation start date.

Test For Condition 1

Latest Year RU to Implement Targeting/Marketing Program: 1999

	Single Family	Multi Family
Year RU Reported Implementing Targeting/Marketing Program:	1990	1990
RU Met Targeting/Marketing Coverage Requirement:	Yes	Yes

Test For Condition 2

Latest Year Survey Program to Start: 1998

Select a Reporting Period: 07-08

	Single Family	Multi Family
Res Survey Offers (%)	2.69%	1.73%
Survey Offers 20%	No	No

Test For Condition 3

	Completed Residential Surveys	
	Single Family	Multi Family
Total Completed Surveys through 2008	46,796	169,066
Credit for Surveys Completed Prior to Implementation of Reporting Database	53,384	67,216
Total + Credit	100,180	236,282
Res. Accounts in Base Year	464,661	724,199
RU Survey Coverage as % of Base Year Res Accounts	21.56%	32.63%
Coverage Requirement by Year 10 of Implementation per Exhibit 1	13.50%	13.50%
RU on Schedule to Meet 10 Year Coverage Requirement	Yes	Yes

BMP 1 Coverage Status Summary

Water supplier has met the coverage requirements for this BMP.

BMP 2 Coverage Requirement Status

Reporting Unit ID 152

Rep Unit Name: Los Angeles Dept. of Water and Power

Date MOU Signed: 9/12/1991

Reporting Period: 07-08

Rep Unit Category: Retail Only

RU indicated "At least as effective as" implementation during report period: No

RU filed an exemption for this BMP during report period: No exemption request filed

If exemption filed, type:

Exhibit 1 Coverage Requirement

An agency must meet **one** of three conditions to satisfy strict compliance for BMP 2.

Condition 1: The agency has demonstrated that 75% of SF accounts and 75% of MF units constructed prior to 1992 are fitted with low-flow showerheads.

Condition 2: An enforceable ordinance requiring the replacement of high-flow showerheads and other water use fixtures with their low-flow counterparts is in place for the agency's service area.

Condition 3: The agency has distributed or directly installed low-flow showerheads and other low-flow plumbing devices to not less than 10% of single-family accounts and 10% of multi-family units constructed prior to 1992 during the reporting period.

Test For Condition 1

Report Year	Report Period	Single Family Reported Saturation	Single Family Saturation 75%?	Multi Family Reported Saturation	Multi Family Saturation 75%?
1999	99-00	99	Yes	99	Yes
2000	99-00	99	Yes	99	Yes
2001	01-02	99	Yes	99	Yes
2002	01-02	99	Yes	99	Yes
2003	03-04	99	Yes	99	Yes
2004	03-04	99	Yes	99	Yes
2005	05-06	99	Yes	99	Yes
2006	05-06	99	Yes	99	Yes
2007	07-08	99	Yes	99	Yes
2008	07-08	99	Yes	99	Yes

BMP 2 Coverage Requirement Status

Test For Condition 2

Report Year	Report Period	RU has ordinance requiring showerhead retrofit?
1999	99-00	Yes
2000	99-00	Yes
2001	01-02	Yes
2002	01-02	Yes
2003	03-04	Yes
2004	03-04	Yes
2005	05-06	Yes
2006	05-06	Yes
2007	07-08	Yes
2008	07-08	Yes

Test For Condition 3

1992 SF Accounts	Num. Showerheads Distributed to SF Accounts	Single Family Coverage Ratio	SF Coverage Ratio 10%
462,000	11,506	2.5%	No

1992 MF Accounts	Num. Showerheads Distributed to MF Accounts	Multi Family Coverage Ratio	MF Coverage Ratio 10%
710,000	37,083	5.2%	No

BMP 2 Coverage Status Summary

Water supplier has met the coverage requirements for this BMP.

BMP 3 Coverage Requirement Status

Reporting Unit ID 152

Rep Unit Name: Los Angeles Dept. of Water and Power

Date MOU Signed: 9/12/1991

Reporting Period: 07-08

Rep Unit Category: Retail Only

RU indicated "At least as effective as" implementation during report period: No

RU filed an exemption for this BMP during report period: No exemption request filed

If exemption filed, type:

Exhibit 1 Coverage Requirement

An agency must meet one of two conditions to be in compliance with BMP 3:

Condition 1: Perform a prescreening audit. If the result is equal to or greater than 0.9 nothing more needs be done.

Condition 2: Perform a prescreening audit. If the result is less than 0.9, perform a full audit in accordance with AWWA's Manual of Water Supply Practices, Water Audits, and Leak Detection.

RU operates a water distribution system: Yes

Tests For Conditions 1 and 2

Report Year	Report Period	Pre Screen Completed	Pre Screen Result	Full Audit Indicated	Full Audit Completed
1999	99-00	Yes	93.8%	No	No
2000	99-00	Yes	91.8%	No	No
2001	01-02	No			No
2002	01-02	No			No
2003	03-04	No			No
2004	03-04	No			No
2005	05-06	No			No
2006	05-06	No			No
2007	07-08	Yes	95.2%	No	No
2008	07-08	Yes	94.3%	No	No

BMP 3 Coverage Status Summary

Water supplier has met the coverage requirements for this BMP.

BMP 4 Coverage Requirement Status

Reporting Unit ID 152

Rep Unit Name: Los Angeles Dept. of Water and Power

Date MOU Signed: 9/12/1991

Reporting Period: 07-08

Rep Unit Category: Retail Only

RU indicated "At least as effective as" implementation during report period: No

RU filed an exemption for this BMP during report period: No exemption request filed

If exemption filed, type:

Exhibit 1 Coverage Requirement

For agencies signing the MOU prior to December 31, 1997:

100% of existing unmetered accounts to be metered and billed by volume of use by July 1, 2009.

For agencies signing the MOU after December 31, 1997:

100% of existing unmetered accounts to be metered and billed by volume of use by July 1, 2012 OR within six years of signing the MOU (whichever date is later). All retrofits must be completed no later than one year prior to the requirements of state law (January 1, 2025).

Tests For Compliance

Total Meter Retrofits Reported through 2008	0
No. of Unmetered Accounts in Base Year	159
Meter Retrofit Coverage as % of Base Year Unmetered Accounts	0.0%
Coverage Requirement by Year 10 of Implementation	90.0%
RU on Schedule to Meet 10 Year Coverage Requirement	Yes

BMP 4 Coverage Status Summary

Water supplier has met the coverage requirements for this BMP.

BMP 5 Coverage Requirement Status

Reporting Unit ID 152

Rep Unit Name: Los Angeles Dept. of Water and Power

Date MOU Signed: 9/12/1991

Reporting Period: 07-08

Rep Unit Category: Retail Only

RU filed an exemption for this BMP during report period: No exemption request filed

If exemption filed, type:

RU indicated "At least as effective as" implementation during report period: Yes

Exhibit 1 Coverage Requirement

An agency must meet three conditions to comply with BMP 5.

Condition 1: Develop water budgets for 90% of its dedicated landscape meter accounts within four years of the date implementation is to start.

Condition 2: (a) Offer landscape surveys to at least 20% of its CII accounts with mixed use meters each report cycle and be on track to survey at least 15% of its CII accounts with mixed use meters within 10 years of the date implementation is to start OR (b) Implement a dedicated landscape meter retrofit program for CII accounts with mixed use meters or assign landscape budgets to mixed use meters.

Condition 3: Implement and maintain customer incentive program(s) for irrigation equipment retrofits.

Test For Condition 1

Report Year	Report Period	BMP 5 Implementation Year	No. of Irrigation Meter Accounts	No. of Irrigation Accounts with Budgets	Budget Coverage Ratio	90% Coverage Met by Year 4
1999	99-00	0	952	37	0.04	NA
2000	99-00	1	1198	118	0.10	NA
2001	01-02	2	949	132	0.14	NA
2002	01-02	3	949	175	0.18	NA
2003	03-04	4	955	249	0.26	No
2004	03-04	5	956	250	0.26	No
2005	05-06	6	879	252	0.29	No
2006	05-06	7	743	256	0.34	No
2007	07-08	8	745	258	0.35	No
2008	07-08	9	766	269	0.35	No

Test For Condition 2a (survey offers)

Select Reporting Period: 07-08

Large Landscape Survey Offers as % of Mixed Use Meter CII Accounts: 0.0%

Survey Offers Equal or Exceed 20% Coverage Requirement: No

BMP 5 Coverage Requirement Status

Test For Condition 2a (surveys completed)

Total Completed Landscape Surveys Reported through 2008	530
Credit for Surveys Completed Prior to Implementation of Reporting Database	114
Total + Credit	644
CII Accounts with Mixed Use Meters in Base Year	74,316
RU Survey Coverage as % of Base Year CII Accounts	0.9%
Coverage Requirement by Year 9 of Implementation per Exhibit 1	11.5%
RU on Schedule to Meet 10 Year Coverage Requirement	No

Test For Condition 2b (mixed use budget or meter retrofit program)

Report Year	Report Period	BMP 5 Implementation Year	Agency has mix-use budget program	No. of mixed-use budgets
1999	99-00	0	no	0
2000	99-00	1	no	0
2001	01-02	2	no	
2002	01-02	3	no	
2003	03-04	4	no	0
2004	03-04	5	no	0
2005	05-06	6	no	0
2006	05-06	7	no	0
2007	07-08	8	no	0
2008	07-08	9	no	0

Report Year	Report Period	BMP 4 Implementation Year	No. of mixed use CII accounts	No. of mixed use CII accounts fitted with irrig. meters
1999	99-00	1	74500	0
2000	99-00	2	71768	0
2001	01-02	3	76866	0
2002	01-02	4	77165	0
2003	03-04	5	76616	0
2004	03-04	6	77144	0
2005	05-06	7	62479	0
2006	05-06	8	63735	0
2007	07-08	9	60437	0
2008	07-08	10	60327	0

BMP 5 Coverage Requirement Status

Test For Condition 3

Report Year	Report Period	BMP 5 Implementation Year	RU offers financial incentives?	Loans No.	Loans Total Amount	Grants No.	Grants Total Amount	Rebates No.	Rebates Total Amount
1999	99-00	0	yes	0	0	0	0	1	1050
2000	99-00	1	yes	0	0	0	0	1	1740
2001	01-02	2	yes	0	0	0	0	4	133900
2002	01-02	3	yes	0	0	31	120000	5	22475
2003	03-04	4	yes	0	0	0	0	2	11624
2004	03-04	5	yes	0	0	0	0	5	21542
2005	05-06	6	yes	0	0	0	0	4	58760
2006	05-06	7	yes	0	0	16	80000	0	0
2007	07-08	8	yes	0	0	0	0	0	0
2008	07-08	9	yes	0	0	0	0	1	8538

BMP 5 Coverage Status Summary

Water supplier has selected an "At Least As Effective As" option for this BMP.

BMP 6 Coverage Requirement Status

Reporting Unit ID 152

Rep Unit Name: Los Angeles Dept. of Water and Power

Date MOU Signed: 9/12/1991

Reporting Period: 07-08

Rep Unit Category: Retail Only

RU indicated "At least as effective as" implementation during report period: No

RU filed an exemption for this BMP during report period: No exemption request filed

If exemption filed, type:

Pre-2004 Exhibit 1 Coverage Requirement

An agency must meet one condition to comply with BMP 6.

Condition 1: Offer a cost-effective financial incentive for high-efficiency washers if one or more energy service providers in service area offer financial incentives for high-efficiency washers.

Revised Exhibit 1 Coverage Requirement

An agency must meet two conditions to comply with BMP 6.

Condition 1: Offer cost-effective financial incentives for high-efficiency washers with Water Factors of 9.5 or less.

Condition 2: Meet Coverage Goal (CG=Total Dwelling Units x 0.0768) by July 1, 2008. Agencies signing the MOU after July 1, 2003, shall have a prorated Coverage Goal, based on implementation period of less than 4.0 years.

Test For Condition 1

Agency offered cost-effective financial incentives for high-efficiency washers with Water Factors of 9.5 or less: yes

Test For Condition 2

Coverage Goal:	91,304
Total Coverage Points Awarded (incl. past credit):	110,989
% of Coverage Goal:	121.6%

BMP 6 Coverage Status Summary

Water supplier has met the coverage requirements for this BMP.

BMP 7 Coverage Requirement Status

Reporting Unit ID 152

Rep Unit Name: Los Angeles Dept. of Water and Power

Date MOU Signed: 9/12/1991

Reporting Period: 07-08

Rep Unit Category: Retail Only

RU indicated "At least as effective as" implementation during report period: No

RU filed an exemption for this BMP during report period: No exemption request filed

If exemption filed, type:

Exhibit 1 Coverage Requirement

An agency must meet one condition to comply with BMP 7.

Condition 1: Implement and maintain a public information program consistent with BMP 7's definition.

Test For Condition 1:07-08

Report Year	Report Period	BMP 7 Implementation Year	RU Has Public Information Program
1999	99-00	1	Yes
2000	99-00	2	Yes
2001	01-02	3	Yes
2002	01-02	4	Yes
2003	03-04	5	Yes
2004	03-04	6	Yes
2005	05-06	7	Yes
2006	05-06	8	Yes
2007	07-08	9	Yes
2008	07-08	10	Yes

BMP 7 Coverage Status Summary

Water supplier has met the coverage requirements for this BMP.

BMP 8 Coverage Requirement Status

Reporting Unit ID 152

Rep Unit Name: Los Angeles Dept. of Water and Power

Date MOU Signed: 9/12/1991

Reporting Period: 07-08

Rep Unit Category: Retail Only

RU indicated "At least as effective as" implementation during report period: No

RU filed an exemption for this BMP during report period: No exemption request filed

If exemption filed, type:

Exhibit 1 Coverage Requirement

An agency must meet one condition to comply with BMP 8.

Condition 1: Implement and maintain a school education program consistent with BMP 8's definition.

Test For Condition 1

Report Year	Report Period	BMP 8 Implementation Year	RU Has School Education Program
1999	99-00	1	Yes
2000	99-00	2	Yes
2001	01-02	3	Yes
2002	01-02	4	Yes
2003	03-04	5	Yes
2004	03-04	6	Yes
2005	05-06	7	Yes
2006	05-06	8	Yes
2007	07-08	9	Yes
2008	07-08	10	Yes

BMP 8 Coverage Status Summary

Water supplier has met the coverage requirements for this BMP.

BMP 9 Coverage Requirement Status

Reporting Unit ID 152

Rep Unit Name: Los Angeles Dept. of Water and Power

Date MOU Signed: 9/12/1991

Reporting Period: 07-08

Rep Unit Category: Retail Only

RU indicated "At least as effective as" implementation during report period: No

RU filed an exception for this BMP during report period: No exemption request filed

If exemption filed, type:

Exhibit 1 Coverage Requirement

An agency must meet two conditions to comply with BMP 9.

Condition 1: Agency has identified and ranked by use commercial, industrial, and institutional accounts.

Condition 2(a): Agency is on track to survey 10% of commercial accounts, 10% of industrial accounts, and 10% of institutional accounts within 10 years of date implementation to commence.

OR

Condition 2(b): Agency is on track to reduce CII water use by an amount equal to 10% of baseline use within 10 years of date implementation to commence.

OR

Condition 2(c): Agency is on track to meet the combined target as described in Exhibit 1 BMP 9 documentation.

Test For Condition 1

Ranked Commercial Customers	yes
Ranked Industrial Customers	yes
Ranked Institutional Customers	yes
Rank Coverage Met	Yes

Test For Condition 2a

	Commercial	Industrial	Institutional
Total Completed Surveys Reported through 2008	248	51	32
Credit for Surveys Completed Prior to Implementation of Reporting Database	32	3	8
Total + Credit	280	54	40
CII Accounts in Base Year	59,649	7,298	7,369
RU Survey Coverage as % of Base Year CII Accounts	0.5%	0.7%	0.5%
Coverage Requirement by Year 9 of Implementation per Exhibit 1	7.7%	7.7%	7.7%
RU on Schedule to Meet 10 Year Coverage Requirement	No	No	No

BMP 9 Coverage Requirement Status

Test For Condition 2b

Coverage Year	Performance Target Savings (AF/Yr)	Performance Target Savings Coverage	Performance Target Savings Coverage Requirement	Coverage Requirement Met
1999	5,097	3%	0.5%	Yes
2000	8,383	5%	1%	Yes
2001	12,281	8%	1.7%	Yes
2002	16,716	10%	2.4%	Yes
2003	21,743	14%	3.3%	Yes
2004	28,619	18%	4.2%	Yes
2005	29,420	18%	5.3%	Yes
2006	33,135	21%	6.4%	Yes
2007	33,819	21%	7.7%	Yes
2008	34,673	22%	9%	Yes

Test For Condition 2c

Total BMP 9 Surveys + Credit	374
BMP 9 Survey Coverage	0.5%
BMP 9 Performance Target Coverage	21.7%
BMP 9 Survey + Performance Target Coverage	22.2%
Combined Coverage Equals or Exceeds BMP 9 Survey Coverage Requirement?	Yes

BMP 9 Coverage Status Summary

Water supplier has met the coverage requirements for this BMP.

BMP 11 Coverage Requirement Status

Reporting Unit ID 152

Rep Unit Name: Los Angeles Dept. of Water and Power

Date MOU Signed: 9/12/1991

Reporting Period: 07-08

Rep Unit Category: Retail Only

RU indicated "At least as effective as" implementation during report period: No

RU filed an exception for this BMP during report period: No exemption request filed

If exemption filed, type:

Exhibit 1 Coverage Requirement

Agency shall maintain rate structure consistent with BMP 11's definition of conservation pricing.

Test For Compliance

Fully metered?	Yes
Water Coverage Met?	Yes
Provide Sewer Service?	No
Sewer Coverage Met?	Yes

BMP 11 Coverage Status Summary

Water supplier has met the coverage requirements for this BMP.

BMP 11 Sewer Coverage Status Summary

Agency does not provide sewer service

BMP 12 Coverage Requirement Status

Reporting Unit ID 152

Rep Unit Name: Los Angeles Dept. of Water and Power

Date MOU Signed: 9/12/1991

Reporting Period: 07-08

Rep Unit Category: Retail Only

RU indicated "At least as effective as" implementation during report period: No

RU filed an exemption for this BMP during report period: No exemption request filed

If exemption filed, type:

Exhibit 1 Coverage Requirement

Agency shall staff and maintain the position of conservation coordinator and provide support staff as necessary.

Test For Compliance

Report Year	Report Period	Conservation Coordinator Position Staffed?	Total Staff on Team (incl. CC)
1999	99-00	yes	6
2000	99-00	yes	5
2001	01-02	yes	5
2002	01-02	yes	6
2003	03-04	yes	6
2004	03-04	yes	6
2005	05-06	yes	6
2006	05-06	yes	6
2007	07-08	yes	5
2008	07-08	yes	5

BMP 12 Coverage Status Summary

Water supplier has met the coverage requirements for this BMP.

BMP 13 Coverage Requirement Status

Reporting Unit ID 152

Rep Unit Name: Los Angeles Dept. of Water and Power

Date MOU Signed: 9/12/1991

Reporting Period: 07-08

Rep Unit Category: Retail Only

RU indicated "At least as effective as" implementation during report period: No

RU filed an exemption for this BMP during report period: No exemption request filed

If exemption filed, type:

Exhibit 1 Coverage Requirement

Implementation methods shall be enacting and enforcing measures prohibiting gutter flooding, single pass cooling systems in new connections, non-recirculating systems in all new conveyer car wash and commercial laundry systems, and non-recycling decorative water fountains.

Test For Compliance

Agency or service area prohibits:

Report Year	Gutter Flooding	Single-Pass Cooling Systems	Single-Pass Car Wash	Single-Pass Laundry	Single-Pass Fountains	Other	RU has ordinance that meets coverage requirement
1999	yes	no	no	no	yes	yes	No
2000	yes	no	no	no	yes	yes	No
2001	yes	no	no	no	yes	yes	No
2002	yes	no	no	no	yes	yes	No
2003	yes	no	no	no	yes	yes	No
2004	yes	no	no	no	yes	yes	No
2005	yes	no	no	no	yes	yes	No
2006	yes	no	no	no	yes	yes	No
2007	yes	Yes	Yes	Yes	yes	yes	Yes
2008	yes	Yes	Yes	Yes	yes	yes	Yes

BMP 13 Coverage Status Summary

Water supplier has met the coverage requirements for this BMP.

BMP 14 Coverage Requirement Status

Reporting Unit ID: 152

Base Year: 1997

Rep Unit Name: Los Angeles Dept. of Water and Power

Rep Unit Category: Retail Only

Exhibit 1 Coverage Requirement

An agency must meet one of the following conditions to be in compliance with BMP 14.

Condition 1: Retrofit-on-resale (ROR) in effect in service area
Condition 2: Water savings from toilet replacement programs equal to 90% of Exhibit 6 coverage requirement.

An agency with an exemption for BMP 14 is not required to meet one of the above conditions.
The report treats an agency with missing base year data required to compute the Exhibit 6 coverage requirement as out of compliance with BMP 14.

Coverage Year	BMP 14 Data Submitted to CUWCC	Exemption Filed with CUWCC	ALAEA	ROR Ordinance in Effect	Exhibit 6 Coverage Req'mt (AF)	Toilet Replacement Program Water Savings (AF)
1999	☒	☐	☐	☒	3,511	159,92
2000	☒	☐	☐	☒	9,987	188,96
2001	☒	☐	☐	☒	18,948	219,42
2002	☒	☐	☐	☒	29,980	250,86
2003	☒	☐	☐	☒	42,721	282,87
2004	☒	☐	☐	☒	56,857	315,57
2005	☒	☐	☐	☒	72,115	348,59
2006	☒	☐	☐	☒	88,259	381,44
2007	☒	☐	☐	☒	105,08	413,69
2008	☒	☐	☐	☒	122,41	444,64

BMP 14 Coverage Status Summary: 2010

Water supplier has met the coverage requirements for this BMP.

2007 CUWCC Biennial Report

Water Supply & Reuse

Reporting Unit: Year:
Los Angeles Dept. of Water and Power **2007**

Water Supply Source Information

Supply Source Name	Quantity (AF) Supplied	Supply Type
LA Aqueduct	277942	Imported
MWDSC	295602	Imported
Groundwater	88906	Groundwater
Recycled	5186	Recycled
Transfer	1136	Imported
Storage	242	Imported

Total AF: 669014

Reported as of 6/10/10

Accounts & Water Use

Reporting Unit Name:	Submitted to CUWCC	Year:
Los Angeles Dept. of Water and Power	**02/08/2009**	**2007**

What is the reporting year?	Fiscal	**Month Ending**	June

A. Service Area Population Information:

1. Total service area population 4044080

B. Number of Accounts and Water Deliveries (AF)

Type	Metered		Unmetered	
	No. of Accounts	Water Deliveries (AF)	No. of Accounts	Water Deliveries (AF)
1. Single-Family	481908	261323	0	0
2. Multi-Family	123597	188149	0	0
3. Commercial	72130	114298	0	0
4. Industrial	6867	21838	0	0
5. Institutional	7403	48320	0	0
6. Dedicated Irrigation	745	248	0	0
7. Recycled Water	42	6509	0	0
8. Other	0	0	0	0
9. Unaccounted	NA	32080	NA	0
Total	692692	672765	0	0
	Metered		**Unmetered**	

Reported as of 6/10/10

BMP 01: Water Survey Programs for Single-Family and Multi-Family Residential Customers

Reporting Unit:	BMP Form Status:	Year:
Los Angeles Dept. of Water and Power	**100% Complete**	**2007**

A. Implementation

1. Based on your signed MOU date, 09/12/1991, your Agency STRATEGY DUE DATE is:	09/11/1993
2. Has your agency developed and implemented a targeting/ marketing strategy for SINGLE-FAMILY residential water use surveys?	yes
a. If YES, when was it implemented?	06/01/1990
3. Has your agency developed and implemented a targeting/ marketing strategy for MULTI-FAMILY residential water use surveys?	yes
a. If YES, when was it implemented?	06/01/1990

B. Water Survey Data

Single

Survey Counts:	Family Accounts	Multi-Family Units
1. Number of surveys offered:	12500	12500
2. Number of surveys completed:	5444	9913
Indoor Survey:		
3. Check for leaks, including toilets, faucets and meter checks	yes	yes
4. Check showerhead flow rates, aerator flow rates, and offer to replace or recommend replacement, if necessary	yes	yes
5. Check toilet flow rates and offer to install or recommend installation of displacement device or direct customer to ULFT replacement program, as neccesary; replace leaking toilet flapper, as necessary	yes	yes
Outdoor Survey:		
6. Check irrigation system and timers	no	no
7. Review or develop customer irrigation schedule	no	no
8. Measure landscaped area (Recommended but not required for surveys)	no	no
9. Measure total irrigable area (Recommended but not required for surveys)	no	no
10. Which measurement method is typically used (Recommended but not required for surveys)		None
11. Were customers provided with information packets that included evaluation results and water savings recommendations?	no	no
12. Have the number of surveys offered and completed, survey results, and survey costs been tracked?	yes	no
a. If yes, in what form are surveys tracked?		database

b. Describe how your agency tracks this information.

Contractor reporting & invoice support documentation

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Period: FY 06-07. Interior assessments with installation of devices as needed (ULFTs, showerheads, aerators, flappers). Direct and indirect marketing for MF segment

Reported as of 6/10/10

BMP 02: Residential Plumbing Retrofit

Reporting Unit:

Los Angeles Dept. of Water and Power	BMP Form Status: **100% Complete**	Year: **2007**

A. Implementation

1. Is there an enforceable ordinance in effect in your service area requiring replacement of high-flow showerheads and other water use fixtures with their low-flow counterparts?	yes

a. If YES, list local jurisdictions in your service area and code or ordinance in each:

City of Los Angeles "Water Closet, Urinal and Showerhead Regulations-Retrofit on Resale" Ordinance (No. 172075)

2. Has your agency satisfied the 75% saturation requirement for single-family housing units?	yes
3. Estimated percent of single-family households with low-flow showerheads:	99%
4. Has your agency satisfied the 75% saturation requirement for multi-family housing units?	yes
5. Estimated percent of multi-family households with low-flow showerheads:	99%

6. If YES to 2 OR 4 above, please describe how saturation was determined, including the dates and results of any survey research.

LA enacted an ordinance requiring all LADWP customers to install low flow showerheads & have installations certified or incur financial penalties for non-compliance. 99+% of LADWP customers have demonstrated compliance

B. Low-Flow Device Distribution Information

1. Has your agency developed a targeting/ marketing strategy for distributing low-flow devices?	yes
a. If YES, when did your agency begin implementing this strategy?	07/01/1988

b. Describe your targeting/ marketing strategy.

Direct mail to all SF customers; element of all survey pgms; req'd per L.A. ordinance; provided upon request to any residential customer; distributed with program ULFTs.

Low-Flow Devices Distributed/ Installed	SF Accounts	MF Units
2. Number of low-flow showerheads distributed:	7694	24187
3. Number of toilet-displacement devices distributed:	3	0
4. Number of toilet flappers distributed:	118	1658
5. Number of faucet aerators distributed:	9395	38148

6. Does your agency track the distribution and cost of low-flow devices?	yes
a. If YES, in what format are low-flow devices tracked?	Database

b. If yes, describe your tracking and distribution system :

Tracking: in-house inventory control; contractor invoices & support documentation. Distribution: direct install by CBOs; distribution by CBOs & through Conservation office.

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Direct install accounts for vast majority of devices and cost.
Showerheads are 2.0 gpm

Reported as of 6/10/10

BMP 03: System Water Audits, Leak Detection and Repair

Reporting Unit:	BMP Form Status:	Year:
Los Angeles Dept. of Water and Power	**100% Complete**	**2007**

A. Implementation

1. Does your agency own or operate a water distribution system?	yes
2. Has your agency completed a pre-screening system audit for this reporting year?	Yes
3. If YES, enter the values (AF/Year) used to calculate verifiable use as a percent of total production:	
a. Determine metered sales (AF)	634178
b. Determine other system verifiable uses (AF)	0
c. Determine total supply into the system (AF)	666258
d. Using the numbers above, if (Metered Sales + Other Verifiable Uses) / Total Supply is < 0.9 then a full-scale system audit is required.	0.95
4. Does your agency keep necessary data on file to verify the values entered in question 3?	yes
5. Did your agency complete a full-scale audit during this report year?	no
6. Does your agency maintain in-house records of audit results or completed AWWA M36 audit worksheets for the completed audit which could be forwarded to CUWCC?	yes
7. Does your agency operate a system leak detection program?	no
a. If yes, describe the leak detection program:	

B. Survey Data

1. Total number of miles of distribution system line.	7228
2. Number of miles of distribution system line surveyed.	0

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Voluntary Questions (Not used to calculate compliance)

E. Volumes

	Estimated	Verified
1. Volume of raw water supplied to the system:		
2. Volume treated water supplied into the system:		
3. Volume of water exported from the system:		
4. Volume of billed authorized metered consumption:		

5. Volume of billed authorized unmetered consumption:

6. Volume of unbilled authorized metered consumption:

7. Volume of unbilled authorized unmetered consumption:

F. Infrastructure and Hydraulics

1. System input (source or master meter) volumes metered at the entry to the:

2. How frequently are they tested and calibrated?

3. Length of mains:

4. What % of distribution mains are rigid pipes (metal, ac, concrete)?

5. Number of service connections:

6. What % of service connections are rigid pipes (metal)?

7. Are residential properties fully metered?

8. Are non-residential properties fully metered?

9. Provide an estimate of customer meter under-registration:

10. Average length of customer service line from the main to the point of the meter:

11. Average system pressure:

12. Range of system pressures: From to

13. What percentage of the system is fed from gravity feed?

14. What percentage of the system is fed by pumping and re-pumping?

G. Maintenance Questions

1. Who is responsible for providing, testing, repairing and replacing customer meters?

2. Does your agency test, repair and replace your meters on a regular timed schedule?

a. If yes, does your agency test by meter size or customer category?:

b. If yes to meter size, please provide the frequency of testing by meter size:

Less than or equal to 1"

1.5" to 2"

3" and Larger

c. If yes to customer category, provide the frequency of testing by customer category:

SF residential

MF residential

Commercial

Industrial & Institutional

3. Who is responsible for repairs to the customer lateral or customer service line?

4. Who is responsible for service line repairs downstream of the customer meter?

5. Does your agency proactively search for leaks using leak

survey techniques or does your utility reactively repair leaks which are called in, or both?

6. What is the utility budget breakdown for:

Leak Detection	$
Leak Repair	$
Auditing and Water Loss Evaluation	$
Meter Testing	$

H. Comments

Reported as of 6/10/10

BMP 04: Metering with Commodity Rates for all New Connections and Retrofit of Existing

Reporting Unit:	BMP Form Status:	Year:
Los Angeles Dept. of Water and Power	**100% Complete**	**2007**

A. Implementation

1. Does your agency have any unmetered service connections?	No
a. If YES, has your agency completed a meter retrofit plan?	
b. If YES, number of previously unmetered accounts fitted with meters during report year:	
2. Are all new service connections being metered and billed by volume of use?	Yes
3. Are all new service connections being billed volumetrically with meters?	Yes
4. Has your agency completed and submitted electronically to the Council a written plan, policy or program to test, repair and replace meters?	Yes

5. Please fill out the following matrix:

Account Type	Number of Metered Accounts	Number of Metered Accounts Read	Number of Metered Accounts Billed by Volume	Billing Frequency Per Year	Number of Volume Estimates
a. Single Family	483433	483433	483433	6	0
b. Multi-Family	121693	121693	121693	6	0
c. Commercial	60327	60327	60327	12	0
d. Industrial	6552	6552	6552	12	0
e. Institutional	6707	6707	6707	12	0
f. Landscape Irrigation	766	766	766	12	0

B. Feasibility Study

1. Has your agency conducted a feasibility study to assess the merits of a program to provide incentives to switch mixed-use accounts to dedicated landscape meters?	no
a. If YES, when was the feasibility study conducted? (mm/dd/yy)	

b. Describe the feasibility study:

2. Number of CII accounts with mixed-use meters:	60437
3. Number of CII accounts with mixed-use meters retrofitted with dedicated irrigation meters during reporting period.	0

C. "At Least As Effective As"

1. Is your agency implementing an "at least as effective as" variant of this BMP?	No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Fire services are metered; hydrants are not.

BMP 05: Large Landscape Conservation Programs and Incentives

Reporting Unit: **Los Angeles Dept. of Water and Power**	BMP Form Status: **100% Complete**	Year: **2007**

A. Water Use Budgets

1. Number of Dedicated Irrigation Meter Accounts:	745
2. Number of Dedicated Irrigation Meter Accounts with Water Budgets:	258
3. Budgeted Use for Irrigation Meter Accounts with Water Budgets (AF):	0
4. Actual Use for Irrigation Meter Accounts with Water Budgets (AF):	0
5. Does your agency provide water use notices to accounts with budgets each billing cycle?	yes

B. Landscape Surveys

1. Has your agency developed a marketing / targeting strategy for landscape surveys?	yes
a. If YES, when did your agency begin implementing this strategy?	6/10/1996

b. Description of marketing / targeting strategy:

Work with LA Dept Rec & Parks, school district to audit and provide audit training. All accts applying for landscape incentives also audited. Review consumption history for excess use.

2. Number of Surveys Offered.	15
3. Number of Surveys Completed.	11

4. Indicate which of the following Landscape Elements are part of your survey:

a. Irrigation System Check	yes
b. Distribution Uniformity Analysis	yes
c. Review / Develop Irrigation Schedules	yes
d. Measure Landscape Area	yes
e. Measure Total Irrigable Area	yes
f. Provide Customer Report / Information	yes

5. Do you track survey offers and results?	yes
6. Does your agency provide follow-up surveys for previously completed surveys?	yes

a. If YES, describe below:

Accounts with poor distribution uniformity re-audited after system improvements completed

C. Other BMP 5 Actions

1. An agency can provide mixed-use accounts with ETo-based landscape budgets in lieu of a large landscape survey program. Does your agency provide mixed-use accounts with landscape budgets?	no
2. Number of CII mixed-use accounts with landscape budgets.	0
3. Do you offer landscape irrigation training?	yes
4. Does your agency offer financial incentives to improve landscape water use efficiency?	yes

Type of Financial Incentive:	Budget (Dollars/ Year)	Number Awarded to Customers	Total Amount Awarded
a. Rebates	100000	0	0
b. Loans	0	0	0
c. Grants	80000	0	0

5. Do you provide landscape water use efficiency information to new customers and customers changing services?	No
a. If YES, describe below:	
6. Do you have irrigated landscaping at your facilities?	yes
a. If yes, is it water-efficient?	yes
b. If yes, does it have dedicated irrigation metering?	yes
7. Do you provide customer notices at the start of the irrigation season?	no
8. Do you provide customer notices at the end of the irrigation season?	no

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	Yes

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

The Los Angeles Department of Water and Power (LADWP) is taking a multi-pronged approach and implementing several programs to target our large landscapes (e.g. parks and schools) and commercial, industrial, and institutional (CII) customers having irrigated landscapes. LADWP implements the ambitious Technical Assistance Program (TAP), which is a custom financial incentive program offering CII and Multi-Family Residential customers in Los Angeles up to $250,000 for the installation of pre-approved equipment and products (including the design and installation of efficient irrigation systems) that demonstrate persistent water savings. LADWP staff is currently working with a major customer on significant modifications for a new proprietary process that will conserve a considerable amount of water annually. LADWP has entered into a Memorandum of Understanding (MOU) with the Los Angeles

Department of Recreation and Parks (RAP) for the purpose of funding water use efficiency improvements for large landscapes in City parks. These water conservation improvements that LADWP and RAP are working in partnership to advance include installation of weather-based irrigation controllers, high efficiency sprinkler heads, and repair or replacement of irrigation distribution systems. The MOU strengthens LADWP's commitment to conservation as a means of providing a sustainable source of water to the City of Los Angeles as adopted by the Board in the 2005 Urban Water Management Plan. In August of 2008, LADWP amended its Emergency Water Conservation Plan (a City Ordinance) to address the increasing water shortage. The Plan's requirements are applicable to all LADWP customers, and are focused primarily on landscape irrigation. The Plan permits customers to use water only during specified hours of the day and specified days of the week, depending on the declared severity of water shortage. Water allotment varies by each phase (I-VI), such that phase I has the least amount of restrictions and phase VI having the most stringent restrictions. LADWP is currently developing a proposal for "Shortage Year" Water Rates (Tier 1 and Tier 2) for both commercial and residential customers that will become effective in mid-2009. Customers will be required to conserve 15% below their Tier 1 allotment to avoid a bill increase; however, those who exceed their allotment must pay Tier 2 rates resulting in higher water bills. Shortage Year Water Rates are designed to ensure that costs are recovered without penalizing customers who conserve during the years when projected demand for water exceeds the available supply. As has been demonstrated by LADWP's 100% volumetric rate structure, price signal is a most effective conservation tool. In addition to the Ordinance modifications described above, LADWP has developed and is planning to launch a Turf Buy Back Program in 2009. This new program will pay single family residential and commercial customers $1.00 per square foot of turf removed and replaced with drought tolerant plants, mulch or permeable hardscape. Any subsequent irrigation requirements will be met with low volume drip or microspray emitters. LADWP is also in the process of expanding our recycled water program and are working with water intensive CII customers such as golf courses, parks, and refineries to promote and use recycled water. LADWP is currently converting all of our golf courses and parks to dedicated irrigation meters for the usage of recycled water. Our recycled water goal is to deliver at least 50,000 acre-feet per year by 2019. This will be done by expanding the "purple pipe" distribution system to new customers who can use recycled water for non-potable uses such as irrigation and industrial processes.

E. Comments

Reported as of 6/10/10

BMP 06: High-Efficiency Washing Machine Rebate Programs

Reporting Unit: **Los Angeles Dept. of Water and Power**	BMP Form Status: **100% Complete**	Year: **2007**

A. Implementation

1. Do any energy service providers or waste water utilities in your service area offer rebates for high-efficiency washers?

   a. If YES, describe the offerings and incentives as well as who the energy/waste water utility provider is.

2. Does your agency offer rebates for high-efficiency washers?	yes
3. What is the level of the rebate?	
4. Number of rebates awarded.	

B. Rebate Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures		
2. Actual Expenditures		

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 6/10/10

BMP 07: Public Information Programs

Reporting Unit:	BMP Form Status:	Year:
Los Angeles Dept. of Water and Power	**100% Complete**	**2007**

A. Implementation

1. How is your public information program implemented?
   Wholesaler and retailer both materially participate in program
   Which wholesaler(s)?
   Metropolitan Water District of Southern California

2. Describe the program and how it's organized:
   LADWP's Public Affairs Division works closely with the Water Conservation office. Information is made available on LADWP Web site, conservation publications distributed at public venues and by request (in English and Spanish); customer newsletter; Speakers Bureau and school presentations; fleet vehicle signage; posters and brochures in LADWP Customer Service Centers and City Council field offices; permanent water display located at Olvera Street, a popular Los Angeles landmark and tourist venue; a special flier regarding conservation was produced and inserted for distribution in the Los Angeles Times and Daily News in English and in Impacto in Spanish. Print advertisements were placed twice monthly beginning in November of 2005 and terminating December 2006 in various languages in the community press and major daily newspapers serving Los Angeles to Promote awareness of and participation in LADWP's residential water conservation programs. The LADWP Public Affairs Division prepares an outreach program annually based on the specific program needs of the Water Conservation office. Public Affairs implements the elements of the program which include development and production of collateral materials and exhibits; development and placement of all advertisements and public service announcements; development and posting of Web site announcements. MWDSC independently promotes conservation through various media channels and directly promotes programs via the bewaterwise.com website as well as by its program

implementation contractor.

3. Indicate which and how many of the following activities are included in your public information program:

Public Information Program Activity in Retail Service Area	Yes/No	Number of Events
a. Paid Advertising	yes	81
b. Public Service Announcement	no	
c. Bill Inserts / Newsletters / Brochures	yes	21
d. Bill showing water usage in comparison to previous year's usage	yes	
e. Demonstration Gardens	no	
f. Special Events, Media Events	yes	3
g. Speaker's Bureau	yes	5
h. Program to coordinate with other government agencies, industry and public interest groups and media	yes	

B. Conservation Information Program Expenditures

1. Annual Expenditures (Excluding Staffing)

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 6/10/10

BMP 08: School Education Programs

Reporting Unit:
Los Angeles Dept. of Water and Power

BMP Form Status:
100% Complete

Year:
2007

A. Implementation

1. How is your public information program implemented?
Retailer runs program without wholesaler sponsorship

2. Please provide information on your region-wide school programs (by grade level):

Grade	Are grade-appropriate materials distributed?	No. of class presentations	No. of students reached	No. of teachers' workshops
Grades K-3rd	yes	2	490	13
Grades 4th-6th	yes	2	4325	13
Grades 7th-8th	yes	0	37800	13
High School	yes	0	56800	13

4. Did your Agency's materials meet state education framework requirements?	yes
5. When did your Agency begin implementing this program?	09/15/1975

B. School Education Program Expenditures

1. Annual Expenditures (Excluding Staffing)

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Teachers' guide and supporting materials funded and/or provided by LADWP. Dedicated LADWP staff coordinate with school district throughout the school year.

Reported as of 6/10/10

BMP 09: Conservation Programs for CII Accounts

Reporting Unit:	BMP Form Status:	Year:
Los Angeles Dept. of Water and Power	**100% Complete**	**2007**

A. Implementation

1. Has your agency identified and ranked COMMERCIAL customers according to use?	yes
2. Has your agency identified and ranked INDUSTRIAL customers according to use?	yes
3. Has your agency identified and ranked INSTITUTIONAL customers according to use?	yes

Option A: CII Water Use Survey and Customer Incentives Program

4. Is your agency operating a CII water use survey and customer incentives program for the purpose of complying with BMP 9 under this option? If so, please describe activity during reporting period:	yes

CII Surveys	Commercial Accounts	Industrial Accounts	Institutional Accounts
a. Number of New Surveys Offered	25	10	4
b. Number of New Surveys Completed	25	10	4
c. Number of Site Follow-ups of Previous Surveys (within 1 yr)	10	6	1
d. Number of Phone Follow-ups of Previous Surveys (within 1 yr)	10	3	1

CII Survey Components	Commercial	Industrial	Institutional

	Accounts	Accounts	Accounts
e. Site Visit	yes	yes	yes
f. Evaluation of all water-using apparatus and processes	yes	yes	yes
g. Customer report identifying recommended efficiency measures, paybacks and agency incentives	yes	yes	yes
Agency CII Customer Incentives	**Budget ($/Year)**	**# Awarded to Customers**	**Total $ Amount Awarded**
h. Rebates	150000	6980	737808
i. Loans	0	0	0
j. Grants	350000	0	0
k. Others	0	0	0

Option B: CII Conservation Program Targets

5. Does your agency track CII program interventions and water savings for the purpose of complying with BMP 9 under this option?	yes
6. Does your agency document and maintain records on how savings were realized and the method of calculation for estimated savings?	yes

7. **System Calculated** annual savings (AF/yr):

CII Programs	# Device Installations
a. Ultra Low Flush Toilets	4469
b. Dual Flush Toilets	1
c. High Efficiency Toilets	1404
d. High Efficiency Urinals	0
e. Non-Water Urinals	0
f. Commercial Clothes Washers (coin-op only; not industrial)	1037
g. Cooling Tower Controllers	23
h. Food Steamers	0
i. Ice Machines	0
j. Pre-Rinse Spray Valves	0
k. Steam Sterilizer Retrofits	0
l. X-ray Film Processors	0

8. **Estimated** annual savings (AF/yr) from agency programs not including the devices listed in Option B. 7., above:

CII Programs	Annual Savings (AF/yr)
a. Site-verified actions taken by agency:	0
b. Non-site-verified actions taken by agency:	0

B. Conservation Program Expenditures for CII Accounts

	This Year	Next Year

1. Budgeted Expenditures	2750000	2750000
2. Actual Expenditures	737808	

C. "At Least As Effective As"

1. Is your agency implementing an "at least as effective as" variant of this BMP? No

    a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

BMP 11: Conservation Pricing

Reporting Unit:	BMP Form Status:	Year:
Los Angeles Dept. of Water and Power	**100% Complete**	**2007**

A. Implementation

Water Service Rate Structure Data by Customer Class

1. Single Family Residential

a. Rate Structure	Increasing Block Seasonal
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 274,814,458
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$,

2. Multi-Family Residential

a. Rate Structure	Increasing Block Seasonal
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 188,638,894
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$ 0

3. Commercial

a. Rate Structure	Increasing Block Seasonal
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 119,179,953
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$ 0

4. Industrial

a. Rate Structure	Increasing Block Seasonal
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 23,200,289
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$ 0

5. Institutional / Government

a. Rate Structure	Increasing Block Seasonal
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 32,620,283
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$ 0

6. Dedicated Irrigation (potable)

a. Rate Structure	Increasing Block Seasonal
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 7,587,195
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$ 0

7. Recycled-Reclaimed

a. Rate Structure	Uniform
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 2,665,729
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$ 0

8. Raw

a. Rate Structure	Service Not Provided
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 0
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$ 0

9. Other

a. Rate Structure	Service Not Provided
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 0
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$ 0

B. Implementation Options

Select Either Option 1 or Option 2:

1. Option 1: Use Annual Revenue As Reported
V/(V+M) >= 70%

V = Total annual revenue from volumetric rates
M = Total annual revenue from customer meter/service (fixed) charges

Selected

2. Option 2: Use Canadian Water & Wastewater Association Rate Design Model
V/(V+M) >= V'/(V'+M')
V = Total annual revenue from volumetric rates
M = Total annual revenue from customer meter/service (fixed) charges
V' = The uniform volume rate based on the signatory's long-run incremental cost of service
M' = The associated meter charge

a. If you selected Option 2, has your agency submitted to the Council a completed Canadian Water & Wastewater Association rate design model?

b. Value for **V'** (uniform volume rate based on agency's long-run incremental cost of service) as determined by the Canadian Water & Wastewater Association rate design model:

c. Value for **M'** (meter charge associated with V' uniform volume rate) as determined by the Canadian Water & Wastewater Association rate design model:

C. Retail Wastewater (Sewer) Rate Structure Data by Customer Class

1. Does your agency provide sewer service? (If YES, answer questions 2 - 7 below, else continue to section D.)		No
2. Single Family Residential		
a. Sewer Rate Structure		
b. Total Annual Revenue	$ 0	
c. Total Revenue from Commodity Charges (Volumetric Rates)	$ 0	
3. Multi-Family Residential		
a. Sewer Rate Structure		
b. Total Annual Revenue	$ 0	
c. Total Revenue from Commodity Charges (Volumetric Rates)	$ 0	
4. Commercial		
a. Sewer Rate Structure		
b. Total Annual Revenue	$ 0	
c. Total Revenue from Commodity Charges (Volumetric Rates)	$ 0	
5. Industrial		
a. Sewer Rate Structure		
b. Total Annual Revenue	$ 0	
c. Total Revenue from Commodity Charges (Volumetric Rates)	$ 0	
6. Institutional / Government		
a. Sewer Rate Structure		
b. Total Annual Revenue	$ 0	
c. Total Revenue from Commodity Charges (Volumetric Rates)	$ 0	
7. Recycled-reclaimed water		
a. Sewer Rate Structure		
b. Total Annual Revenue	$ 0	
c. Total Revenue from Commodity Charges (Volumetric Rates)	$ 0	

D. "At Least As Effective As"

1. Is your agency implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

E. Comments

Link to LADWP Water Rate Ordinance:
http://www.ladwp.com/ladwp/cms/ladwp001149.pdf

BMP 12: Conservation Coordinator

Reporting Unit: **Los Angeles Dept. of Water and Power**	BMP Form Status: **100% Complete**	Year: **2007**

A. Implementation

1. Does your Agency have a conservation coordinator?	yes
2. Is a coordinator position supplied by another agency with which you cooperate in a regional conservation program ?	no
a. Partner agency's name:	
3. If your agency supplies the conservation coordinator:	
a. What percent is this conservation coordinator's position?	100%
b. Coordinator's Name	Thomas Gackstetter
c. Coordinator's Title	Water Conservation Manager
d. Coordinator's Experience and Number of Years	20
e. Date Coordinator's position was created (mm/dd/yyyy)	12/11/1991
4. Number of conservation staff (FTEs), including Conservation Coordinator.	5

B. Conservation Staff Program Expenditures

1. Staffing Expenditures (In-house Only)	597610
2. BMP Program Implementation Expenditures	5989000

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

BMP 13: Water Waste Prohibition

Reporting Unit: **Los Angeles Dept. of Water and Power**	BMP Form Status: **100% Complete**	Year: **2007**

A. Requirements for Documenting BMP Implementation

1. Is a water waste prohibition ordinance in effect in your service area? yes

a. If YES, describe the ordinance:

Prohibits use of water on hardscape, gutter flooding, unattended leaks, mid-day watering, serving water in restaurants w/o request, non recirc fountains

2. Is a copy of the most current ordinance(s) on file with CUWCC? yes

a. List local jurisdictions in your service area in the first text box and water waste ordinance citations in each jurisdiction in the second text box:

City of Los Angeles	Ord No. 166080

B. Implementation

1. Indicate which of the water uses listed below are prohibited by your agency or service area.

a. Gutter flooding	yes
b. Single-pass cooling systems for new connections	Yes
c. Non-recirculating systems in all new conveyor or car wash systems	Yes
d. Non-recirculating systems in all new commercial laundry systems	Yes
e. Non-recirculating systems in all new decorative fountains	yes
f. Other, please name See above	yes

2. Describe measures that prohibit water uses listed above:

Specific ordinance language, monetary penalties, service restrictions/shutoff. Cost of water/wastewater and common practice limits number of single pass systems

Water Softeners:

3. Indicate which of the following measures your agency has supported in developing state law:

a. Allow the sale of more efficient, demand-initiated regenerating DIR models.	no
b. Develop minimum appliance efficiency standards that:	
i.) Increase the regeneration efficiency standard to at least 3,350 grains of hardness removed per pound of common salt used.	no
ii.) Implement an identified maximum number of gallons discharged per gallon of soft water produced.	no
c. Allow local agencies, including municipalities and special districts, to set more stringent standards and/or to ban on-site regeneration of water softeners if it is demonstrated and found by the agency governing board that there is an adverse effect on the reclaimed water or groundwater supply.	no

4. Does your agency include water softener checks in home water audit programs?	no
5. Does your agency include information about DIR and exchange-type water softeners in educational efforts to encourage replacement of less efficient timer models?	no

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

BMP 14: Residential ULFT Replacement Programs

Reporting Unit: **Los Angeles Dept. of Water and Power**	BMP Form Status: **100% Complete**	Year: **2007**

A. Implementation

Number of 1.6 gpf Toilets Replaced by Agency Program During Report Year

	Single-Family Accounts	Multi-Family Units
1. Does your Agency have program(s) for replacing high-water-using toilets with ultra-low flush toilets?	yes	yes
Replacement Method	**SF Accounts**	**MF Units**
2. Rebate	2043	386
3. Direct Install	5448	9912
4. CBO Distribution	126	92
5. Other	0	0
Total	**7617**	**10390**

Number of 1.2 gpf High-Efficiency Toilets (HETs) Replaced by Agency Program During Report Year

	Single-Family Accounts	Multi-Family Units
6. Does your Agency have program(s) for replacing high-water-using toilets with ultra-low flush toilets?	no	no
Replacement Method	**SF Accounts**	**MF Units**
7. Rebate		
8. Direct Install		
9. CBO Distribution		
10. Other		
Total		

Number of Dual-Flush Toilets Replaced by Agency Program During Report Year

	Single-Family Accounts	Multi-Family Units
11. Does your Agency have program(s) for replacing high-water-using toilets with ultra-low flush toilets?	no	no
Replacement Method	**SF Accounts**	**MF Units**
12. Rebate	0	0
13. Direct Install	0	0
14. CBO Distribution	0	0
15. Other	0	0
Total	**0**	**0**

16. Describe your agency's ULFT, HET, and/or Dual-Flush Toilet programs for

single-family residences.

Rebate of $100 per toilet replaced or free toilet in exchange for old toilet (installed free on request). Rebate paid on ULFT, HET and Dual Flush.

17. Describe your agency's ULFT, HET, and/or Dual-Flush Toilet programs for multi-family residences.

Rebate of $75 per toilet replaced or free toilet in exchange for old toilet (installed free on request). Rebate paid on ULFT, HET and Dual Flush.

18. Is a toilet retrofit on resale ordinance in effect for your service area? yes

19. List local jurisdictions in your service area in the left box and ordinance citations in each jurisdiction in the right box:

City of Los Angeles	Ord. No. 172075

B. Residential ULFT Program Expenditures

1. Estimated cost per ULFT/HET replacement: 242.86

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Cost per unit includes all programmatic costs.

2008 CUWCC Biennial Report

Water Supply & Reuse

Reporting Unit: **Los Angeles Dept. of Water and Power**

Year: **2008**

Water Supply Source Information

Supply Source Name	Quantity (AF) Supplied	Supply Type
LA Aqueduct	152642	Imported
MWDSC	421732	Imported
Groundwater	71023	Groundwater
Recycled	4273	Recycled
Transfer	1241	Imported
Storage	198	Imported

Total AF: 651109

Reported as of 6/10/10

Accounts & Water Use

Reporting Unit Name:	Submitted to CUWCC	Year:
Los Angeles Dept. of Water and Power	**02/08/2009**	**2008**

What is the reporting year?	Fiscal	**Month Ending**	June

A. Service Area Population Information:

1. Total service area population 4071873

B. Number of Accounts and Water Deliveries (AF)

Type	Metered		Unmetered	
	No. of Accounts	Water Deliveries (AF)	No. of Accounts	Water Deliveries (AF)
1. Single-Family	482675	249530	0	0
2. Multi-Family	124403	183064	0	0
3. Commercial	72403	109091	0	0
4. Industrial	6830	24257	0	0
5. Institutional	7583	44803	0	0
6. Dedicated Irrigation	766	264	0	0
7. Recycled Water	45	4130	0	0
8. Other	0	0	0	0
9. Unaccounted	NA	37223	NA	0
Total	694705	652362	0	0
	Metered		**Unmetered**	

Reported as of 6/10/10

BMP 01: Water Survey Programs for Single-Family and Multi-Family Residential Customers

Reporting Unit:	BMP Form Status:	Year:
Los Angeles Dept. of Water and Power	**100% Complete**	**2008**

A. Implementation

1. Based on your signed MOU date, 09/12/1991, your Agency STRATEGY DUE DATE is:	09/11/1993
2. Has your agency developed and implemented a targeting/ marketing strategy for SINGLE-FAMILY residential water use surveys?	yes
a. If YES, when was it implemented?	06/01/1990
3. Has your agency developed and implemented a targeting/ marketing strategy for MULTI-FAMILY residential water use surveys?	yes
a. If YES, when was it implemented?	06/01/1990

B. Water Survey Data

Single

Survey Counts:	**Family Accounts**	**Multi-Family Units**
1. Number of surveys offered:	0	0
2. Number of surveys completed:	0	0
Indoor Survey:		
3. Check for leaks, including toilets, faucets and meter checks	yes	yes
4. Check showerhead flow rates, aerator flow rates, and offer to replace or recommend replacement, if necessary	yes	yes
5. Check toilet flow rates and offer to install or recommend installation of displacement device or direct customer to ULFT replacement program, as neccesary; replace leaking toilet flapper, as necessary	yes	yes
Outdoor Survey:		
6. Check irrigation system and timers	no	no
7. Review or develop customer irrigation schedule	no	no
8. Measure landscaped area (Recommended but not required for surveys)	no	no
9. Measure total irrigable area (Recommended but not required for surveys)	no	no
10. Which measurement method is typically used (Recommended but not required for surveys)		None
11. Were customers provided with information packets that included evaluation results and water savings recommendations?	no	no
12. Have the number of surveys offered and completed, survey results, and survey costs been tracked?	yes	no
a. If yes, in what form are surveys tracked?		manual activity

b. Describe how your agency tracks this information.

In-house filing system

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Period: FY 07-08 ULFT Rebate and D.I. programs end on 12/31/06. Marketing stops.

Reported as of 6/10/10

BMP 02: Residential Plumbing Retrofit

Reporting Unit:
Los Angeles Dept. of Water and BMP Form Status: Year:

Power **100% Complete** **2008**

A. Implementation

1. Is there an enforceable ordinance in effect in your service area requiring replacement of high-flow showerheads and other water use fixtures with their low-flow counterparts? yes

   a. If YES, list local jurisdictions in your service area and code or ordinance in each:

   City of Los Angeles "Water Closet, Urinal and Showerhead Regulations-Retrofit on Resale" Ordinance (No. 172075)

2. Has your agency satisfied the 75% saturation requirement for single-family housing units? yes

3. Estimated percent of single-family households with low-flow showerheads: 99%

4. Has your agency satisfied the 75% saturation requirement for multi-family housing units? yes

5. Estimated percent of multi-family households with low-flow showerheads: 99%

6. If YES to 2 OR 4 above, please describe how saturation was determined, including the dates and results of any survey research.

   LA enacted an ordinance requiring all LADWP customers to install low flow showerheads & have installations certified or incur financial penalties for non-compliance. 99+% of LADWP customers have demonstrated compliance

B. Low-Flow Device Distribution Information

1. Has your agency developed a targeting/ marketing strategy for distributing low-flow devices? yes

   a. If YES, when did your agency begin implementing this strategy? 07/01/1988

   b. Describe your targeting/ marketing strategy.

   Direct mail to all SF customers; element of all survey pgms; req'd per L.A. ordinance; provided upon request to any residential customer; distributed with program ULFTs.

Low-Flow Devices Distributed/ Installed	SF Accounts	MF Units
2. Number of low-flow showerheads distributed:	3812	12896
3. Number of toilet-displacement devices distributed:	2	0
4. Number of toilet flappers distributed:	39	11
5. Number of faucet aerators distributed:	57	2300

6. Does your agency track the distribution and cost of low-flow devices? yes

   a. If YES, in what format are low-flow devices tracked? Database

   b. If yes, describe your tracking and distribution system :

   Tracking: in-house inventory control; Distribution through Water Conservation office to customers who call in and through LADWP account executivs.

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

   a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 6/10/10

BMP 03: System Water Audits, Leak Detection and Repair

Reporting Unit:	BMP Form Status:	Year:
Los Angeles Dept. of Water and Power	**100% Complete**	**2008**

A. Implementation

1. Does your agency own or operate a water distribution system?	yes
2. Has your agency completed a pre-screening system audit for this reporting year?	Yes
3. If YES, enter the values (AF/Year) used to calculate verifiable use as a percent of total production:	
a. Determine metered sales (AF)	611008
b. Determine other system verifiable uses (AF)	0
c. Determine total supply into the system (AF)	648231
d. Using the numbers above, if (Metered Sales + Other Verifiable Uses) / Total Supply is < 0.9 then a full-scale system audit is required.	0.94
4. Does your agency keep necessary data on file to verify the values entered in question 3?	yes
5. Did your agency complete a full-scale audit during this report year?	no
6. Does your agency maintain in-house records of audit results or completed AWWA M36 audit worksheets for the completed audit which could be forwarded to CUWCC?	yes
7. Does your agency operate a system leak detection program?	no
a. If yes, describe the leak detection program:	

B. Survey Data

1. Total number of miles of distribution system line.	7228
2. Number of miles of distribution system line surveyed.	0

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Voluntary Questions (Not used to calculate compliance)

E. Volumes

	Estimated	Verified
1. Volume of raw water supplied to the system:		
2. Volume treated water supplied into the system:		
3. Volume of water exported from the system:		
4. Volume of billed authorized metered consumption:		

5. Volume of billed authorized unmetered consumption:

6. Volume of unbilled authorized metered consumption:

7. Volume of unbilled authorized unmetered consumption:

F. Infrastructure and Hydraulics

1. System input (source or master meter) volumes metered at the entry to the:

2. How frequently are they tested and calibrated?

3. Length of mains:

4. What % of distribution mains are rigid pipes (metal, ac, concrete)?

5. Number of service connections:

6. What % of service connections are rigid pipes (metal)?

7. Are residential properties fully metered?

8. Are non-residential properties fully metered?

9. Provide an estimate of customer meter under-registration:

10. Average length of customer service line from the main to the point of the meter:

11. Average system pressure:

12. Range of system pressures: From to

13. What percentage of the system is fed from gravity feed?

14. What percentage of the system is fed by pumping and re-pumping?

G. Maintenance Questions

1. Who is responsible for providing, testing, repairing and replacing customer meters?

2. Does your agency test, repair and replace your meters on a regular timed schedule?

a. If yes, does your agency test by meter size or customer category?:

b. If yes to meter size, please provide the frequency of testing by meter size:

Less than or equal to 1"

1.5" to 2"

3" and Larger

c. If yes to customer category, provide the frequency of testing by customer category:

SF residential

MF residential

Commercial

Industrial & Institutional

3. Who is responsible for repairs to the customer lateral or customer service line?

4. Who is responsible for service line repairs downstream of the customer meter?

5. Does your agency proactively search for leaks using leak

survey techniques or does your utility reactively repair leaks which are called in, or both?

6. What is the utility budget breakdown for:

Leak Detection	$
Leak Repair	$
Auditing and Water Loss Evaluation	$
Meter Testing	$

H. Comments

Reported as of 6/10/10

BMP 04: Metering with Commodity Rates for all New Connections and Retrofit of Existing

Reporting Unit: **Los Angeles Dept. of Water and Power**	BMP Form Status: **100% Complete**	Year: **2008**

A. Implementation

1. Does your agency have any unmetered service connections?	No
a. If YES, has your agency completed a meter retrofit plan?	
b. If YES, number of previously unmetered accounts fitted with meters during report year:	
2. Are all new service connections being metered and billed by volume of use?	Yes
3. Are all new service connections being billed volumetrically with meters?	Yes
4. Has your agency completed and submitted electronically to the Council a written plan, policy or program to test, repair and replace meters?	Yes

5. Please fill out the following matrix:

Account Type	Number of Metered Accounts	Number of Metered Accounts Read	Number of Metered Accounts Billed by Volume	Billing Frequency Per Year	Number of Volume Estimates
a. Single Family	483433	483433	483433	6	0
b. Multi-Family	121693	121693	121693	6	0
c. Commercial	60327	60327	60327	12	0
d. Industrial	6552	6552	6552	12	0
e. Institutional	6707	6707	6707	12	0
f. Landscape Irrigation	766	766	766	12	0

B. Feasibility Study

1. Has your agency conducted a feasibility study to assess the merits of a program to provide incentives to switch mixed-use accounts to dedicated landscape meters?	no
a. If YES, when was the feasibility study conducted? (mm/dd/yy)	

b. Describe the feasibility study:

2. Number of CII accounts with mixed-use meters:	60327
3. Number of CII accounts with mixed-use meters retrofitted with dedicated irrigation meters during reporting period.	0

C. "At Least As Effective As"

1. Is your agency implementing an "at least as effective as" variant of this BMP?	No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Fire services are metered; hydrants are not.

BMP 05: Large Landscape Conservation Programs and Incentives

Reporting Unit: **Los Angeles Dept. of Water and Power**	BMP Form Status: **100% Complete**	Year: **2008**

A. Water Use Budgets

1. Number of Dedicated Irrigation Meter Accounts:	766
2. Number of Dedicated Irrigation Meter Accounts with Water Budgets:	269
3. Budgeted Use for Irrigation Meter Accounts with Water Budgets (AF):	0
4. Actual Use for Irrigation Meter Accounts with Water Budgets (AF):	0
5. Does your agency provide water use notices to accounts with budgets each billing cycle?	yes

B. Landscape Surveys

1. Has your agency developed a marketing / targeting strategy for landscape surveys?	yes
a. If YES, when did your agency begin implementing this strategy?	6/10/1996

b. Description of marketing / targeting strategy:

Work with LA Dept Rec & Parks, school district to audit and provide audit training. All accts applying for landscape incentives also audited. Review consumption history for excess use.

2. Number of Surveys Offered.	6
3. Number of Surveys Completed.	6

4. Indicate which of the following Landscape Elements are part of your survey:

a. Irrigation System Check	yes
b. Distribution Uniformity Analysis	yes
c. Review / Develop Irrigation Schedules	yes
d. Measure Landscape Area	yes
e. Measure Total Irrigable Area	yes
f. Provide Customer Report / Information	yes

5. Do you track survey offers and results? yes

6. Does your agency provide follow-up surveys for previously completed surveys? yes

a. If YES, describe below:

Accounts with poor distribution uniformity re-audited after system improvements completed

C. Other BMP 5 Actions

1. An agency can provide mixed-use accounts with ETo-based landscape budgets in lieu of a large landscape survey program.
Does your agency provide mixed-use accounts with landscape budgets? no

2. Number of CII mixed-use accounts with landscape budgets. 0

3. Do you offer landscape irrigation training? yes

4. Does your agency offer financial incentives to improve landscape water use efficiency? yes

Type of Financial Incentive:	Budget (Dollars/ Year)	Number Awarded to Customers	Total Amount Awarded
a. Rebates	1000000	1	8538
b. Loans	0	0	0
c. Grants	80000	0	0

5. Do you provide landscape water use efficiency information to new customers and customers changing services? No

a. If YES, describe below:

6. Do you have irrigated landscaping at your facilities? yes

a. If yes, is it water-efficient? yes

b. If yes, does it have dedicated irrigation metering? yes

7. Do you provide customer notices at the start of the irrigation season? no

8. Do you provide customer notices at the end of the irrigation season? no

D. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? Yes

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

The Los Angeles Department of Water and Power (LADWP) is taking a multi-pronged approach and implementing several programs to target our large landscapes (e.g. parks and schools) and commercial, industrial, and institutional (CII) customers having irrigated landscapes. LADWP implements the ambitious Technical Assistance Program (TAP), which is a custom financial incentive program offering CII and Multi-Family Residential customers in Los Angeles up to $250,000 for the installation of pre-approved equipment and products (including the design and installation of efficient irrigation systems) that demonstrate persistent water savings. LADWP staff is currently working with a major customer on significant modifications for a new proprietary process that will conserve a considerable amount of water annually. LADWP has entered into a Memorandum of Understanding (MOU) with the Los Angeles

Department of Recreation and Parks (RAP) for the purpose of funding water use efficiency improvements for large landscapes in City parks. These water conservation improvements that LADWP and RAP are working in partnership to advance include installation of weather-based irrigation controllers, high efficiency sprinkler heads, and repair or replacement of irrigation distribution systems. The MOU strengthens LADWP's commitment to conservation as a means of providing a sustainable source of water to the City of Los Angeles as adopted by the Board in the 2005 Urban Water Management Plan. In August of 2008, LADWP amended its Emergency Water Conservation Plan (a City Ordinance) to address the increasing water shortage. The Plan's requirements are applicable to all LADWP customers, and are focused primarily on landscape irrigation. The Plan permits customers to use water only during specified hours of the day and specified days of the week, depending on the declared severity of water shortage. Water allotment varies by each phase (I-VI), such that phase I has the least amount of restrictions and phase VI having the most stringent restrictions. LADWP is currently developing a proposal for "Shortage Year" Water Rates (Tier 1 and Tier 2) for both commercial and residential customers that will become effective in mid-2009. Customers will be required to conserve 15% below their Tier 1 allotment to avoid a bill increase; however, those who exceed their allotment must pay Tier 2 rates resulting in higher water bills. Shortage Year Water Rates are designed to ensure that costs are recovered without penalizing customers who conserve during the years when projected demand for water exceeds the available supply. As has been demonstrated by LADWP's 100% volumetric rate structure, price signal is a most effective conservation tool. In addition to the Ordinance modifications described above, LADWP has developed and is planning to launch a Turf Buy Back Program in 2009. This new program will pay single family residential and commercial customers $1.00 per square foot of turf removed and replaced with drought tolerant plants, mulch or permeable hardscape. Any subsequent irrigation requirements will be met with low volume drip or microspray emitters. LADWP is also in the process of expanding our recycled water program and are working with water intensive CII customers such as golf courses, parks, and refineries to promote and use recycled water. LADWP is currently converting all of our golf courses and parks to dedicated irrigation meters for the usage of recycled water. Our recycled water goal is to deliver at least 50,000 acre-feet per year by 2019. This will be done by expanding the "purple pipe" distribution system to new customers who can use recycled water for non-potable uses such as irrigation and industrial processes.

E. Comments

Reported as of 6/10/10

BMP 06: High-Efficiency Washing Machine Rebate Programs

Reporting Unit:	BMP Form Status:	Year:
Los Angeles Dept. of Water and Power	**100% Complete**	**2008**

A. Implementation

1. Do any energy service providers or waste water utilities in your service area offer rebates for high-efficiency washers?

   a. If YES, describe the offerings and incentives as well as who the energy/waste water utility provider is.

2. Does your agency offer rebates for high-efficiency washers?	yes
3. What is the level of the rebate?	
4. Number of rebates awarded.	

B. Rebate Program Expenditures

	This Year	Next Year
1. Budgeted Expenditures		
2. Actual Expenditures		

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 6/10/10

BMP 07: Public Information Programs

Reporting Unit:	BMP Form Status:	Year:
Los Angeles Dept. of Water and Power	**100% Complete**	**2008**

A. Implementation

1. How is your public information program implemented?
   Wholesaler and retailer both materially participate in program
   Which wholesaler(s)?
   Metropolitan Water District of Southern California

2. Describe the program and how it's organized:
   LADWP's Public Affairs Division works closely with the Water Conservation office. Information is made available on LADWP Web site, conservation publications distributed at public venues and by request (in English and Spanish); customer newsletter; Speakers Bureau and school presentations; fleet vehicle signage; posters and brochures in LADWP Customer Service Centers and City Council field offices; permanent water display located at Olvera Street, a popular Los Angeles landmark and tourist venue; a special flier regarding conservation was produced and inserted for distribution in the Los Angeles Times and Daily News in English and in Impacto in Spanish. Print advertisements were placed twice monthly beginning in November of 2005 and terminating December 2006 in various languages in the community press and major daily newspapers serving Los Angeles to Promote awareness of and participation in LADWP's residential water conservation programs. The LADWP Public Affairs Division prepares an outreach program annually based on the specific program needs of the Water Conservation office. Public Affairs implements the elements of the program which include development and production of collateral materials and exhibits; development and placement of all advertisements and public service announcements; development and posting of Web site announcements. MWDSC independently promotes conservation through various media channels and directly promotes programs via the bewaterwise.com website as well as by its program

implementation contractor

3. Indicate which and how many of the following activities are included in your public information program:

Public Information Program Activity in Retail Service Area	Yes/No	Number of Events
a. Paid Advertising	yes	250
b. Public Service Announcement	no	
c. Bill Inserts / Newsletters / Brochures	yes	22
d. Bill showing water usage in comparison to previous year's usage	yes	
e. Demonstration Gardens	no	
f. Special Events, Media Events	yes	3
g. Speaker's Bureau	yes	10
h. Program to coordinate with other government agencies, industry and public interest groups and media	yes	

B. Conservation Information Program Expenditures

1. Annual Expenditures (Excluding Staffing)

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Reported as of 6/10/10

BMP 08: School Education Programs

Reporting Unit:
Los Angeles Dept. of Water and Power

BMP Form Status:
100% Complete

Year:
2008

A. Implementation

1. How is your public information program implemented?
Retailer runs program without wholesaler sponsorship

2. Please provide information on your region-wide school programs (by grade level):

Grade	Are grade-appropriate materials distributed?	No. of class presentations	No. of students reached	No. of teachers' workshops
Grades K-3rd	yes	0	0	0
Grades 4th-6th	yes	0	3600	0
Grades 7th-8th	yes	0	18500	0
High School	yes	0	29500	0

4. Did your Agency's materials meet state education framework requirements?	yes
5. When did your Agency begin implementing this program?	09/15/1975

B. School Education Program Expenditures

1. Annual Expenditures (Excluding Staffing)

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Teachers' guide and supporting materials funded and/or provided by LADWP. Dedicated LADWP staff coordinate with school district throughout the school year.

Reported as of 6/10/10

BMP 09: Conservation Programs for CII Accounts

Reporting Unit:	BMP Form Status:	Year:
Los Angeles Dept. of Water and Power	**100% Complete**	**2008**

A. Implementation

1. Has your agency identified and ranked COMMERCIAL customers according to use?	yes
2. Has your agency identified and ranked INDUSTRIAL customers according to use?	yes
3. Has your agency identified and ranked INSTITUTIONAL customers according to use?	yes

---

Option A: CII Water Use Survey and Customer Incentives Program

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4. Is your agency operating a CII water use survey and customer incentives program for the purpose of complying with BMP 9 under this option? If so, please describe activity during reporting period:	yes

CII Surveys	Commercial Accounts	Industrial Accounts	Institutional Accounts
a. Number of New Surveys Offered	15	7	4
b. Number of New Surveys Completed	15	7	4
c. Number of Site Follow-ups of Previous Surveys (within 1 yr)	6	4	1
d. Number of Phone Follow-ups of Previous Surveys (within 1 yr)	6	2	1

CII Survey Components	Commercial	Industrial	Institutional

	Accounts	Accounts	Accounts
e. Site Visit	yes	yes	yes
f. Evaluation of all water-using apparatus and processes	yes	yes	yes
g. Customer report identifying recommended efficiency measures, paybacks and agency incentives	yes	yes	yes
Agency CII Customer Incentives	**Budget ($/Year)**	**# Awarded to Customers**	**Total $ Amount Awarded**
h. Rebates	1500000	6605	925931
i. Loans	0	0	0
j. Grants	350000	0	0
k. Others	0	0	0

Option B: CII Conservation Program Targets

5. Does your agency track CII program interventions and water savings for the purpose of complying with BMP 9 under this option?	yes
6. Does your agency document and maintain records on how savings were realized and the method of calculation for estimated savings?	yes

7. **System Calculated** annual savings (AF/yr):

CII Programs	# Device Installations
a. Ultra Low Flush Toilets	1127
b. Dual Flush Toilets	525
c. High Efficiency Toilets	1721
d. High Efficiency Urinals	1327
e. Non-Water Urinals	346
f. Commercial Clothes Washers (coin-op only; not industrial)	835
g. Cooling Tower Controllers	26
h. Food Steamers	13
i. Ice Machines	0
j. Pre-Rinse Spray Valves	2
k. Steam Sterilizer Retrofits	5
l. X-ray Film Processors	0

8. **Estimated** annual savings (AF/yr) from agency programs not including the devices listed in Option B. 7., above:

CII Programs	Annual Savings (AF/yr)
a. Site-verified actions taken by agency:	0
b. Non-site-verified actions taken by agency:	0

B. Conservation Program Expenditures for CII Accounts

	This Year	Next Year

1. Budgeted Expenditures	2750000	2750000
2. Actual Expenditures	925931	

C. "At Least As Effective As"

1. Is your agency implementing an "at least as effective as" variant of this BMP? No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

BMP 11: Conservation Pricing

Reporting Unit:	BMP Form Status:	Year:
Los Angeles Dept. of Water and Power	**100% Complete**	**2008**

A. Implementation

Water Service Rate Structure Data by Customer Class

1. Single Family Residential

a. Rate Structure	Increasing Block Seasonal
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 299,536,198
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$,

2. Multi-Family Residential

a. Rate Structure	Increasing Block Seasonal
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 216,210,111
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$ 0

3. Commercial

a. Rate Structure	Increasing Block Seasonal
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 138,218,700
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$ 0

4. Industrial

a. Rate Structure	Increasing Block Seasonal
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 30,670,561
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$ 0

5. Institutional / Government

a. Rate Structure	Increasing Block Seasonal
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 36,762,959
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$ 0

6. Dedicated Irrigation (potable)

a. Rate Structure	Increasing Block Seasonal
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 7,965,994
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$ 0

7. Recycled-Reclaimed

a. Rate Structure	Uniform
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 1,679,516
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$ 0

8. Raw

a. Rate Structure	Service Not Provided
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 0
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$ 0

9. Other

a. Rate Structure	Service Not Provided
b. Total Revenue from Commodity Charges (Volumetric Rates)	$ 0
c. Total Revenue from Customer Meter/Service (Fixed) Charges	$ 0

B. Implementation Options

Select Either Option 1 or Option 2:

1. Option 1: Use Annual Revenue As Reported
V/(V+M) >= 70%

V = Total annual revenue from volumetric rates
M = Total annual revenue from customer meter/service (fixed) charges

Selected

2. Option 2: Use Canadian Water & Wastewater Association Rate Design Model
V/(V+M) >= V'/(V'+M')
V = Total annual revenue from volumetric rates
M = Total annual revenue from customer meter/service (fixed) charges
V' = The uniform volume rate based on the signatory's long-run incremental cost of service
M' = The associated meter charge

a. If you selected Option 2, has your agency submitted to the Council a completed Canadian Water & Wastewater Association rate design model?

b. Value for **V'** (uniform volume rate based on agency's long-run incremental cost of service) as determined by the Canadian Water & Wastewater Association rate design model:

c. Value for **M'** (meter charge associated with V' uniform volume rate) as determined by the Canadian Water & Wastewater Association rate design model:

C. Retail Wastewater (Sewer) Rate Structure Data by Customer Class

1. Does your agency provide sewer service? (If YES, answer questions 2 - 7 below, else continue to section D.)	No

2. Single Family Residential

a. Sewer Rate Structure	
b. Total Annual Revenue	$ 0
c. Total Revenue from Commodity Charges (Volumetric Rates)	$ 0

3. Multi-Family Residential

a. Sewer Rate Structure	
b. Total Annual Revenue	$ 0
c. Total Revenue from Commodity Charges (Volumetric Rates)	$ 0

4. Commercial

a. Sewer Rate Structure	
b. Total Annual Revenue	$ 0
c. Total Revenue from Commodity Charges (Volumetric Rates)	$ 0

5. Industrial

a. Sewer Rate Structure	
b. Total Annual Revenue	$ 0
c. Total Revenue from Commodity Charges (Volumetric Rates)	$ 0

6. Institutional / Government

a. Sewer Rate Structure	
b. Total Annual Revenue	$ 0
c. Total Revenue from Commodity Charges (Volumetric Rates)	$ 0

7. Recycled-reclaimed water

a. Sewer Rate Structure	
b. Total Annual Revenue	$ 0
c. Total Revenue from Commodity Charges (Volumetric Rates)	$ 0

D. "At Least As Effective As"

1. Is your agency implementing an "at least as effective as" variant of this BMP?	No

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

E. Comments

Link to LADWP Water Rate Ordinance:
http://www.ladwp.com/ladwp/cms/ladwp001149.pdf

BMP 12: Conservation Coordinator

Reporting Unit: **Los Angeles Dept. of Water and Power**	BMP Form Status: **100% Complete**	Year: **2008**

A. Implementation

1. Does your Agency have a conservation coordinator?	yes
2. Is a coordinator position supplied by another agency with which you cooperate in a regional conservation program ?	no
a. Partner agency's name:	
3. If your agency supplies the conservation coordinator:	
a. What percent is this conservation coordinator's position?	100%
b. Coordinator's Name	Thomas Gackstetter
c. Coordinator's Title	Water Conservation Manager
d. Coordinator's Experience and Number of Years	21
e. Date Coordinator's position was created (mm/dd/yyyy)	12/11/1991
4. Number of conservation staff (FTEs), including Conservation Coordinator.	5

B. Conservation Staff Program Expenditures

1. Staffing Expenditures (In-house Only)	609562
2. BMP Program Implementation Expenditures	6989200

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

BMP 13: Water Waste Prohibition

Reporting Unit: **Los Angeles Dept. of Water and Power**	BMP Form Status: **100% Complete**	Year: **2008**

A. Requirements for Documenting BMP Implementation

1. Is a water waste prohibition ordinance in effect in your service area?	yes

a. If YES, describe the ordinance:

Prohibits use of water on hardscape, gutter flooding, unattended leaks, mid-day watering, serving water in restaurants w/o request, non recirc fountains

2. Is a copy of the most current ordinance(s) on file with CUWCC?	yes

a. List local jurisdictions in your service area in the first text box and water waste ordinance citations in each jurisdiction in the second text box:

City of Los Angeles	Ord No. 166080

B. Implementation

1. Indicate which of the water uses listed below are prohibited by your agency or service area.

a. Gutter flooding	yes
b. Single-pass cooling systems for new connections	Yes
c. Non-recirculating systems in all new conveyor or car wash systems	Yes
d. Non-recirculating systems in all new commercial laundry systems	Yes
e. Non-recirculating systems in all new decorative fountains	yes
f. Other, please name See above	yes

2. Describe measures that prohibit water uses listed above:

Specific ordinance language, monetary penalties, service restrictions/shutoff. Cost of water/wastewater and common practice limits number of single pass systems

Water Softeners:

3. Indicate which of the following measures your agency has supported in developing state law:

a. Allow the sale of more efficient, demand-initiated regenerating DIR models.	no
b. Develop minimum appliance efficiency standards that:	
i.) Increase the regeneration efficiency standard to at least 3,350 grains of hardness removed per pound of common salt used.	no
ii.) Implement an identified maximum number of gallons discharged per gallon of soft water produced.	no
c. Allow local agencies, including municipalities and special districts, to set more stringent standards and/or to ban on-site regeneration of water softeners if it is demonstrated and found by the agency governing board that there is an adverse effect on the reclaimed water or groundwater supply.	no
4. Does your agency include water softener checks in home water audit programs?	no
5. Does your agency include information about DIR and exchange-type water softeners in educational efforts to encourage replacement of less efficient timer models?	no

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

BMP 14: Residential ULFT Replacement Programs

Reporting Unit:	BMP Form Status:	Year:
Los Angeles Dept. of Water and Power	**100% Complete**	**2008**

A. Implementation

Number of 1.6 gpf Toilets Replaced by Agency Program During Report Year

	Single-Family Accounts	**Multi-Family Units**
1. Does your Agency have program(s) for replacing high-water-using toilets with ultra-low flush toilets?	yes	yes
Replacement Method	**SF Accounts**	**MF Units**
2. Rebate	0	42
3. Direct Install	0	0
4. CBO Distribution	0	0
5. Other	0	0
Total	**0**	**42**

Number of 1.2 gpf High-Efficiency Toilets (HETs) Replaced by Agency Program During Report Year

	Single-Family Accounts	**Multi-Family Units**
6. Does your Agency have program(s) for replacing high-water-using toilets with ultra-low flush toilets?	no	no
Replacement Method	**SF Accounts**	**MF Units**
7. Rebate		
8. Direct Install		
9. CBO Distribution		
10. Other		
Total		

Number of Dual-Flush Toilets Replaced by Agency Program During Report Year

	Single-Family Accounts	**Multi-Family Units**
11. Does your Agency have program(s) for replacing high-water-using toilets with ultra-low flush toilets?	no	no
Replacement Method	**SF Accounts**	**MF Units**
12. Rebate	0	0
13. Direct Install	0	0
14. CBO Distribution	0	0
15. Other	0	0
Total	**0**	**0**

16. Describe your agency's ULFT, HET, and/or Dual-Flush Toilet programs for

single-family residences.

Residential ULFT rebate and distribution programs ended in 2007.

17. Describe your agency's ULFT, HET, and/or Dual-Flush Toilet programs for multi-family residences.

Residential ULFT rebate and distribution programs ended in 2007.

18. Is a toilet retrofit on resale ordinance in effect for your service area?	yes

19. List local jurisdictions in your service area in the left box and ordinance citations in each jurisdiction in the right box:

City of Los Angeles	Ord. No. 172075

B. Residential ULFT Program Expenditures

1. Estimated cost per ULFT/HET replacement:	242.86

C. "At Least As Effective As"

1. Is your AGENCY implementing an "at least as effective as" variant of this BMP?	no

a. If YES, please explain in detail how your implementation of this BMP differs from Exhibit 1 and why you consider it to be "at least as effective as."

D. Comments

Urban Water Management Plan
Appendix I

Emergency Water Conservation Plan

ORDINANCE NO. 181288

An ordinance amending Chapter XII, Article I of the Los Angeles Municipal Code to clarify prohibited uses and modify certain water conservation requirements of the Water Conservation Plan of the City of Los Angeles.

THE PEOPLE OF THE CITY OF LOS ANGELES
DO ORDAIN AS FOLLOWS:

Section 1. Chapter XII, Article I, of the Los Angeles Municipal Code is amended in its entirety to read:

ARTICLE I
EMERGENCY WATER CONSERVATION PLAN

SEC. 121.00. SCOPE AND TITLE.

This Article shall be known as The Emergency Water Conservation Plan of the City of Los Angeles.

SEC. 121.01. DECLARATION OF POLICY.

It is hereby declared that because of the conditions prevailing in the City of Los Angeles and in the areas of this State and elsewhere from which the City obtains its water supplies, the general welfare requires that the water resources available to the City be put to the maximum beneficial use to the extent to which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interests of the people of the City and for the public welfare.

SEC. 121.02. DECLARATION OF PURPOSE.

The purpose of this Article is to provide a mandatory water conservation plan to minimize the effect of a shortage of water to the Customers of the City and, by means of this Article, to adopt provisions that will significantly reduce the consumption of water over an extended period of time, thereby extending the available water required for the Customers of the City while reducing the hardship of the City and the general public to the greatest extent possible, voluntary conservation efforts having proved to be insufficient.

SEC. 121.03. DEFINITIONS

The following words and phrases, whenever used in this Article, shall be construed as defined in this Section unless from the context a different meaning is intended or unless a different meaning is specifically defined within individual Sections of this Article:

a. "**Article**" means the ordinance providing for "**The Emergency Water Conservation Plan of the City of Los Angeles**".

b. **"Baseline Water Usage"** means the amount of water used for the same period during Fiscal Year 2006-2007. The Baseline Water Usage for Customers without a water usage history prior to 2007 shall be calculated pursuant to a Department water budget.

c. "**Billing Unit**" means the unit amount of water used to apply water rates for purposes of calculating commodity charges for Customer water usage and equals one hundred (100) cubic feet or seven hundred forty-eight (748) gallons of water.

d. "**City**" means the City of Los Angeles.

e. "**City Council**" means the Council of the City of Los Angeles.

f. "**Conservation Phase**" means that level of mandatory water conservation presently required from Customers pursuant to this Article.

g. "**Customer**" means any person, persons, association, corporation or governmental agency supplied or entitled to be supplied with water service by the Department.

h. "**Department**" means the Los Angeles Department of Water and Power.

i. **"Drip Irrigation"** means an efficient and targeted form of irrigation in which water is delivered in drops directly to the plants roots where no emitter produces more than four (4) gallons of water per hour.

j. **"Even-numbered"** means street addresses ending with the following numerals: 0 (Zero), 2 (Two), 4 (Four), 6 (Six), 8 (Eight). Street addresses ending in ½ or any fraction shall conform to the permitted uses for the last whole number in the address.

k. "**Gray Water**" means a Customer's second or subsequent use of water supplied by the Department on the Customer's premises, such as the use of laundry or bathing water for other purposes.

l. "**His**" as used herein includes masculine, feminine or neuter, as appropriate.

m. **“Irrigate”** means any exterior application of water, other than for firefighting purposes, dust control, or as process water, including but not limited to the watering of any vegetation whether it be natural or planted.

n. **“Large Landscape Area”** means an area of vegetation at least three acres in size supporting a business necessity or public benefit uses such as parks, golf courses, schools, and cemeteries, and includes without limitation Schedule F and Provision M rate Customers.

o. “**Mayor**” means the Mayor of the City of Los Angeles

p. **“Notice to the Department”** means written communication documenting compliance with all requirements and directed to the Department.

q. **“Odd-numbered”** means street addresses ending with the following numerals: 1 (One), 3 (Three), 5 (Five), 7 (Seven), 9 (Nine). Street addresses ending in ½ or any fraction shall conform to the permitted uses for the last whole number in the address.

r. “**Officer**” means every person designated in Section 200 of the Los Angeles City Charter as an officer of the City of Los Angeles.

s. **“Potable Water”** means water supplied by the Department which is suitable for drinking and excludes recycled water from any source.

t. **“Private Golf Course”** means a facility with a business license where play is restricted to members and their guests, and does not include personal use facilities such as backyard golf greens or courses.

u. “**Process Water**” means water used to manufacture, alter, convert, clean, heat, or cool a product, or the equipment used for such purpose; water used for plant and equipment washing and for transporting of raw materials and products; and water used for community gardens, or to grow trees, plants, or turf for sale or installation.

v. **“Recycled Water”** means water which as a result of treatment of wastewater, is suitable for a direct beneficial use, or a controlled use as approved by the California Department of Public Health.

w. “**Section**” means a section of this Article unless some other ordinance or statute is specifically mentioned.

x. **“Single pass cooling systems”** means equipment where water is circulated only once to cool equipment before being disposed.

y. **"Sports Fields"** means a public or private facility supporting a business necessity or public benefit use that provides turf areas as a playing surface for individual and team sports, and does not include a facility on a residential property.

z. **"Station"** means those sprinklers or other water-emitting devices controlled by a single valve.

SEC. 121.04. AUTHORIZATION.

The various officers, boards, departments, bureaus and agencies of the City are hereby authorized and directed to immediately implement the applicable provisions of this Article upon the effective date hereof.

SEC. 121.05. APPLICATION.

The provisions of this Article shall apply to all Customers and property served by the Department wherever situated, and shall also apply to all property and facilities owned, maintained, operated, or under the jurisdiction of the various officers, boards, departments, bureaus or agencies of the City.

SEC. 121.06. WATER CONSERVATION PHASES.

A. No Customer of the Department shall make, cause, use, or permit the use of water from the Department for any residential, commercial, industrial, agricultural, governmental, or any other purpose in a manner contrary to any provision of this Article. The waste or unreasonable use of water is prohibited.

B. For the purposes of this Article, a use of water by a tenant or by an employee, agent, contractor or other designee acting on behalf of a Customer whether with real or ostensible authority shall be imputed to the Customer. Nothing contained in this Article shall limit the remedies available to a Customer under law or equity for the actions of a tenant, agent, contractor or other acting on behalf of a Customer.

SEC. 121.07. CONSERVATION PHASE IMPLEMENTATION.

A. Notwithstanding any other provisions of this Article, the provisions of Section 121.08A, Phase I, Prohibited Uses applicable to all Customers, shall take effect immediately upon the effective date of this Article, shall be permanent and shall not be subject to termination pursuant to the provisions of this Article providing for the termination of a conservation phase.

B. The Department shall monitor and evaluate the projected supply and demand for water by its Customers monthly, and shall recommend to the Mayor and Council by concurrent written notice the extent of the conservation required by the Customers of the Department in order for the Department to prudently plan for and supply water to its Customers. The Mayor shall, in turn, independently evaluate such recommendation and notify the Council of the Mayor's determination as to the particular phase of water conservation, Phase I through Phase V that should be implemented. Thereafter, the Mayor may, with the concurrence of the Council, order that the appropriate phase of water conservation be implemented in accordance with the applicable provisions of this Article. Said order shall be made by public proclamation and shall be published one time only in a daily newspaper of general circulation and shall become effective immediately upon such publication. The prohibited water uses for each phase shall take effect with the first full billing period commencing on or after the effective date of the public proclamation by the Mayor.

In the event the Mayor independently recommends to the Council a phase of conservation different from that recommended by the Department, the Mayor shall include detailed supporting data and the reasons for the independent recommendation in the notification to the Council of the Mayor's determination as to the appropriate phase of conservation to be implemented.

C. Phase Termination

1. At such time as the Department reports an April 1 forecast of annual Owens Valley and Mono Basin Runoff equal to or exceeding 110 percent of normal and the Metropolitan Water District of Southern California officially states that the sum of its Colorado River and State Water Project supplies exceeds 100 percent of projected demand, the Mayor shall forthwith recommend to the Council the termination of any Customer curtailment phase then in effect. Said recommendation to terminate shall take effect upon concurrence of the Council.

2. The provisions of Subsection C1 above shall not preclude the Department on the basis of information available to it from recommending to the Mayor the termination of a water conservation phase then in effect. The Mayor shall forward said recommendation to the Council and it shall take effect upon concurrence by the Council.

SEC. 121.08. WATER CONSERVATION PHASES.

A. PHASE I

Prohibited Uses Applicable To All Customers.

1. No Customer of the Department shall use a water hose to wash any paved surfaces including, but not limited to, sidewalks, walkways, driveways, and parking areas, except to alleviate immediate safety or sanitation hazards. This Section shall not apply to Department-approved water-conserving spray cleaning devices. Use of water-pressure devices for graffiti removal is exempt. A simple spray nozzle does not qualify as a water-conserving spray cleaning device.

2. No Customer of the Department shall use water to clean, fill, or maintain levels in decorative fountains, ponds, lakes, or similar structures used for aesthetic purposes unless such water is part of a recirculating system.

3. No restaurant, hotel, café, cafeteria, or other public place where food is sold, served or offered for-sale, shall serve drinking water to any person unless expressly requested.

4. No Customer of the Department shall permit water to leak from any pipe or fixture on the Customer's premises; failure or refusal to effect a timely repair of any leak of which the Customer knows or has reason to know shall subject said Customer to all penalties provided herein for a prohibited use of water.

5. No Customer of the Department shall wash a vehicle with a hose if the hose does not have a self-closing water shut-off or device attached to it, or otherwise allow a hose to run continuously while washing a vehicle.

6. No Customer of the Department shall irrigate during periods of rain.

7. No Customer of the Department shall water or irrigate lawn, landscape, or other vegetated areas between the hours of 9:00 a.m. and 4:00 p.m. During these hours, public and private golf course greens and tees and professional sports fields may be irrigated in order to maintain play areas and accommodate event schedules. Supervised testing or repairing of irrigation systems is allowed anytime with proper signage.

8. All irrigating of landscape with potable water using spray head sprinklers and bubblers shall be limited to no more than ten (10) minutes per watering day per station. All irrigating of landscape with potable water using standard rotors and multi-stream rotary heads shall be limited to no more than fifteen (15) minutes per cycle and up to two (2) cycles per watering day per station. Exempt from these landscape irrigation restrictions are irrigation systems using very low-flow drip-type irrigation when no emitter produces more than four (4) gallons of water per hour and micro-sprinklers using less than fourteen (14) gallons per hour. This provision does not apply to Schedule F water Customers or water service that has been granted the General Provision M rate adjustment under the City's Water Rates Ordinance, subject to the Customer having complied with best management practices for irrigation approved by the Department. The 9:00 a.m. to 4:00 p.m. irrigation restriction shall apply unless specifically exempt as stated in subsection 7 above.

9. No Customer of the Department shall water or irrigate any lawn, landscape, or other vegetated area in a manner that causes or allows excess or continuous water flow or runoff onto an adjoining sidewalk, driveway, street, gutter or ditch.

10. No installation of single pass cooling systems shall be permitted in buildings requesting new water service.

11. No installation of non-recirculating systems shall be permitted in new conveyor car wash and new commercial laundry systems.

12. Operators of hotels and motels shall provide guests with the option of choosing not to have towels and linens laundered daily. The hotel or motel shall prominently display notice of this option in each bathroom using clear and easily understood language. The Department shall make suitable displays available.

13. No Large Landscape Areas shall have irrigation systems without rain sensors that shut off the irrigation systems. Large Landscape Areas with approved weather-based irrigation controllers registered with the Department are in compliance with this requirement.

B. PHASE II

1. **Prohibited Uses Applicable To All Customers.** Should Phase II be implemented, uses applicable to Phase I of this Section shall continue to be applicable, except as specifically provided below.

2. Non-Watering Days. No landscape irrigation shall be permitted on any day other than Monday, Wednesday, or Friday for odd-numbered street addresses and Tuesday, Thursday , or Sunday for even-numbered street addresses. Street addresses ending in ½ or any fraction shall conform to the permitted uses for the last whole number in the address. Watering times shall be limited to:

(a) Non-conserving nozzles (spray head sprinklers and bubblers) – no more than eight (8) minutes per watering day per station for a total of 24 minutes per week.

(b) Conserving nozzles (standard rotors and multi-stream rotary heads) – no more than fifteen (15) minutes per cycle and up to two (2) cycles per watering day per station for a total of 90 minutes per week.

(With the above watering times, water consumption used for both types of nozzles is essentially equal.)

3. Upon written Notice to the Department, irrigation of Sports Fields may deviate from the non-watering days to maintain play areas and accommodate event schedules; however, to be eligible for this means of compliance, a Customer must reduce his overall monthly water use by the Department's Board of Water and Power Commissioners (Board)-adopted

degree of shortage plus an additional five percent from the Customer Baseline Water Usage within 30 days.

4. Upon written Notice to the Department, Large Landscape Areas may deviate from the non-watering days by meeting the following requirements: 1) must have approved weather-based irrigation controllers registered with the Department (eligible weather-based irrigation controllers are those approved by the Metropolitan Water District of Southern California or the Irrigation Association Smart Water Application Technologies [SWAT] initiative); 2) must reduce overall monthly water use by the Department's Board-adopted degree of shortage plus an additional five percent from the Customer Baseline Water Usage within 30 days; and 3) must use recycled water if it is available from the Department.

5. These provisions do not apply to drip irrigation supplying water to a food source or to hand-held hose watering of vegetation, if the hose is equipped with a self-closing water shut-off device, which is allowed everyday during Phase II except between the hours of 9:00 am and 4:00 pm.

C. PHASE III

1. **Prohibited Uses Applicable to All Customers.** Should Phase III be implemented, uses applicable to Phase I of this Section shall continue to be applicable, except as specifically provided below.

2. Non-Watering Days. No landscape irrigation shall be permitted on any day other than Monday for odd-numbered street addresses and Tuesday for even-numbered street addresses. Street addresses ending in ½ or any fraction shall conform to the permitted uses for the last whole number in the address.

3. No washing of vehicles allowed except at commercial car wash facilities.

4. No filling of residential swimming pools and spas with potable water.

5. Upon written Notice to the Department, irrigation of Sports Fields may deviate from the specific non-watering days and be granted one additional watering day (for a total of 2 days allowed). To be eligible for this means of compliance, a Customer must reduce overall monthly water use by the Department's Board-adopted degree of shortage plus an additional ten percent from the Customer Baseline Water Usage within 30 days.

6. Upon written Notice to the Department, Large Landscape Areas may deviate from the specific non-watering days and be granted one additional watering day (for a total of 2 days allowed) by meeting the following requirements: 1) must have approved weather-based irrigation controllers

registered with the Department (eligible weather-based irrigation controllers are those approved by the Metropolitan Water District of Southern California or the Irrigation Association Smart Water Application Technologies [SWAT] initiative); 2) must reduce overall monthly water use by the Department's Board-adopted degree of shortage plus an additional ten percent from the Customer Baseline Water Usage within 30 days; and 3) must use recycled water if it is available from the Department.

7. These provisions do not apply to drip irrigation supplying water to a food source or to hand-held hose watering of vegetation, if the hose is equipped with a self-closing water shut-off device, which is allowed everyday during Phase IV except between the hours of 9:00 a.m. and 4:00 p.m.

D. PHASE IV

1. **Prohibited Uses Applicable To All Customers**. Should Phase IV be implemented, uses applicable to Phases I, II, and III of this Section shall continue to be applicable, except as specifically provided below.

2. Non-Watering Days. No landscape irrigation allowed.

E. PHASE V

1. **Prohibited Uses Applicable To All Customers.** Phases I, II, III, and IV of Section 121.08 shall continue to remain in effect.

2. Additional Prohibited Uses - The Board is hereby authorized to implement additional prohibited uses of water based on the water supply situation. Any additional prohibition shall be published at least once in a daily newspaper of general circulation and shall become effective immediately upon such publication and shall remain in effect until cancelled.

F. EXCEPTION. The prohibited uses of water provided for by Subsections A, B, C, D, and E of this Section are not applicable to the uses of water necessary for public health and safety or for essential government services such as police, fire, and other similar emergency services.

G. VARIANCE. If, due to unique circumstances, a specific requirement of this Section would result in undue hardship to a Customer using water or to property upon which water is used, that is disproportionate to the impacts to water users generally or to similar property or classes of water uses, then the Customer may apply for a variance from the requirements. Unique circumstances include, but are not limited to, physical disabilities which prevent compliance with the Water Conservation Plan. The Department shall adopt procedures for variance applications, review, and decision.

SEC. 121.09 FAILURE TO COMPLY.

A. Penalties – Water Meters Smaller Than Two Inches (2"). It shall be unlawful for any Customer of the Department to fail to comply with any of the provisions of this Article. Notwithstanding any other provision of the Los Angeles Municipal Code, the penalties set forth herein shall be exclusive and not cumulative with any other provisions of this Code. The penalties for failure to comply with any of the provisions of this Article shall be as follows:

1. For the first violation by any Customer of any of the provisions of Subsection A, B, C and D of Section 121.08, the Department shall issue a written notice of the fact of such violation to the Customer.

2. For a second violation by any Customer of any of the provisions of Subsection A, B, C and D of Section 121.08 within the preceding twelve (12) calendar months, a surcharge in the amount of One Hundred Dollars ($100.00) shall be added to the Customer's water bill.

3. For a third violation by any Customer of any of the provisions of Subsection A, B, C and D of Section 121.08 within the preceding twelve (12) calendar months, a surcharge in the amount of Two Hundred Dollars ($200.00) shall be added to the Customer's water bill.

4. For a fourth and any subsequent violation by a Customer of any of the provisions of Subsection A, B, C and D of Section 121.08 within the preceding twelve (12) calendar months, a surcharge in the amount of Three Hundred Dollars ($300.00) shall be added to the Customer's water bill.

5. After a fifth or subsequent violation, the Department may install a flow-restricting device of one-gallon-per-minute (1 GPM) capacity for services up to one and one-half inch (1-1/2") size and comparatively sized restrictors for larger services or terminate a Customer's service, in addition to the financial surcharges provided for herein. Such action shall be taken only after a hearing held by the Department where the Customer has an opportunity to respond to the Department's information or evidence that the Customer has repeatedly violated this Article or Department rules regarding the conservation of water and that such action is reasonably necessary to assure compliance with this Article and Department rules regarding the conservation of water.

   Any such restricted or terminated service may be restored upon application of the Customer made not less than forty-eight (48) hours after the implementation of the action restricting or terminating service and only upon a showing by the Customer that the Customer is ready, willing and able to comply with the provisions of this Article and Department rules regarding the conservation of water. Prior to any restoration of service, the Customer shall pay all Department charges for any restriction or termination of service and its restoration as provided for in the Department's rules governing water service, including but not limited to payment of all past due bills and fines.

B. Penalties – Water Meters Two Inches (2") and Larger. It shall be unlawful for any Customer of the Department to fail to comply with any of the provisions of this Article. Notwithstanding any other provision of the Los Angeles Municipal Code, the penalties set forth herein shall be exclusive and not cumulative with any other provisions of this Code. The penalties for failure to comply with any of the provisions of this Article shall be as follows:

1. For the first violation by any Customer of any of the provisions of Subsection A, B, C and D of Section 121.08, the Department shall issue a written notice of the fact of such violation to the commercial or industrial Customer.

2. For a second violation by any Customer of any of the provisions of Subsection A, B, C and D of Section 121.08 within the preceding twelve (12) calendar months, a surcharge in the amount of Two Hundred Dollars ($200.00) shall be added to the Customer's water bill.

3. For a third violation by any Customer of any of the provisions of Subsection A, B, C and D of Section 121.08 within the preceding twelve (12) calendar months, a surcharge in the amount of Four Hundred Dollars ($400.00) shall be added to the Customer's water bill.

4. For a fourth and any subsequent violation by a Customer of any of the provisions of Subsection A, B, C and D of Section 121.08 within the preceding twelve (12) calendar months, a surcharge in the amount of Six Hundred Dollars ($600.00) shall be added to the Customer's water bill.

5. After a fifth or subsequent violation, the Department may install a flow-restricting device or terminate a Customer's service, in addition to the financial surcharges provided for herein. Such action shall be taken only after a hearing held by the Department where the Customer has an opportunity to respond to the Department's information or evidence that the Customer has repeatedly violated this Article or Department rules regarding the conservation of water and that such action is reasonably necessary to assure compliance with this Article and Department rules regarding the conservation of water.

Any such restricted or terminated service may be restored upon application of the Customer made not less than forty-eight (48) hours after the implementation of the action restricting or terminating service and only upon a showing by the Customer that the Customer is ready, willing and able to comply with the provisions of this Article and Department rules regarding the conservation of water. Prior to any restoration of service, the Customer shall pay all Department charges for any restriction or termination of service and its restoration as provided for in the Department's rules governing water service, including but not limited to payment of all past due bills and fines.

C. Notice. The Department shall give notice of each violation to the Customer committing such violation as follows:

1. For any violation of the provisions of Section 121.08, the Department may give written notice of the fact of such violation to the Customer personally, by posting a notice at a conspicuous place on the Customer's premises, or by United States mail, First-Class, postage prepaid addressed to the Customer's billing address.

2. If the penalty assessed is, or includes, the installation of a flow restrictor or the termination of water service to the Customer, notice of the violation shall be given in the following manner:

(a) By giving written notice thereof to the Customer personally; or

(b) If the Customer is absent from or unavailable at either his place of residence or his place of business, by leaving a copy with some person of suitable age and discretion at either place, and sending a copy through the United States mail, First-Class postage prepaid, addressed to the Customer at his place of business, residence, or such other address provided by the Customer for bills for water or electric service if such can be ascertained; or

(c) If such place of residence, business or other address cannot be ascertained, or a person of suitable age or discretion at any such place cannot be found, then by affixing a copy in a conspicuous place on the property where the failure to comply is occurring and also by delivering a copy to a person of suitable age and discretion there residing, or employed, if such person can be found, and also sending a copy through the United States mail, First-Class, postage prepaid, addressed to the Customer at the place where the property is situated as well as such other address provided by the Customer for bills for water or electric service if such can be ascertained.

Said notice shall contain, in addition to the facts of the violation, a statement of the possible penalties for each violation and statement informing the Customer of his right to a hearing on the violation.

D. **Hearing**. Any Customer who disputes any penalty levied pursuant to this Section shall have a right to a dispute determination conducted pursuant to the Department's Rules Governing Water and Electric Service. Any Customer dissatisfied with the Department's dispute determination may appeal that determination within 15 days of issuance to the Board, or to a designated hearing officer at the election of the Board. The provisions of Sections 19.24, 19.25, 19.26 and Sections 19.29 through 19.39 of the Los Angeles Administrative Code shall apply to such appeals. All defenses, both equitable and legal, may be asserted by a Customer in the appeal process. The decisions of the Board shall become final at the expiration of 45 calendar days, unless the Council acts within that time by a majority vote to bring the action before it or to waive review of the action. If the Council timely asserts jurisdiction, the Council may, by a majority vote, amend, veto or approve the action of the Board within 21 calendar days of voting to bring the matter before it, or the action of the Board shall become final. If the City Council asserts jurisdiction over the matter and acts within 21 calendar days of voting to bring the matter before it, the City Council's action shall be the final decision.

E. Reservation of Rights. The rights of the Department hereunder shall be cumulative to any other right of the Department to discontinue service. All monies collected by the Department pursuant to any of the surcharge provisions of this Article shall be deposited in the Water Revenue Fund as reimbursement for the Department's costs and expenses of administering and enforcing this Article.

SEC. 121.10. GENERAL PROVISIONS.

A. Enforcement. The Department of Water and Power shall enforce the provisions of this Article.

B. Department to Give Effect to Legislative Intent. The Department shall provide water to its Customers in accordance with the provisions of this Article, and in a manner reasonably calculated to effectuate the intent hereof.

C. Public Health and Safety Not to be Affected. Nothing contained in this Article shall be construed to require the Department to curtail the supply of water to any Customer when, in the discretion of the Department, such water is required by that Customer to maintain an adequate level of public health and safety; provided further that a Customer's use of water to wash the Customer's property immediately following the aerial application of a pesticide, such as Malathion, shall not constitute a violation of this Article.

D. **Recycled Water and Gray Water.** The provisions of this Article shall not apply to the use of Recycled Water or Gray Water, provided that such use does not result in excess water flow or runoff onto the adjoining sidewalk, driveway, street, gutter, or ditch. This provision shall not be construed to authorize the use of Gray Water if such use is otherwise prohibited by law.

E. Large Landscape Areas. Large Landscape Areas that have multiple irrigation system stations can deviate from prescribed non-watering days if their systems include weather-based irrigation controllers, and each irrigation station is limited to the number of days prescribed in this ordinance.

F. Hillside Burn Areas. The provisions of this Article shall not apply to hillside areas recovering from fire that have been replanted for erosion control. To qualify for this exemption, a Customer must obtain verification from the agency requiring erosion control measures. The duration of the exemption is limited to, either, one growing cycle, one year, or establishment of the vegetation, whichever is the lesser time period.

SEC. 121.11. SEVERABILITY.

If any section, subsection, clause or phrase in this Article or the application thereof to any person or circumstances is for any reason held invalid, the validity of the remainder of the Article or the application of such provision to other persons or circumstances shall not be affected thereby. The City Council hereby declares that it would have passed this Article and each section, subsection, sentence, clause, or phrase thereof, irrespective of the fact that one or more sections, subsections, sentences, clauses, or phrases or the application thereof to any person or circumstance be held invalid.

Sec. 2. **URGENCY CLAUSE.**

The Council of the City of Los Angeles hereby finds and declares that there exists within this City a current water shortage and the likelihood of a continuing water shortage into the immediate future and that as a result there is an urgent necessity to take legislative action through the exercise of the police power to protect the public peace, health, and safety of this City from a public disaster or calamity. Therefore, this Ordinance shall take effect immediately upon publication.

Sec. 3. The City Clerk shall certify to the passage of this ordinance and have it published in accordance with Council policy, either in a daily newspaper circulated in the City of Los Angeles or by posting for ten days in three public places in the City of Los Angeles: one copy on the bulletin board located at the Main Street entrance to the Los Angeles City Hall; one copy on the bulletin board located at the Main Street entrance to the Los Angeles City Hall East; and one copy on the bulletin board located at the Temple Street entrance to the Los Angeles County Hall of Records.

I hereby certify that the foregoing ordinance was introduced at the meeting of the Council of the City of Los Angeles AUG 1 1 2010, and passed at it's meeting of AUG 1 8 2010.

JUNE LAGMAY, City Clerk

By ____________________ Deputy

Approved AUG 23 2010

____________________ Mayor

Approved as to Form and Legality

CARMEN A. TRUTANICH, City Attorney

By Victor Sofelkanik (VBE)
VICTOR SOFELKANIK
Deputy City Attorney)

Date 8/4/10

File No. 09-0369-S9

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City of Los Angeles

Recycled Water Master Planning

Los Angeles Department of Water and Power
and
Department of Public Works

Non-Potable Reuse Master Planning Report

Prepared by:

RMC
in association with
CDM Smith

Volume 1 of 3: Report
March 2012

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City of Los Angeles
Recycled Water Master Planning

Non-Potable Reuse

Master Planning Report

Prepared by:

RMC in association with CDM Smith

March 2012

REGISTERED PROFESSIONAL ENGINEER
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LA DWP

CITY OF LOS ANGELES
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DEPARTMENT OF
PUBLIC WORKS

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Date:	March 2012	
Reference:	Task 2: Non-Potable Reuse Master Planning Report Subtask 8.4 Non-Potable Reuse Master Plan	

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7.3 Harbor – Gateway System

The potential Harbor – Gateway System takes advantage of existing WBMWD recycled water infrastructure within the City for LADWP customers that are too far from the City's reclamation plants. In this case, two potential WRPs were defined around three anchor customers within a cost-effective distance from WBMWD's Title 22 system.

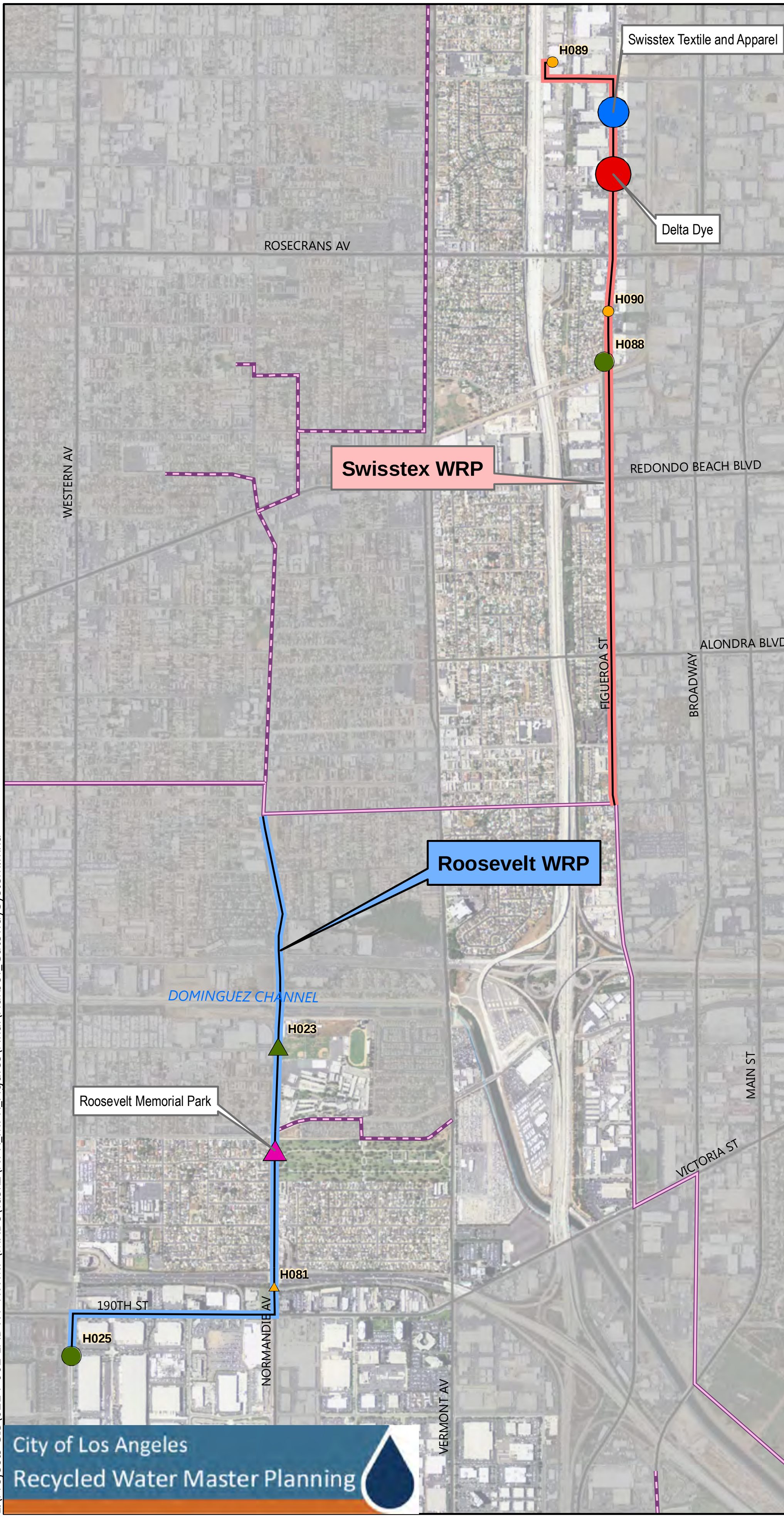
Table 7-7: Harbor – Gateway System – Summary of Potential WRPs

WRP	Annual Demand (AFY)	Annual Demand (mgd)	Peak Day Demand (mgd)	Capital Cost ($M)	O&M Cost ($M/yr)	PV Unit Cost ($/AF)
Roosevelt	123	0.11	0.22	$2.70	$0.10	$1,470
Swisstex	523	0.47	0.61	$3.52	$0.39	$1,120
Total	**645**	**0.58**	**0.83**	**$6.21**	**$0.48**	**$1,180**

Note: Total system demands or costs may not be equal to the sum of the individual WRP demands or costs due to rounding. See **Appendix I** for individual WRP descriptions.

Implementation Considerations

Each WRP in this system can be implemented independently so the primary consideration for each WRP is the anchor customer's commitment to use recycled water. Also, the availability of additional supply and conveyance capacity from WBMWD must be confirmed prior to implementation. The availability of additional supply from WBMWD in the future is not ensured since WBWMD has plans to potentially use all remaining treatment capacity at ELWRF. The WBMWD recycled water distribution system has some potential hydraulic capacity limitations.



Potential System
Harbor Gateway
Figure 7-3

Potential Irrigation-Only Customer
- ≥ 5 AFY
- ≥ 25 AFY
- ≥ 50 AFY
- ≥ 100 AFY
- ≥ 250 AFY

Potential Non-Irrigation Customer
- ≥ 5 AFY
- ≥ 25 AFY
- ≥ 50 AFY
- ≥ 100 AFY
- ≥ 250 AFY

Exisiting Facilities
- Tank
- PS Pump Station
- Pipeline

Planned Facilities
- Tank
- PS Pump station
- Pipeline

Potential Facilities
- Tank
- PS Pump Station
- PRV

Potential System
- Roosevelt WRP
- Swisstex WRP

Non-LADWP Pipeline
- Existing Pipeline
- Planned Pipeline

Existing/Planned Customers
- Existing Customer
- Planned Customer

Other Feature
- Other City

N

0 0.25 0.5 Miles

LA DWP

CITY OF LOS ANGELES SANITATION DEPARTMENT OF PUBLIC WORKS

RMC in association with CDM

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Data Sources: USGS, LADWP, ESRI, NAIP Note: Only potential customers ≥ 50 AFY are labeled and potential customers <50 AFY have IDs shown

Customers

Table 7-8: Harbor – Gateway System – Summary of Potential Customers

Customers[1]	Type of Use	Annual Demand (AFY)	Annual Demand (mgd)	Peak Day Demand (mgd)	Conversion Rating[1] Initial[2]	Conversion Rating[1] Compre-hensive[3]
Roosevelt WRP		**123**	**0.11**	**0.22**		
Roosevelt Memorial Park	Irrigation	60	0.05	0.12	B	--
Non-Anchor Customers (3)		63	0.06	0.10		
Swisstex WRP		**523**	**0.47**	**0.61**		
Delta Dye	Industrial	270	0.24	0.31	B	B,B
Swisstex Textile and Apparel	Industrial	180	0.16	0.21	B	C,B
Non-Anchor Customers (3)		73	0.06	0.08		
Total[4]		**645**	**0.58**	**0.83**		

1. Anchor customers, which have an estimated annual average demand of at least 50 AFY, are individually listed and non-anchor customers are summarized for each WRP.
2. The "Initial" conversion ratings were prepared for all customers with initial non-potable demands of greater than 75 AFY.
3. The "Comprehensive" conversion ratings based on a more detailed assessment than the initial evaluation and conducted for a shorter list of priority anchor customers. This assessment has two conversion ratings – one for likelihood to convert and one strictly related to the conversion cost.
4. Total system demands may not be equal to the sum of the individual WRP demands due to rounding.

Facilities

This system depends on the WBMWD Title 22 system for supply and pressure and the availability of conveyance capacity and sufficient pressure must be confirmed with WBMWD. Each WRP requires a connection with the existing WBMWD Title 22 Distribution System. The Roosevelt WRP connection is at W 168th Street and S Figueroa Street. The Swisstex WRP connection is at W 168th Street and South Normandie Avenue. No new major facilities are included in this system since it is dependent on the WBMWD Title 22 system.

Costs

Table 7-9: Harbor – Gateway System – Summary of Potential Costs

WRP / Item	Roosevelt	Swisstex	Total
Annual Yield (AFY)	123	523	645
Capital Cost ($M)			
Storage Tanks	--	--	--
Pump Stations	--	--	--
PRVs	--	--	--
Pipelines	$1.60	$2.08	$3.68
Subtotal	*$1.60*	*$2.08*	*$3.68*
Construction Cont.	$0.48	$0.62	$1.10
Subtotal	*$2.07*	*$2.70*	*$4.78*
Implementation	$0.62	$0.81	$1.43
Total	**$2.70**	**$3.52**	**$6.21**
Annual O&M Cost ($M/yr)			
Facility O&M	$0.01	$0.01	$0.01
RW Purchase Cost	$0.09	$0.38	$0.47
Total	**$0.10**	**$0.39**	**$0.48**
50-Year Present Value Analysis			
Present Value ($M)	$9.00	$29.28	$38.21
Total Yield (AF)	6,127	26,131	32,257
PV Unit Cost ($/AF)	**$1,470**	**$1,120**	**$1,180**

Note: Total costs may not be equal to the sum of the individual component costs due to rounding. See **Appendix J** for detailed cost estimates.

4. Harbor – Gateway System

Overview

The potential Harbor – Gateway System takes advantage of existing WBMWD recycled water infrastructure within the City for LADWP customers that are too far from the City's reclamation plants. In this case, two potential WRPs were defined around three anchor customers within a cost-effective distance from WBMWD's Title 22 system.

Harbor – Gateway System – Summary of WRPs

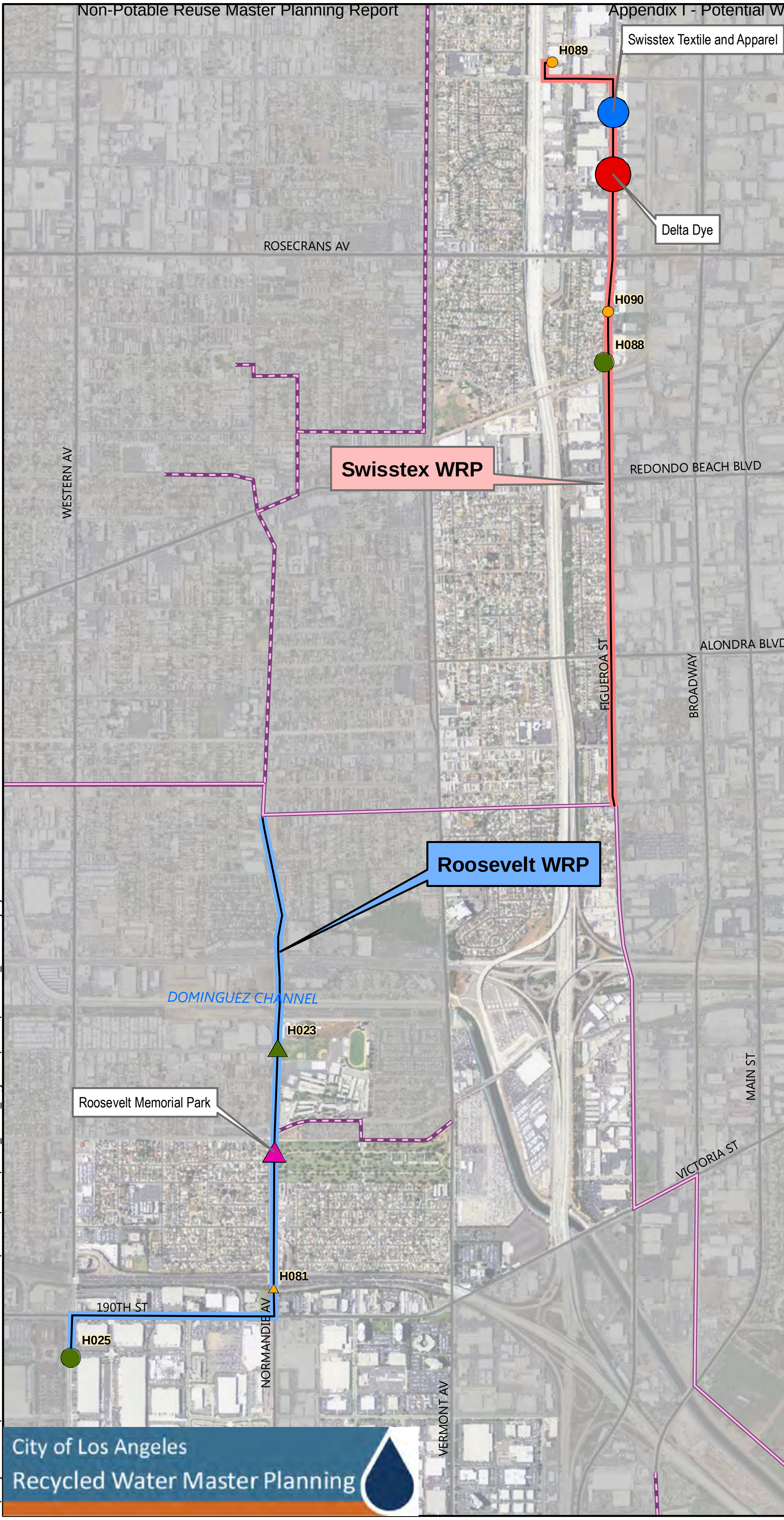
WRP	Annual Demand (AFY)	Annual Demand (MGD)	Peak Day Demand (MGD)	Capital Cost ($M)	O&M Cost ($M/yr)	Lifecycle Unit Cost ($/yr)
Roosevelt	123	0.11	0.22	$2.70	$0.10	$1,470
Swisstex	523	0.47	0.61	$3.52	$0.39	$1,120
Total	**645**	**0.58**	**0.83**	**$6.21**	**$0.48**	**$1,180**

Note: Total system demands or costs may not be equal to the sum of the individual WRP demands or costs due to rounding.

Implementation Considerations

Each WRP in this system can be implemented independently so the primary consideration for each WRP is the anchor customer's commitment to use recycled water. Also, the availability of supply and conveyance capacity from WBMWD must be confirmed prior to implementation. WBWMD has plans to potentially use all remaining treatment capacity at ELWRF so the availability of supply from WBMWD in the future is not guaranteed. A potential challenge to this WRP is that the WBMWD recycled water distribution system may have hydraulic restrictions which prevent it delivering the additional supply for these potential WRPs.

Potential System
Harbor Gateway
Figure 7-3



Potential Irrigation-Only Customer
- ≥ 5 AFY
- ≥ 25 AFY
- ≥ 50 AFY
- ≥ 100 AFY
- ≥ 250 AFY

Potential Non-Irrigation Customer
- ≥ 5 AFY
- ≥ 25 AFY
- ≥ 50 AFY
- ≥ 100 AFY
- ≥ 250 AFY

Exisiting Facilities
- Tank
- PS Pump Station
- Pipeline

Planned Facilities
- Tank
- PS Pump station
- Pipeline

Potential Facilities
- Tank
- PS Pump Station
- PRV

Potential System
- Roosevelt WRP
- Swisstex WRP

Non-LADWP Pipeline
- Existing Pipeline
- Planned Pipeline

Existing/Planned Customers
- Existing Customer
- Planned Customer

Other Feature
- Other City

N

0 0.25 0.5 Miles

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Data Sources: USGS, LADWP, ESRI, NAIP

Note: Only potential customers ≥ 50 AFY are labeled and potential customers <50 AFY have IDs shown

DESCRIPTION: Present Value Estimate   Date: 3/14/2012

SYSTEM: Harbor Gateway

WRP: All

Annual Yield (AFY)
645

Item	Qty	Units	Unit Cost		Cost
Capital Costs					
Storage					
Tank 1	0.0	MG	$0	$	-
Pump Station					
PS 1	0	gpm	formula	$	-
Pressure Reducing Stations	Diam (in)				
Pressure Reducer 1	0	LS	$0	$	-
Conveyance	Length (ft)				
6 inch	12,015	in-diam*LF	$24	$	1,730,000
8 inch	10,131	in-diam*LF	$24	$	1,945,000
10 inch	0	in-diam*LF	$20	$	-
			Construction Subtotal	**$**	**3,675,000**
		Contingency Costs	30%	$	1,103,000
			Construction Total	**$**	**4,778,000**
		Implementation Costs	30%	$	1,433,000
			Total Capital Cost	**$**	**6,211,000**
Capital Replacement Costs					
20-Year Useful Life					
Storage			10%	$	-
Pump Station			50%	$	-
Conveyance			0%	$	-
Pressure Reducing Stations			50%	$	-
			Construction Subtotal	**$**	**-**
		Contingency Costs	30%	$	-
			Construction Total	**$**	**-**
		Implementation Costs	30%	$	-
			Total 20-year Capital Cost	**$**	**-**

Item		Qty	Units	Unit Cost		Cost
O&M Costs ($ / Year)						
Storage		-	LS	$75,000	$	-
Pump Station						
Maintenance	$	-	capital cost	5.0%	$	-
Maintenance		-	LS	$10,000	$	-
PS 1 - Electricity		-	kWh	$0.12	$	-
PS 2 - Electricity		-	kWh	$0.12	$	-
Conveyance		22,146	LF	$0.60	$	13,000
Pressure Reducing Stations		-	station(s)	$20,000	$	-
				Total Annual O&M	**$**	**13,000**
Recycled Water Purchase ($ / Year)						
West Basin - Nitrified			AFY	$800	$	-
West Basin - Tertiary		645	AFY	$728	$	470,000
Central Basin MWD			AFY	$500	$	-
Burbank WP			AFY	$0	$	-
Las Virgenes MWD			AFY	$500	$	-
		645		**Purchase Cost Total**	**$**	**470,000**

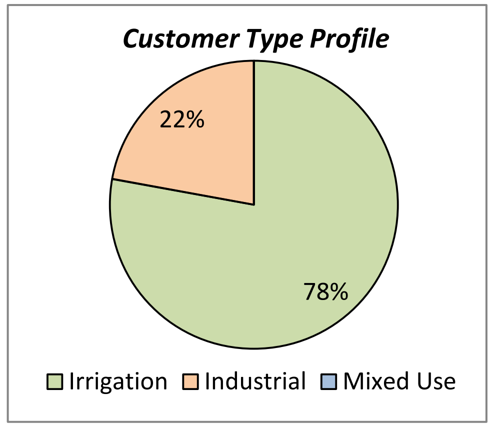
PV Calculations			
Inflation / Discount Rate		Project Yield	
Construction/O&M Esca	3.0%	Annual Yield (AFY)	645
Water Purchase Escalat	4.0%	Total Yield (AF)	32,257
Discount Rate	3.0%		

Economic Cost Summary					
Present Value Calculations			PV Factor		
Initial Capital Cost	$	6,211,000	1.00	$	6,211,000
20-Year Capital Costs	$	-	2.00	$	-
Annual O&M Costs	$	13,000	49.00	$	637,000
Recycled Water Cost	$	470,000	66.73	$	31,363,000
Salvage	$	-	1.00	$	-
			Total PV	**$**	**38,211,000**
			50-year Project Yield (AF)		**32,257**
			Unit Cost ($/af)		**$1,180**

4.1 Roosevelt WRP

This WRP defines service to four potential customers located south of the existing WBMWD recycled system in the Gateway area of the City, including one anchor customer:

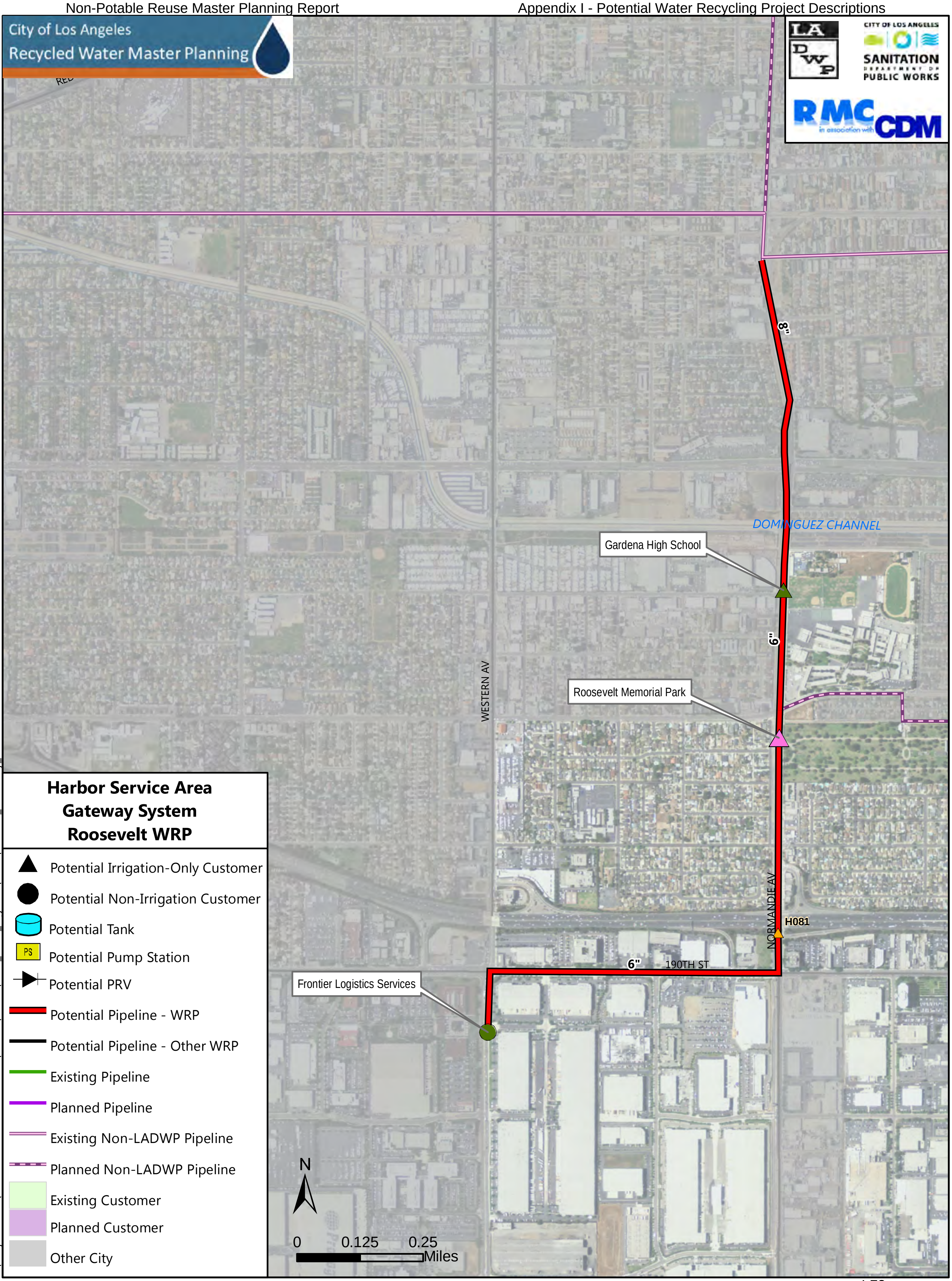
- Roosevelt Memorial Park



Avg Annual Demand (AFY)	Avg Annual Demand (MGD)	Peak Day Demand (MGD)	Capital Cost ($M)	O&M Cost ($M/yr)	Unit Lifecycle Cost ($/AF)
123	0.11	0.22	$2.70	$0.10	$1,470/AF

Facilities

- **WBMWD Connection:** This WRP requires a connection with the existing WBMWD Title 22 Distribution System along W 168th St at S Figueroa St.
- **Crossings:** A crossing of I-405 at the Normandie Ave underpass is required to serve Frontier Logistics but is not necessary for the WRP's other customers.
- **Pipelines:** This WRP includes approximately 1.9 miles of 6"to 8" pipe. The utility review was conducted for transmission pipelines but not completed for laterals and only laterals are included in this WRP so there are no review findings.



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Note: Only potential customers ≥ 25 AFY are labeled. Other potential customers have IDs shown.

Customers

Gateway System – Roosevelt WRP Potential Customers

ID[1]	Name[2]	Type of Use	Annual Demand (AFY)	Annual Demand (MGD)	Peak Day Demand (MGD)	Conversion Rating Initial[3]	Conversion Rating Comprehensive[4]
H015	Roosevelt Memorial Park	Irrigation	60	0.05	0.12	B	--
H023	Gardena High School	Irrigation	30	0.03	0.06	--	--
H025	Frontier Logistics Services	Industrial	27	0.02	0.03	--	--
H081	Caltrans (405 at Normandie Ave)	Irrigation	5	0.00	0.01	--	--
		Total[5]	**123**	**0.11**	**0.22**		

Notes:

1. Table is sorted by the customer's ID from the database and GIS.
2. Names in all caps were not individually reviewed.
3. The "Initial" conversion ratings were prepared for all customers with initial non-potable demands of greater than 75 AFY and were documented in the Initial Customer Evaluations TMs.
4. The basis for the "Comprehensive" conversion ratings were documented in the Customer Conversion Evaluations TMs. The evaluations were a more detailed assessment than the initial evaluation and conducted for a shorter list of priority anchor customers. This assessment has two conversion ratings – one for likelihood to convert and one strictly related to the conversion cost.
5. Individual customer demand values are rounded. Total values are based on the sum of unrounded individual customer demand values.

The following are considerations for the anchor customer:

- **Roosevelt Memorial Park:** LADWP received a Letter of Intent from Roosevelt on June 1, 2010 that states their commitment to using recycled water. However, an issue that must be addressed by all cemeteries is use of recycled in hose bibs across the site because recent CDPH decisions dictate that the hose bibs must remain on potable water, which requires a separate potable water system and significantly increases the cost of the non-potable conversion.

DESCRIPTION: Present Value Estimate Date: 3/14/2012

SYSTEM: Harbor Gateway

WRP: Roosevelt

Annual Yield (AFY)
123

Item	Qty	Units	Unit Cost	Cost
Capital Costs				
Storage				
Tank 1	0.0	MG	$0	$ -
Pump Station				
PS 1	0	gpm	formula	$ -
Pressure Reducing Stations	Diam (in)			
Pressure Reducer	0	LS	$0	$ -
Conveyance	Length (ft)			
6 inch	6,407	in-diam*LF	$24	$ 923,000
8 inch	3,506	in-diam*LF	$24	$ 673,000
10 inch	0	in-diam*LF	$20	$ -
		Construction Subtotal		**$ 1,596,000**
		Contingency Costs	30%	$ 479,000
		Construction Total		**$ 2,075,000**
		Implementation Costs	30%	$ 623,000
		Total Capital Cost		**$ 2,698,000**
Capital Replacement Costs				
20-Year Useful Life				
Storage			10%	$ -
Pump Station			50%	$ -
Conveyance			0%	$ -
Pressure Reducing Stations			50%	$ -
		Construction Subtotal		**$ -**
		Contingency Costs	30%	$ -
		Construction Total		**$ -**
		Implementation Costs	30%	$ -
		Total 20-year Capital Cost		**$ -**

Item		Qty	Units	Unit Cost		Cost
O&M Costs ($ / Year)						
Storage		-	LS	$75,000	$	-
Pump Station						
Maintenance	$	-	capital cost	5.0%	$	-
Maintenance		-	LS	$10,000	$	-
PS 1 - Electricity		-	kWh	$0.12	$	-
PS 2 - Electricity		-	kWh	$0.12	$	-
Conveyance		9,913	LF	$0.60	$	6,000
Pressure Reducing Stations		-	station(s)	$20,000	$	-
				Total Annual O&M	**$**	**6,000**
Recycled Water Purchase ($ / Year)						
West Basin - Nitrified			AFY	$800	$	-
West Basin - Tertiary		123	AFY	$728	$	90,000
Central Basin MWD			AFY	$500	$	-
Burbank WP			AFY	$0	$	-
Las Virgenes MWD			AFY	$500	$	-
		123		**Purchase Cost Total**	**$**	**90,000**

PV Calculations

Inflation / Discount Rate		Project Yield	
Construction/O&M Esca	3.0%	Annual Yield (AFY)	123
Water Purchase Escalat	4.0%	Total Yield (AF)	6,127
Discount Rate	3.0%		

Economic Cost Summary

Present Value Calculations			PV Factor		
Initial Capital Cost	$	2,698,000	1.00	$	2,698,000
20-Year Capital Costs	$	-	2.00	$	-
Annual O&M Costs	$	6,000	49.00	$	294,000
Recycled Water Cost	$	90,000	66.73	$	6,006,000
Salvage	$	-	1.00	$	-
			Total PV	**$**	**8,998,000**
			50-year Project Yield (AF)		**6,127**
			Unit Cost ($/af)		**$1,470**

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Using Effluent Water On Your Golf Course

by DR. DAVID KOPEC, DR. CHARLES MANCINO, and DOUGLAS NELSON
University of Arizona, Tucson, Arizona

YOU MIGHT CALL IT a recycler's nightmare. Every day, 365 days a year, hundreds of millions of gallons of useable treated water is dumped needlessly into the ground, rivers, and oceans of the world. Is this truly necessary, or is there an alternative method of disposal to allow the recapture of some of this water and put it through a natural filter? Actually, there is! Parks, golf courses, sports fields, and certain agricultural crops all can use effluent water for irrigation.

In addition to preventing needless dumping, a useable effluent water supply has several other advantages. These include (1) guaranteed availability, even during periods of drought, (2) a nutrient content that potentially can lessen dependence on manufactured fertilizers, (3) the freeing of limited supplies of potable water for other, more essential uses, and (4) income, from the sale of effluent water to agricultural users, to pay for the construction of public sewage treatment plants.

Before running to the faucet and turning on an effluent water supply, however, there are several points that should be considered. To begin with, a thorough understanding of effluent water and how it is produced is essential.

What is Effluent?

The source of most effluent water supplies comes from municipal sewage that is approximately 99.9% water (effluent) and

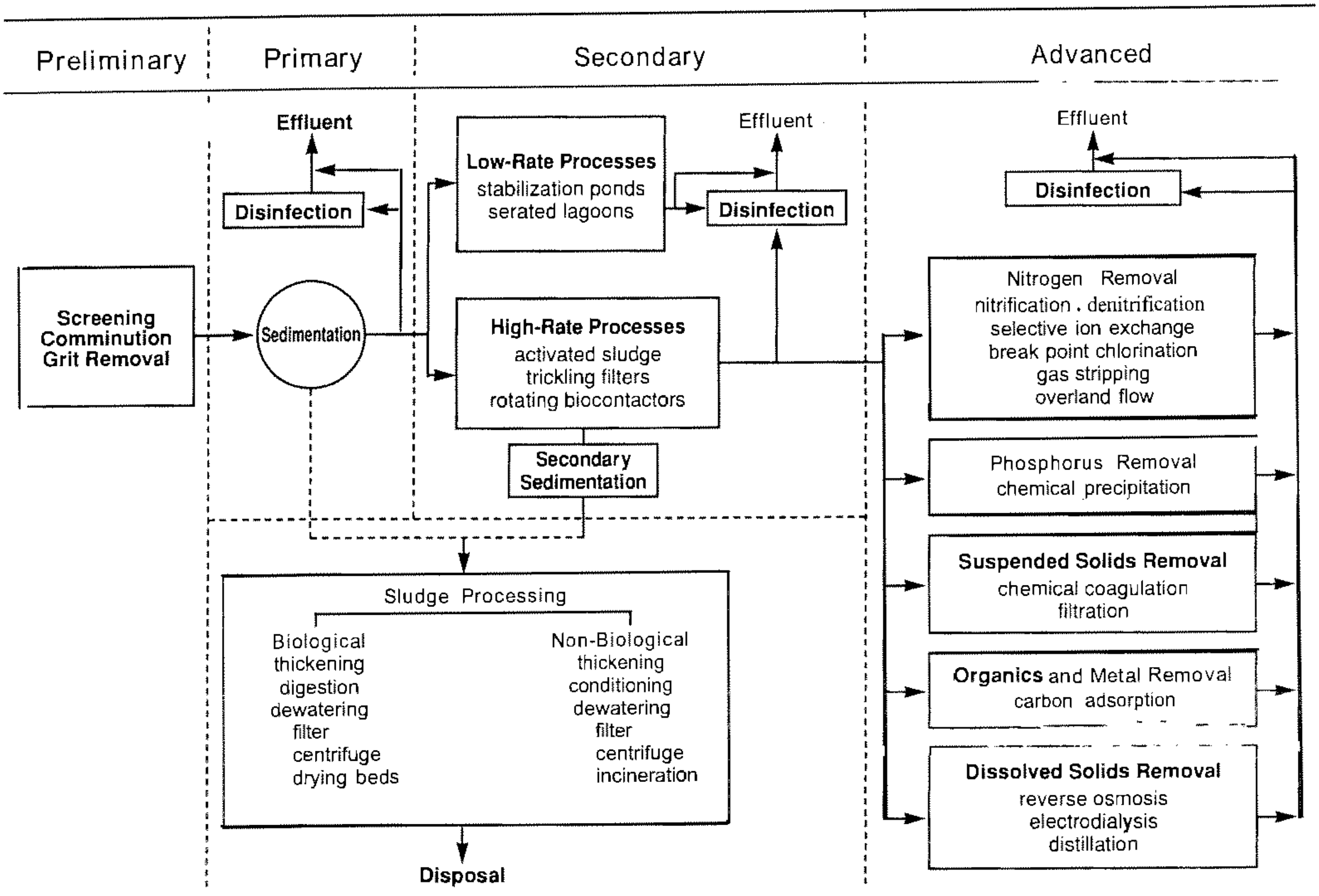

Figure 1 — Generalized Flow Sheet for Wastewater Treatment
Source: Asano, T., R. G. Smith, and G. Tschobanoglous, 1984

(Na), chlorine (Cl), magnesium (Mg), calcium (Ca), sulfate (SO_4), and bicarbonates (HCO_3). After irrigation with effluent, these salts accumulate in the soil and attract pure water molecules, preventing some of the water from being absorbed by the turfgrass plants. As a result, less "free" water is available for turfgrass uptake and symptoms of drought stress begin to occur

Sodium Hazard — Sodium hazard indicates the relative amount of sodium (Na) in relation to calcium (Ca) and magnesium (Mg). A high amount of sodium in effluent water is undesirable from a water and soil standpoint. In addition to being a component of salt stress, sodium (Na) accumulation eventually will result in displacement of calcium (Ca) and magnesium (Mg) on the exchange sites of soil particles. This in turn inhibits the ability of the soil to aggregate and form peds necessary to maintain good soil structure.

Bicarbonate Concentration — Bicarbonate (HCO_3) concentration is important because of its ability to form precipitates of calcium carbonate ($CaCO_3$) and magnesium carbonate ($MgCO_3$). These precipitates "steal" calcium and magnesium from the soil particle exchange sites, and in turn can be replaced by sodium. Of lesser importance is that excess bicarbonate can lead to an increase in soil pH.

Toxic Ion Concentration -High concentrations of specific ions, such as chlorine and boron, can cause damage as they accumulate in plant tissue. Fortunately, turfgrasses are relatively tolerant of several toxic ions. These ions tend to accumulate in the leaf tip and are removed during mowing. Many ornamental trees and shrubs are not as fortunate, however, and can experience disfiguring leaf burns. The type and amount of toxic ions found in effluent is a function of where the raw sewage emanates from. Generally speaking, most municipal effluent does not contain high toxic ion concentrations, whereas industrial and mining effluent does.

pH — The pH (negative logarithm of the hydrogen ion concentration) of effluent water serves as an indication that there may be some type of ion imbalance in the water. In general, it is held that the pH of the water itself is not a problem, as most soils have a great resistance to pH alteration.

What Next?

With an understanding of the chemical characteristics of effluent water, developing maintenance practices that compensate for any negative attributes is a relatively simple matter. To begin with, the highest management priority is determining the water's total salt concentration. As mentioned previously, dissolved salts can quickly accumulate in the soil and inhibit "free" moisture/nutrient uptake.

To avoid such an occurrence, periodic heavy irrigation cycles must be programmed to saturate the soil and leach the salts below the root zone. To accommodate salt leaching, the importance of good subsurface drainage cannot be overstated. This point is especially important in regard to putting greens, where excessively wet conditions would make the soil more susceptible to excessive compaction from concentrated foot traffic.

Another high priority is the sodium hazard, or the relative amount of sodium in comparison to calcium and magnesium. If the sodium hazard is high, the sodium ions will accumulate on the soil exchange sites and cause degradation of the soil structure. As a counterbalance, additional calcium should be added to the soil. In a majority of cases, this can be done by applying calcium sulfate (gypsum) in either a granular or liquid formulation.

In cases where the soil has a high pH and excess free calcium carbonate, however, sulfur should be applied. As the sulfur breaks down, it dissolves the natural calcium deposits and increases the availability of minor nutrients by lowering the

As a potential benefit, many effluent water supplies contain substantial amounts of nitrogen, phosphorus, and potassium (Table 3). However, due to daily and seasonal nutrient fluctuations, it is not possible to calculate the exact amount of these nutrients that will be deposited on the turf so that it can be subtracted from the annual fertilization program. Therefore, monitoring of both turf performance and soil test data should be done to make the necessary adjustments.

Although nutrient content is a potential benefit, toxic ions are another matter. If present, some toxic ions can lead to the deterioration of the turf and the surrounding landscape. Since the removal of toxic ions from an effluent supply would not be economically feasible in most cases, and they cannot be effectively leached through the soil, blending of the effluent with other water sources is likely to be the only real solution. For example, the concentration of boron could be reduced to a nontoxic level by blending an effluent water supply with a well water supply.

Though not directly toxic to plants, high bicarbonate levels in effluent water can contribute to sodium buildup in the soil by reacting with calcium and magnesium. To prevent this reaction, acid injection (the addition of acid to the effluent water) sometimes is nsed to lower the pH and nullify the bicarbonate ion. To determine the potential benefits of acid injection, water samples can be submitted for special testing.

Conclusion

As an alternative to potable water use, effluent water can in fact be a logical, safe, and economical choice for golf course and sports turf irrigation. Furthermore, it offers an environmentally responsible choice to the wholesale dumping of treated water into existing waterways. Turning on the faucet simply requires understanding both what effluent water is and what it is not!

Table 3
Potential Fertilizer Value of Irvine Ranch Water District Reclaimed Water (Per Acre-Foot)

Nutrients	Concentration mg/l	Pounds/ac.-ft.	Commercial* Value $/ac.-ft.
Nitrogen (N)	23.0	62.6	$11.27
Phosphorus (P)	2.2	6.0	2.82
Potassium (K)	13.9	38.1	6.10
Total Potential Fertilizer Value			$20.19

*Commercial value based on average fertilizer prices for the summer of 1980: N = 18¢/lb., P = 47¢/lb., K = 16¢/lb.
Source: Asano, [redacted]

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Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change

Summary for Policymakers

This summary, approved in detail at the Eighth Session of IPCC Working Group II (Brussels, Belgium, 2-5 April 2007), represents the formally agreed statement of the IPCC concerning the sensitivity, adaptive capacity and vulnerability of natural and human systems to climate change, and the potential consequences of climate change.

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A. Introduction

This Summary sets out the key policy-relevant findings of the Fourth Assessment of Working Group II of the Intergovernmental Panel on Climate Change (IPCC).

The Assessment is of current scientific understanding of the impacts of climate change on natural, managed and human systems, the capacity of these systems to adapt and their vulnerability.[1] It builds upon past IPCC assessments and incorporates new knowledge gained since the Third Assessment.

Statements in this Summary are based on chapters in the Assessment and principal sources are given at the end of each paragraph.[2]

B. Current knowledge about observed impacts of climate change on the natural and human environment

A full consideration of observed climate change is provided in the Working Group I Fourth Assessment. This part of the Working Group II Summary concerns the relationship between observed climate change and recent observed changes in the natural and human environment.

The statements presented here are based largely on data sets that cover the period since 1970. The number of studies of observed trends in the physical and biological environment and their relationship to regional climate changes has increased greatly since the Third Assessment in 2001. The quality of the data sets has also improved. There is, however, a notable lack of geographical balance in the data and literature on observed changes, with marked scarcity in developing countries.

Recent studies have allowed a broader and more confident assessment of the relationship between observed warming and impacts than was made in the Third Assessment. That Assessment concluded that "there is high confidence[3] that recent regional changes in temperature have had discernible impacts on many physical and biological systems".

From the current Assessment we conclude the following.

Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases.

With regard to changes in snow, ice and frozen ground (including permafrost),[4] there is high confidence that natural systems are affected. Examples are:
- enlargement and increased numbers of glacial lakes [1.3];
- increasing ground instability in permafrost regions, and rock avalanches in mountain regions [1.3];
- changes in some Arctic and Antarctic ecosystems, including those in sea-ice biomes, and also predators high in the food chain [1.3, 4.4, 15.4].

Based on growing evidence, there is high confidence that the following effects on hydrological systems are occurring:
- increased runoff and earlier spring peak discharge in many glacier- and snow-fed rivers [1.3];
- warming of lakes and rivers in many regions, with effects on thermal structure and water quality [1.3].

There is very high confidence, based on more evidence from a wider range of species, that recent warming is strongly affecting terrestrial biological systems, including such changes as:
- earlier timing of spring events, such as leaf-unfolding, bird migration and egg-laying [1.3];
- poleward and upward shifts in ranges in plant and animal species [1.3, 8.2, 14.2].

Based on satellite observations since the early 1980s, there is high confidence that there has been a trend in many regions towards earlier 'greening'[5] of vegetation in the spring linked to longer thermal growing seasons due to recent warming [1.3, 14.2].

There is high confidence, based on substantial new evidence, that observed changes in marine and freshwater biological systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation [1.3]. These include:
- shifts in ranges and changes in algal, plankton and fish abundance in high-latitude oceans [1.3];
- increases in algal and zooplankton abundance in high-latitude and high-altitude lakes [1.3];
- range changes and earlier migrations of fish in rivers [1.3].

[1] For definitions, see Endbox 1.
[2] Sources to statements are given in square brackets. For example, [3.3] refers to Chapter 3, Section 3. In the sourcing, F = Figure, T = Table, B = Box and ES = Executive Summary.
[3] See Endbox 2.
[4] See Working Group I Fourth Assessment.
[5] Measured by the Normalised Difference Vegetation Index, which is a relative measure of the amount of green vegetation in an area based on satellite images.

The uptake of anthropogenic carbon since 1750 has led to the ocean becoming more acidic, with an average decrease in pH of 0.1 units [IPCC Working Group I Fourth Assessment]. However, the effects of observed ocean acidification on the marine biosphere are as yet undocumented [1.3].

A global assessment of data since 1970 has shown it is likely[6] that anthropogenic warming has had a discernible influence on many physical and biological systems.

Much more evidence has accumulated over the past five years to indicate that changes in many physical and biological systems are linked to anthropogenic warming. There are four sets of evidence which, taken together, support this conclusion:

1. The Working Group I Fourth Assessment concluded that most of the observed increase in the globally averaged temperature since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations.

2. Of the more than 29,000 observational data series,[7] from 75 studies, that show significant change in many physical and biological systems, more than 89% are consistent with the direction of change expected as a response to warming (Figure SPM.1) [1.4].

3. A global synthesis of studies in this Assessment strongly demonstrates that the spatial agreement between regions of significant warming across the globe and the locations of significant observed changes in many systems consistent with warming is very unlikely to be due solely to natural variability of temperatures or natural variability of the systems (Figure SPM.1) [1.4].

4. Finally, there have been several modelling studies that have linked responses in some physical and biological systems to anthropogenic warming by comparing observed responses in these systems with modelled responses in which the natural forcings (solar activity and volcanoes) and anthropogenic forcings (greenhouse gases and aerosols) are explicitly separated. Models with combined natural and anthropogenic forcings simulate observed responses significantly better than models with natural forcing only [1.4].

Limitations and gaps prevent more complete attribution of the causes of observed system responses to anthropogenic warming. First, the available analyses are limited in the number of systems and locations considered. Second, natural temperature variability is larger at the regional than at the global scale, thus affecting identification of changes due to external forcing. Finally, at the regional scale other factors (such as land-use change, pollution, and invasive species) are influential [1.4].

Nevertheless, the consistency between observed and modelled changes in several studies and the spatial agreement between significant regional warming and consistent impacts at the global scale is sufficient to conclude with high confidence that anthropogenic warming over the last three decades has had a discernible influence on many physical and biological systems [1.4].

Other effects of regional climate changes on natural and human environments are emerging, although many are difficult to discern due to adaptation and non-climatic drivers.

Effects of temperature increases have been documented in the following (medium confidence):
- effects on agricultural and forestry management at Northern Hemisphere higher latitudes, such as earlier spring planting of crops, and alterations in disturbance regimes of forests due to fires and pests [1.3];
- some aspects of human health, such as heat-related mortality in Europe, infectious disease vectors in some areas, and allergenic pollen in Northern Hemisphere high and mid-latitudes [1.3, 8.2, 8.ES];
- some human activities in the Arctic (e.g., hunting and travel over snow and ice) and in lower-elevation alpine areas (such as mountain sports) [1.3].

Recent climate changes and climate variations are beginning to have effects on many other natural and human systems. However, based on the published literature, the impacts have not yet become established trends. Examples include:

- Settlements in mountain regions are at enhanced risk of glacier lake outburst floods caused by melting glaciers. Governmental institutions in some places have begun to respond by building dams and drainage works [1.3].

- In the Sahelian region of Africa, warmer and drier conditions have led to a reduced length of growing season with detrimental effects on crops. In southern Africa, longer dry seasons and more uncertain rainfall are prompting adaptation measures [1.3].

- Sea-level rise and human development are together contributing to losses of coastal wetlands and mangroves and increasing damage from coastal flooding in many areas [1.3].

[6] See Endbox 2.
[7] A subset of about 29,000 data series was selected from about 80,000 data series from 577 studies. These met the following criteria: (1) ending in 1990 or later; (2) spanning a period of at least 20 years; and (3) showing a significant change in either direction, as assessed in individual studies.

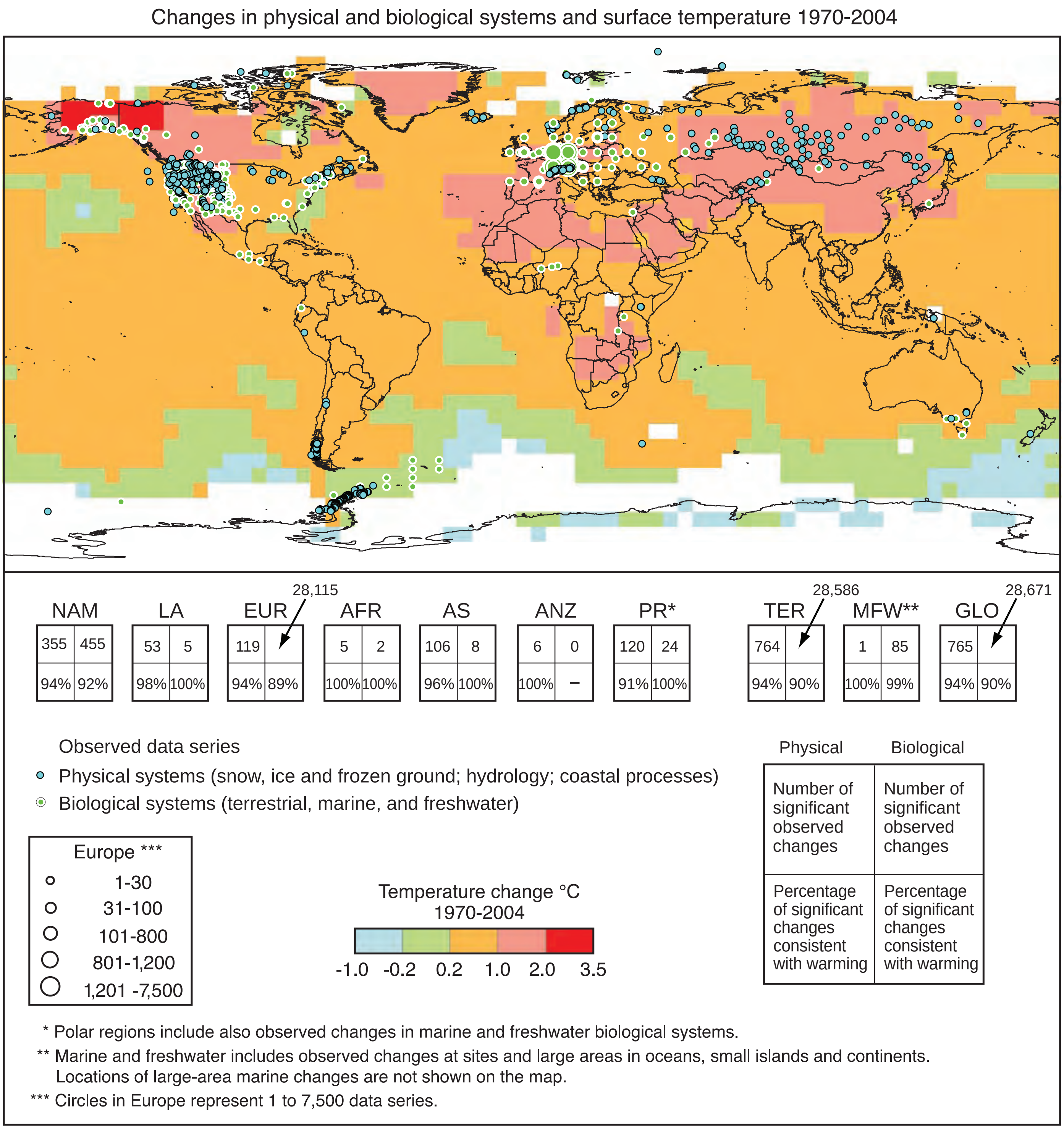

Figure SPM.1. *Locations of significant changes in data series of physical systems (snow, ice and frozen ground; hydrology; and coastal processes) and biological systems (terrestrial, marine, and freshwater biological systems), are shown together with surface air temperature changes over the period 1970-2004. A subset of about 29,000 data series was selected from about 80,000 data series from 577 studies. These met the following criteria: (1) ending in 1990 or later; (2) spanning a period of at least 20 years; and (3) showing a significant change in either direction, as assessed in individual studies. These data series are from about 75 studies (of which about 70 are new since the Third Assessment) and contain about 29,000 data series, of which about 28,000 are from European studies. White areas do not contain sufficient observational climate data to estimate a temperature trend. The 2 x 2 boxes show the total number of data series with significant changes (top row) and the percentage of those consistent with warming (bottom row) for (i) continental regions: North America (NAM), Latin America (LA), Europe (EUR), Africa (AFR), Asia (AS), Australia and New Zealand (ANZ), and Polar Regions (PR) and (ii) global-scale: Terrestrial (TER), Marine and Freshwater (MFW), and Global (GLO). The numbers of studies from the seven regional boxes (NAM, …, PR) do not add up to the global (GLO) totals because numbers from regions except Polar do not include the numbers related to Marine and Freshwater (MFW) systems. Locations of large-area marine changes are not shown on the map. [Working Group II Fourth Assessment F1.8, F1.9; Working Group I Fourth Assessment F3.9b].*

C. Current knowledge about future impacts

The following is a selection of the key findings regarding projected impacts, as well as some findings on vulnerability and adaptation, in each system, sector and region for the range of (unmitigated) climate changes projected by the IPCC over this century[8] judged to be relevant for people and the environment.[9] The impacts frequently reflect projected changes in precipitation and other climate variables in addition to temperature, sea level and concentrations of atmospheric carbon dioxide. The magnitude and timing of impacts will vary with the amount and timing of climate change and, in some cases, the capacity to adapt. These issues are discussed further in later sections of the Summary.

More specific information is now available across a wide range of systems and sectors concerning the nature of future impacts, including for some fields not covered in previous assessments.

Freshwater resources and their management

By mid-century, annual average river runoff and water availability are projected to increase by 10-40% at high latitudes and in some wet tropical areas, and decrease by 10-30% over some dry regions at mid-latitudes and in the dry tropics, some of which are presently water-stressed areas. In some places and in particular seasons, changes differ from these annual figures. ** D[10] [3.4]

Drought-affected areas will likely increase in extent. Heavy precipitation events, which are very likely to increase in frequency, will augment flood risk. ** N [Working Group I Fourth Assessment Table SPM-2, Working Group II Fourth Assessment 3.4]

In the course of the century, water supplies stored in glaciers and snow cover are projected to decline, reducing water availability in regions supplied by meltwater from major mountain ranges, where more than one-sixth of the world population currently lives. ** N [3.4]

Adaptation procedures and risk management practices for the water sector are being developed in some countries and regions that have recognised projected hydrological changes with related uncertainties. *** N [3.6]

Ecosystems

The resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances (e.g., flooding, drought, wildfire, insects, ocean acidification), and other global change drivers (e.g., land-use change, pollution, over-exploitation of resources). ** N [4.1 to 4.6]

Over the course of this century, net carbon uptake by terrestrial ecosystems is likely to peak before mid-century and then weaken or even reverse,[11] thus amplifying climate change. ** N [4.ES, F4.2]

Approximately 20-30% of plant and animal species assessed so far are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5-2.5°C. * N [4.4, T4.1]

For increases in global average temperature exceeding 1.5-2.5°C and in concomitant atmospheric carbon dioxide concentrations, there are projected to be major changes in ecosystem structure and function, species' ecological interactions, and species' geographical ranges, with predominantly negative consequences for biodiversity, and ecosystem goods and services e.g., water and food supply. ** N [4.4]

The progressive acidification of oceans due to increasing atmospheric carbon dioxide is expected to have negative impacts on marine shell-forming organisms (e.g., corals) and their dependent species. * N [B4.4, 6.4]

Food, fibre and forest products

Crop productivity is projected to increase slightly at mid- to high latitudes for local mean temperature increases of up to 1-3°C depending on the crop, and then decrease beyond that in some regions. * D [5.4]

At lower latitudes, especially seasonally dry and tropical regions, crop productivity is projected to decrease for even small local temperature increases (1-2°C), which would increase the risk of hunger. * D [5.4]

Globally, the potential for food production is projected to increase with increases in local average temperature over a range of 1-3°C, but above this it is projected to decrease. * D [5.4, 5.6]

[8] Temperature changes are expressed as the difference from the period 1980-1999. To express the change relative to the period 1850-1899, add 0.5°C.
[9] Criteria of choice: magnitude and timing of impact, confidence in the assessment, representative coverage of the system, sector and region.
[10] In Section C, the following conventions are used:

Relationship to the Third Assessment:
- *D* — *Further development of a conclusion in the Third Assessment*
- *N* — *New conclusion, not in the Third Assessment*

Level of confidence in the whole statement:
- *** — *Very high confidence*
- ** — *High confidence*
- * — *Medium confidence*

[11] Assuming continued greenhouse gas emissions at or above current rates and other global changes including land-use changes.

Increases in the frequency of droughts and floods are projected to affect local crop production negatively, especially in subsistence sectors at low latitudes. ** D [5.4, 5.ES]

Adaptations such as altered cultivars and planting times allow low- and mid- to high-latitude cereal yields to be maintained at or above baseline yields for modest warming. * N [5.5]

Globally, commercial timber productivity rises modestly with climate change in the short- to medium-term, with large regional variability around the global trend. * D [5.4]

Regional changes in the distribution and production of particular fish species are expected due to continued warming, with adverse effects projected for aquaculture and fisheries. ** D [5.4]

Coastal systems and low-lying areas

Coasts are projected to be exposed to increasing risks, including coastal erosion, due to climate change and sea-level rise. The effect will be exacerbated by increasing human-induced pressures on coastal areas. *** D [6.3, 6.4]

Corals are vulnerable to thermal stress and have low adaptive capacity. Increases in sea surface temperature of about 1-3°C are projected to result in more frequent coral bleaching events and widespread mortality, unless there is thermal adaptation or acclimatisation by corals. *** D [B6.1, 6.4]

Coastal wetlands including salt marshes and mangroves are projected to be negatively affected by sea-level rise especially where they are constrained on their landward side, or starved of sediment. *** D [6.4]

Many millions more people are projected to be flooded every year due to sea-level rise by the 2080s. Those densely-populated and low-lying areas where adaptive capacity is relatively low, and which already face other challenges such as tropical storms or local coastal subsidence, are especially at risk. The numbers affected will be largest in the mega-deltas of Asia and Africa while small islands are especially vulnerable. *** D [6.4]

Adaptation for coasts will be more challenging in developing countries than in developed countries, due to constraints on adaptive capacity. ** D [6.4, 6.5, T6.11]

Industry, settlement and society

Costs and benefits of climate change for industry, settlement and society will vary widely by location and scale. In the aggregate, however, net effects will tend to be more negative the larger the change in climate. ** N [7.4, 7.6]

The most vulnerable industries, settlements and societies are generally those in coastal and river flood plains, those whose economies are closely linked with climate-sensitive resources, and those in areas prone to extreme weather events, especially where rapid urbanisation is occurring. ** D [7.1, 7.3 to 7.5]

Poor communities can be especially vulnerable, in particular those concentrated in high-risk areas. They tend to have more limited adaptive capacities, and are more dependent on climate-sensitive resources such as local water and food supplies. ** N [7.2, 7.4, 5.4]

Where extreme weather events become more intense and/or more frequent, the economic and social costs of those events will increase, and these increases will be substantial in the areas most directly affected. Climate change impacts spread from directly impacted areas and sectors to other areas and sectors through extensive and complex linkages. ** N [7.4, 7.5]

Health

Projected climate change-related exposures are likely to affect the health status of millions of people, particularly those with low adaptive capacity, through:

- increases in malnutrition and consequent disorders, with implications for child growth and development;
- increased deaths, disease and injury due to heatwaves, floods, storms, fires and droughts;
- the increased burden of diarrhoeal disease;
- the increased frequency of cardio-respiratory diseases due to higher concentrations of ground-level ozone related to climate change; and,
- the altered spatial distribution of some infectious disease vectors. ** D [8.4, 8.ES, 8.2]

Climate change is expected to have some mixed effects, such as a decrease or increase in the range and transmission potential of malaria in Africa. ** D [8.4]

Studies in temperate areas[12] have shown that climate change is projected to bring some benefits, such as fewer deaths from cold exposure. Overall it is expected that these benefits will be outweighed by the negative health effects of rising temperatures worldwide, especially in developing countries. ** D [8.4]

The balance of positive and negative health impacts will vary from one location to another, and will alter over time as temperatures continue to rise. Critically important will be factors that directly shape the health of populations such as education, health care, public health initiatives and infrastructure and economic development. *** N [8.3]

[12] Studies mainly in industrialised countries.

More specific information is now available across the regions of the world concerning the nature of future impacts, including for some places not covered in previous assessments.

Africa

By 2020, between 75 million and 250 million people are projected to be exposed to increased water stress due to climate change. If coupled with increased demand, this will adversely affect livelihoods and exacerbate water-related problems. ** D [9.4, 3.4, 8.2, 8.4]

Agricultural production, including access to food, in many African countries and regions is projected to be severely compromised by climate variability and change. The area suitable for agriculture, the length of growing seasons and yield potential, particularly along the margins of semi-arid and arid areas, are expected to decrease. This would further adversely affect food security and exacerbate malnutrition in the continent. In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020. ** N [9.2, 9.4, 9.6]

Local food supplies are projected to be negatively affected by decreasing fisheries resources in large lakes due to rising water temperatures, which may be exacerbated by continued over-fishing. ** N [9.4, 5.4, 8.4]

Towards the end of the 21st century, projected sea-level rise will affect low-lying coastal areas with large populations. The cost of adaptation could amount to at least 5-10% of Gross Domestic Product (GDP). Mangroves and coral reefs are projected to be further degraded, with additional consequences for fisheries and tourism. ** D [9.4]

New studies confirm that Africa is one of the most vulnerable continents to climate variability and change because of multiple stresses and low adaptive capacity. Some adaptation to current climate variability is taking place; however, this may be insufficient for future changes in climate. ** N [9.5]

Asia

Glacier melt in the Himalayas is projected to increase flooding, and rock avalanches from destabilised slopes, and to affect water resources within the next two to three decades. This will be followed by decreased river flows as the glaciers recede. * N [10.2, 10.4]

Freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease due to climate change which, along with population growth and increasing demand arising from higher standards of living, could adversely affect more than a billion people by the 2050s. ** N [10.4]

Coastal areas, especially heavily-populated megadelta regions in South, East and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some megadeltas, flooding from the rivers. ** D [10.4]

Climate change is projected to impinge on the sustainable development of most developing countries of Asia, as it compounds the pressures on natural resources and the environment associated with rapid urbanisation, industrialisation, and economic development. ** D [10.5]

It is projected that crop yields could increase up to 20% in East and South-East Asia while they could decrease up to 30% in Central and South Asia by the mid-21st century. Taken together, and considering the influence of rapid population growth and urbanisation, the risk of hunger is projected to remain very high in several developing countries. * N [10.4]

Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in the hydrological cycle associated with global warming. Increases in coastal water temperature would exacerbate the abundance and/or toxicity of cholera in South Asia. **N [10.4]

Australia and New Zealand

As a result of reduced precipitation and increased evaporation, water security problems are projected to intensify by 2030 in southern and eastern Australia and, in New Zealand, in Northland and some eastern regions. ** D [11.4]

Significant loss of biodiversity is projected to occur by 2020 in some ecologically rich sites including the Great Barrier Reef and Queensland Wet Tropics. Other sites at risk include Kakadu wetlands, south-west Australia, sub-Antarctic islands and the alpine areas of both countries. *** D [11.4]

Ongoing coastal development and population growth in areas such as Cairns and South-east Queensland (Australia) and Northland to Bay of Plenty (New Zealand), are projected to exacerbate risks from sea-level rise and increases in the severity and frequency of storms and coastal flooding by 2050. *** D [11.4, 11.6]

Production from agriculture and forestry by 2030 is projected to decline over much of southern and eastern Australia, and over parts of eastern New Zealand, due to increased drought and fire. However, in New Zealand, initial benefits are projected in western and southern areas and close to major rivers due to a longer growing season, less frost and increased rainfall. ** N [11.4]

The region has substantial adaptive capacity due to well-developed economies and scientific and technical capabilities, but there are considerable constraints to implementation and major challenges from changes in extreme events. Natural systems have limited adaptive capacity. ** N [11.2, 11.5]

Europe

For the first time, wide-ranging impacts of changes in current climate have been documented: retreating glaciers, longer growing seasons, shift of species ranges, and health impacts due to a heatwave of unprecedented magnitude. The observed changes described above are consistent with those projected for future climate change. *** N [12.2, 12.4, 12.6]

Nearly all European regions are anticipated to be negatively affected by some future impacts of climate change, and these will pose challenges to many economic sectors. Climate change is expected to magnify regional differences in Europe's natural resources and assets. Negative impacts will include increased risk of inland flash floods, and more frequent coastal flooding and increased erosion (due to storminess and sea-level rise). The great majority of organisms and ecosystems will have difficulty adapting to climate change. Mountainous areas will face glacier retreat, reduced snow cover and winter tourism, and extensive species losses (in some areas up to 60% under high emission scenarios by 2080). *** D [12.4]

In Southern Europe, climate change is projected to worsen conditions (high temperatures and drought) in a region already vulnerable to climate variability, and to reduce water availability, hydropower potential, summer tourism and, in general, crop productivity. It is also projected to increase health risks due to heat-waves, and the frequency of wildfires. ** D [12.2, 12.4, 12.7]

In Central and Eastern Europe, summer precipitation is projected to decrease, causing higher water stress. Health risks due to heatwaves are projected to increase. Forest productivity is expected to decline and the frequency of peatland fires to increase. ** D [12.4]

In Northern Europe, climate change is initially projected to bring mixed effects, including some benefits such as reduced demand for heating, increased crop yields and increased forest growth. However, as climate change continues, its negative impacts (including more frequent winter floods, endangered ecosystems and increasing ground instability) are likely to outweigh its benefits. ** D [12.4]

Adaptation to climate change is likely to benefit from experience gained in reaction to extreme climate events, specifically by implementing proactive climate change risk management adaptation plans. *** N [12.5]

Latin America

By mid-century, increases in temperature and associated decreases in soil water are projected to lead to gradual replacement of tropical forest by savanna in eastern Amazonia. Semi-arid vegetation will tend to be replaced by arid-land vegetation. There is a risk of significant biodiversity loss through species extinction in many areas of tropical Latin America. ** D [13.4]

In drier areas, climate change is expected to lead to salinisation and desertification of agricultural land. Productivity of some important crops is projected to decrease and livestock productivity to decline, with adverse consequences for food security. In temperate zones soybean yields are projected to increase. ** N [13.4, 13.7]

Sea-level rise is projected to cause increased risk of flooding in low-lying areas. Increases in sea surface temperature due to climate change are projected to have adverse effects on Mesoamerican coral reefs, and cause shifts in the location of south-east Pacific fish stocks. ** N [13.4, 13.7]

Changes in precipitation patterns and the disappearance of glaciers are projected to significantly affect water availability for human consumption, agriculture and energy generation. ** D [13.4]

Some countries have made efforts to adapt, particularly through conservation of key ecosystems, early warning systems, risk management in agriculture, strategies for flood drought and coastal management, and disease surveillance systems. However, the effectiveness of these efforts is outweighed by: lack of basic information, observation and monitoring systems; lack of capacity building and appropriate political, institutional and technological frameworks; low income; and settlements in vulnerable areas, among others. ** D [13.2]

North America

Warming in western mountains is projected to cause decreased snowpack, more winter flooding, and reduced summer flows, exacerbating competition for over-allocated water resources. *** D [14.4, B14.2]

Disturbances from pests, diseases and fire are projected to have increasing impacts on forests, with an extended period of high fire risk and large increases in area burned. *** N [14.4, B14.1]

Moderate climate change in the early decades of the century is projected to increase aggregate yields of rain-fed agriculture by 5-

20%, but with important variability among regions. Major challenges are projected for crops that are near the warm end of their suitable range or which depend on highly utilised water resources. ** D [14.4]

Cities that currently experience heatwaves are expected to be further challenged by an increased number, intensity and duration of heatwaves during the course of the century, with potential for adverse health impacts. Elderly populations are most at risk. *** D [14.4].

Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution. Population growth and the rising value of infrastructure in coastal areas increase vulnerability to climate variability and future climate change, with losses projected to increase if the intensity of tropical storms increases. Current adaptation is uneven and readiness for increased exposure is low. *** N [14.2, 14.4]

Polar Regions

In the Polar Regions, the main projected biophysical effects are reductions in thickness and extent of glaciers and ice sheets, and changes in natural ecosystems with detrimental effects on many organisms including migratory birds, mammals and higher predators. In the Arctic, additional impacts include reductions in the extent of sea ice and permafrost, increased coastal erosion, and an increase in the depth of permafrost seasonal thawing. ** D [15.3, 15.4, 15.2]

For human communities in the Arctic, impacts, particularly those resulting from changing snow and ice conditions, are projected to be mixed. Detrimental impacts would include those on infrastructure and traditional indigenous ways of life. ** D [15.4]

Beneficial impacts would include reduced heating costs and more navigable northern sea routes. * D [15.4]

In both polar regions, specific ecosystems and habitats are projected to be vulnerable, as climatic barriers to species invasions are lowered. ** D [15.6, 15.4]

Arctic human communities are already adapting to climate change, but both external and internal stressors challenge their adaptive capacities. Despite the resilience shown historically by Arctic indigenous communities, some traditional ways of life are being threatened and substantial investments are needed to adapt or re-locate physical structures and communities. ** D [15.ES, 15.4, 15.5, 15.7]

Small islands

Small islands, whether located in the tropics or higher latitudes, have characteristics which make them especially vulnerable to the effects of climate change, sea-level rise and extreme events. *** D [16.1, 16.5]

Deterioration in coastal conditions, for example through erosion of beaches and coral bleaching, is expected to affect local resources, e.g., fisheries, and reduce the value of these destinations for tourism. ** D [16.4]

Sea-level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards, thus threatening vital infrastructure, settlements and facilities that support the livelihood of island communities. *** D [16.4]

Climate change is projected by mid-century to reduce water resources in many small islands, e.g., in the Caribbean and Pacific, to the point where they become insufficient to meet demand during low-rainfall periods. *** D [16.4]

With higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands. ** N [16.4]

Magnitudes of impact can now be estimated more systematically for a range of possible increases in global average temperature.

Since the IPCC Third Assessment, many additional studies, particularly in regions that previously had been little researched, have enabled a more systematic understanding of how the timing and magnitude of impacts may be affected by changes in climate and sea level associated with differing amounts and rates of change in global average temperature.

Examples of this new information are presented in Figure SPM.2. Entries have been selected which are judged to be relevant for people and the environment and for which there is high confidence in the assessment. All examples of impact are drawn from chapters of the Assessment, where more detailed information is available.

Depending on circumstances, some of these impacts could be associated with 'key vulnerabilities', based on a number of criteria in the literature (magnitude, timing, persistence/reversibility, the potential for adaptation, distributional aspects, likelihood and 'importance' of the impacts). Assessment of potential key vulnerabilities is intended to provide information on rates and levels of climate change to help decision-makers make appropriate responses to the risks of climate change [19.ES, 19.1].

The 'reasons for concern' identified in the Third Assessment remain a viable framework for considering key vulnerabilities. Recent research has updated some of the findings from the Third Assessment [19.3].

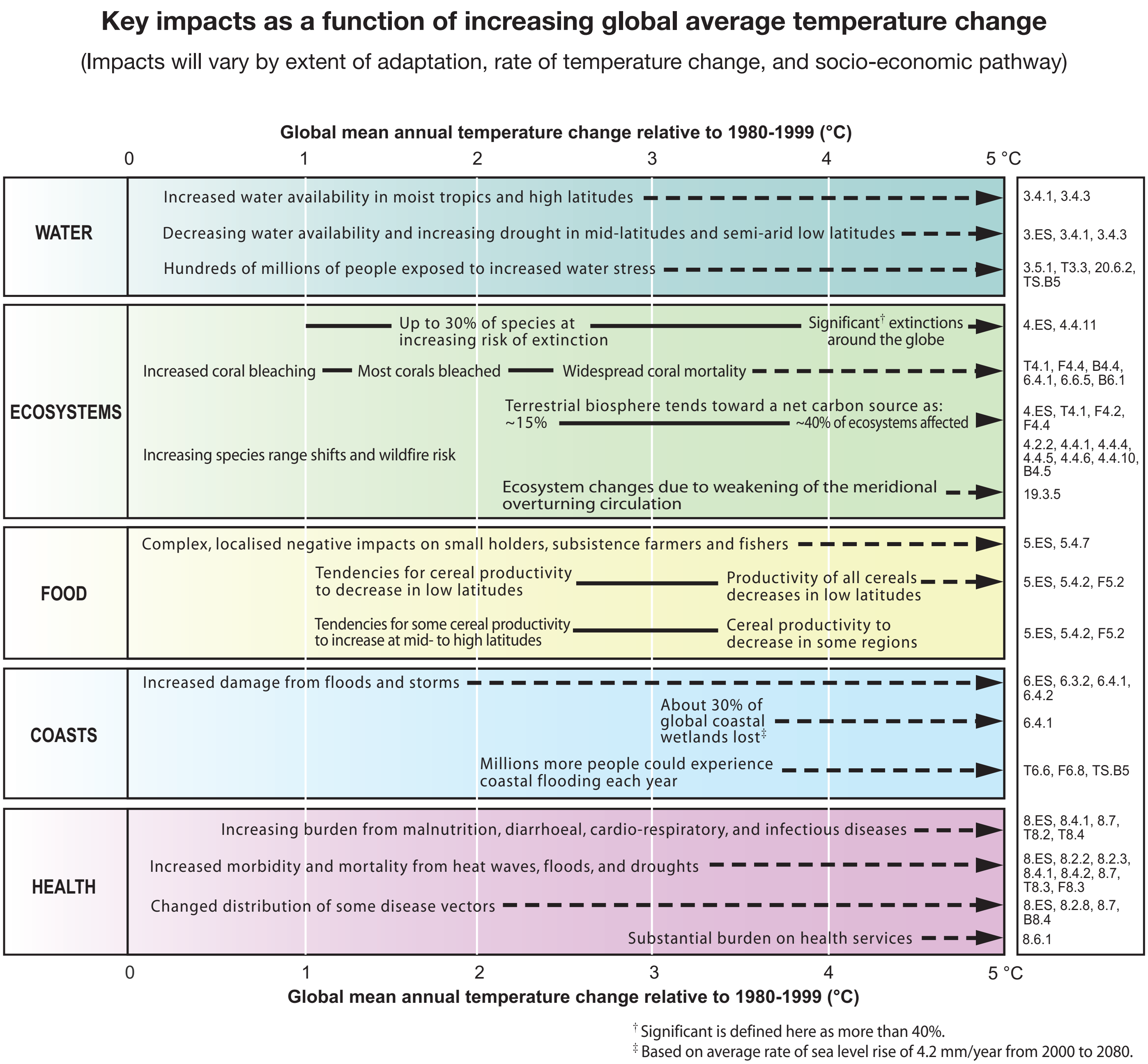

Figure SPM.2. *Illustrative examples of global impacts projected for climate changes (and sea level and atmospheric carbon dioxide where relevant) associated with different amounts of increase in global average surface temperature in the 21st century [T20.8]. The black lines link impacts, dotted arrows indicate impacts continuing with increasing temperature. Entries are placed so that the left-hand side of the text indicates the approximate onset of a given impact. Quantitative entries for water stress and flooding represent the additional impacts of climate change relative to the conditions projected across the range of Special Report on Emissions Scenarios (SRES) scenarios A1FI, A2, B1 and B2 (see Endbox 3). Adaptation to climate change is not included in these estimations. All entries are from published studies recorded in the chapters of the Assessment. Sources are given in the right-hand column of the Table. Confidence levels for all statements are high.*

Impacts due to altered frequencies and intensities of extreme weather, climate and sea-level events are very likely to change.

Since the IPCC Third Assessment, confidence has increased that some weather events and extremes will become more frequent, more widespread and/or more intense during the 21st century; and more is known about the potential effects of such changes. A selection of these is presented in Table SPM.1.

The direction of trend and likelihood of phenomena are for IPCC SRES projections of climate change.

Some large-scale climate events have the potential to cause very large impacts, especially after the 21st century.

Very large sea-level rises that would result from widespread deglaciation of Greenland and West Antarctic ice sheets imply major changes in coastlines and ecosystems, and inundation of low-lying areas, with greatest effects in river deltas. Relocating populations, economic activity, and infrastructure would be costly and challenging. There is medium confidence that at least partial deglaciation of the Greenland ice sheet, and possibly the West Antarctic ice sheet, would occur over a period of time ranging from centuries to millennia for a global average temperature increase of 1-4°C (relative to 1990-2000), causing a contribution to sea-level rise of 4-6 m or more. The complete melting of the Greenland ice sheet and the West Antarctic ice sheet would lead to a contribution to sea-level rise of up to 7 m and about 5 m, respectively [Working Group I Fourth Assessment 6.4, 10.7; Working Group II Fourth Assessment 19.3].

Based on climate model results, it is very unlikely that the Meridional Overturning Circulation (MOC) in the North Atlantic will undergo a large abrupt transition during the 21st century. Slowing of the MOC during this century is very likely, but temperatures over the Atlantic and Europe are projected to increase nevertheless, due to global warming. Impacts of large-scale and persistent changes in the MOC are likely to include changes to marine ecosystem productivity, fisheries, ocean carbon dioxide uptake, oceanic oxygen concentrations and terrestrial vegetation [Working Group I Fourth Assessment 10.3, 10.7; Working Group II Fourth Assessment 12.6, 19.3].

Impacts of climate change will vary regionally but, aggregated and discounted to the present, they are very likely to impose net annual costs which will increase over time as global temperatures increase.

This Assessment makes it clear that the impacts of future climate change will be mixed across regions. For increases in global mean temperature of less than 1-3°C above 1990 levels, some impacts are projected to produce benefits in some places and some sectors, and produce costs in other places and other sectors. It is, however, projected that some low-latitude and polar regions will experience net costs even for small increases in temperature. It is very likely that all regions will experience either declines in net benefits or increases in net costs for increases in temperature greater than about 2-3°C [9.ES, 9.5, 10.6, T10.9, 15.3, 15.ES]. These observations confirm evidence reported in the Third Assessment that, while developing countries are expected to experience larger percentage losses, global mean losses could be 1-5% GDP for 4°C of warming [F20.3].

Many estimates of aggregate net economic costs of damages from climate change across the globe (i.e., the social cost of carbon (SCC), expressed in terms of future net benefits and costs that are discounted to the present) are now available. Peer-reviewed estimates of the SCC for 2005 have an average value of US$43 per tonne of carbon (i.e., US$12 per tonne of carbon dioxide), but the range around this mean is large. For example, in a survey of 100 estimates, the values ran from US$-10 per tonne of carbon (US$-3 per tonne of carbon dioxide) up to US$350 per tonne of carbon (US$95 per tonne of carbon dioxide) [20.6].

The large ranges of SCC are due in the large part to differences in assumptions regarding climate sensitivity, response lags, the treatment of risk and equity, economic and non-economic impacts, the inclusion of potentially catastrophic losses, and discount rates. It is very likely that globally aggregated figures underestimate the damage costs because they cannot include many non-quantifiable impacts. Taken as a whole, the range of published evidence indicates that the net damage costs of climate change are likely to be significant and to increase over time [T20.3, 20.6, F20.4].

It is virtually certain that aggregate estimates of costs mask significant differences in impacts across sectors, regions, countries and populations. In some locations and among some groups of people with high exposure, high sensitivity and/or low adaptive capacity, net costs will be significantly larger than the global aggregate [20.6, 20.ES, 7.4].

Phenomenon[a] and direction of trend	Likelihood of future trends based on projections for 21st century using SRES scenarios	Examples of major projected impacts by sector			
		Agriculture, forestry and ecosystems [4.4, 5.4]	Water resources [3.4]	Human health [8.2, 8.4]	Industry, settlement and society [7.4]
Over most land areas, warmer and fewer cold days and nights, warmer and more frequent hot days and nights	Virtually certain[b]	Increased yields in colder environments; decreased yields in warmer environments; increased insect outbreaks	Effects on water resources relying on snow melt; effects on some water supplies	Reduced human mortality from decreased cold exposure	Reduced energy demand for heating; increased demand for cooling; declining air quality in cities; reduced disruption to transport due to snow, ice; effects on winter tourism
Warm spells/heat waves. Frequency increases over most land areas	Very likely	Reduced yields in warmer regions due to heat stress; increased danger of wildfire	Increased water demand; water quality problems, e.g., algal blooms	Increased risk of heat-related mortality, especially for the elderly, chronically sick, very young and socially-isolated	Reduction in quality of life for people in warm areas without appropriate housing; impacts on the elderly, very young and poor
Heavy precipitation events. Frequency increases over most areas	Very likely	Damage to crops; soil erosion, inability to cultivate land due to waterlogging of soils	Adverse effects on quality of surface and groundwater; contamination of water supply; water scarcity may be relieved	Increased risk of deaths, injuries and infectious, respiratory and skin diseases	Disruption of settlements, commerce, transport and societies due to flooding; pressures on urban and rural infrastructures; loss of property
Area affected by drought increases	Likely	Land degradation; lower yields/crop damage and failure; increased livestock deaths; increased risk of wildfire	More widespread water stress	Increased risk of food and water shortage; increased risk of malnutrition; increased risk of water- and food-borne diseases	Water shortages for settlements, industry and societies; reduced hydropower generation potentials; potential for population migration
Intense tropical cyclone activity increases	Likely	Damage to crops; windthrow (uprooting) of trees; damage to coral reefs	Power outages causing disruption of public water supply	Increased risk of deaths, injuries, water- and food-borne diseases; post-traumatic stress disorders	Disruption by flood and high winds; withdrawal of risk coverage in vulnerable areas by private insurers, potential for population migrations, loss of property
Increased incidence of extreme high sea level (excludes tsunamis)[c]	Likely[d]	Salinisation of irrigation water, estuaries and freshwater systems	Decreased freshwater availability due to saltwater intrusion	Increased risk of deaths and injuries by drowning in floods; migration-related health effects	Costs of coastal protection versus costs of land-use relocation; potential for movement of populations and infrastructure; also see tropical cyclones above

[a] See Working Group I Fourth Assessment Table 3.7 for further details regarding definitions.
[b] Warming of the most extreme days and nights each year.
[c] Extreme high sea level depends on average sea level and on regional weather systems. It is defined as the highest 1% of hourly values of observed sea level at a station for a given reference period.
[d] In all scenarios, the projected global average sea level at 2100 is higher than in the reference period [Working Group I Fourth Assessment 10.6]. The effect of changes in regional weather systems on sea level extremes has not been assessed.

Table SPM.1. *Examples of possible impacts of climate change due to changes in extreme weather and climate events, based on projections to the mid- to late 21st century. These do not take into account any changes or developments in adaptive capacity. Examples of all entries are to be found in chapters in the full Assessment (see source at top of columns). The first two columns of the table (shaded yellow) are taken directly from the Working Group I Fourth Assessment (Table SPM-2). The likelihood estimates in Column 2 relate to the phenomena listed in Column 1.*

D. Current knowledge about responding to climate change

Some adaptation is occurring now, to observed and projected future climate change, but on a limited basis.

There is growing evidence since the IPCC Third Assessment of human activity to adapt to observed and anticipated climate change. For example, climate change is considered in the design of infrastructure projects such as coastal defence in the Maldives and The Netherlands, and the Confederation Bridge in Canada. Other examples include prevention of glacial lake outburst flooding in Nepal, and policies and strategies such as water management in Australia and government responses to heat-waves in, for example, some European countries [7.6, 8.2, 8.6, 17.ES, 17.2, 16.5, 11.5].

Adaptation will be necessary to address impacts resulting from the warming which is already unavoidable due to past emissions.

Past emissions are estimated to involve some unavoidable warming (about a further 0.6°C by the end of the century relative to 1980-1999) even if atmospheric greenhouse gas concentrations remain at 2000 levels (see Working Group I Fourth Assessment). There are some impacts for which adaptation is the only available and appropriate response. An indication of these impacts can be seen in Figure SPM.2.

A wide array of adaptation options is available, but more extensive adaptation than is currently occurring is required to reduce vulnerability to future climate change. There are barriers, limits and costs, but these are not fully understood.

Impacts are expected to increase with increases in global average temperature, as indicated in Figure SPM.2. Although many early impacts of climate change can be effectively addressed through adaptation, the options for successful adaptation diminish and the associated costs increase with increasing climate change. At present we do not have a clear picture of the limits to adaptation, or the cost, partly because effective adaptation measures are highly dependent on specific, geographical and climate risk factors as well as institutional, political and financial constraints [7.6, 17.2, 17.4].

The array of potential adaptive responses available to human societies is very large, ranging from purely technological (e.g., sea defences), through behavioural (e.g., altered food and recreational choices), to managerial (e.g., altered farm practices) and to policy (e.g., planning regulations). While most technologies and strategies are known and developed in some countries, the assessed literature does not indicate how effective various options[13] are at fully reducing risks, particularly at higher levels of warming and related impacts, and for vulnerable groups. In addition, there are formidable environmental, economic, informational, social, attitudinal and behavioural barriers to the implementation of adaptation. For developing countries, availability of resources and building adaptive capacity are particularly important [see Sections 5 and 6 in Chapters 3-16; also 17.2, 17.4].

Adaptation alone is not expected to cope with all the projected effects of climate change, and especially not over the long term as most impacts increase in magnitude [Figure SPM.2].

Vulnerability to climate change can be exacerbated by the presence of other stresses.

Non-climate stresses can increase vulnerability to climate change by reducing resilience and can also reduce adaptive capacity because of resource deployment to competing needs. For example, current stresses on some coral reefs include marine pollution and chemical runoff from agriculture as well as increases in water temperature and ocean acidification. Vulnerable regions face multiple stresses that affect their exposure and sensitivity as well as their capacity to adapt. These stresses arise from, for example, current climate hazards, poverty and unequal access to resources, food insecurity, trends in economic globalisation, conflict, and incidence of diseases such as HIV/AIDS [7.4, 8.3, 17.3, 20.3]. Adaptation measures are seldom undertaken in response to climate change alone but can be integrated within, for example, water resource management, coastal defence and risk-reduction strategies [17.2, 17.5].

Future vulnerability depends not only on climate change but also on development pathway.

An important advance since the IPCC Third Assessment has been the completion of impacts studies for a range of different development pathways taking into account not only projected climate change but also projected social and economic changes. Most have been based on characterisations of population and income level drawn from the IPCC Special Report on Emission Scenarios (SRES) (see Endbox 3) [2.4].

[13] A table of options is given in the Technical Summary

These studies show that the projected impacts of climate change can vary greatly due to the development pathway assumed. For example, there may be large differences in regional population, income and technological development under alternative scenarios, which are often a strong determinant of the level of vulnerability to climate change [2.4].

To illustrate, in a number of recent studies of global impacts of climate change on food supply, risk of coastal flooding and water scarcity, the projected number of people affected is considerably greater under the A2-type scenario of development (characterised by relatively low per capita income and large population growth) than under other SRES futures [T20.6]. This difference is largely explained, not by differences in changes of climate, but by differences in vulnerability [T6.6].

Sustainable development[14] can reduce vulnerability to climate change, and climate change could impede nations' abilities to achieve sustainable development pathways.

Sustainable development can reduce vulnerability to climate change by enhancing adaptive capacity and increasing resilience. At present, however, few plans for promoting sustainability have explicitly included either adapting to climate change impacts, or promoting adaptive capacity [20.3].

On the other hand, it is very likely that climate change can slow the pace of progress towards sustainable development, either directly through increased exposure to adverse impact or indirectly through erosion of the capacity to adapt. This point is clearly demonstrated in the sections of the sectoral and regional chapters of this report that discuss the implications for sustainable development [See Section 7 in Chapters 3-8, 20.3, 20.7].

The Millennium Development Goals (MDGs) are one measure of progress towards sustainable development. Over the next half-century, climate change could impede achievement of the MDGs [20.7].

Many impacts can be avoided, reduced or delayed by mitigation.

A small number of impact assessments have now been completed for scenarios in which future atmospheric concentrations of greenhouse gases are stabilised. Although these studies do not take full account of uncertainties in projected climate under stabilisation, they nevertheless provide indications of damages avoided or vulnerabilities and risks reduced for different amounts of emissions reduction [2.4, T20.6].

A portfolio of adaptation and mitigation measures can diminish the risks associated with climate change.

Even the most stringent mitigation efforts cannot avoid further impacts of climate change in the next few decades, which makes adaptation essential, particularly in addressing near-term impacts. Unmitigated climate change would, in the long term, be likely to exceed the capacity of natural, managed and human systems to adapt [20.7].

This suggests the value of a portfolio or mix of strategies that includes mitigation, adaptation, technological development (to enhance both adaptation and mitigation) and research (on climate science, impacts, adaptation and mitigation). Such portfolios could combine policies with incentive-based approaches, and actions at all levels from the individual citizen through to national governments and international organisations [18.1, 18.5].

One way of increasing adaptive capacity is by introducing the consideration of climate change impacts in development planning [18.7], for example, by:
- including adaptation measures in land-use planning and infrastructure design [17.2];
- including measures to reduce vulnerability in existing disaster risk reduction strategies [17.2, 20.8].

E. Systematic observing and research

Although the science to provide policymakers with information about climate change impacts and adaptation potential has improved since the Third Assessment, it still leaves many important questions to be answered. The chapters of the Working Group II Fourth Assessment include a number of judgements about priorities for further observation and research, and this advice should be considered seriously (a list of these recommendations is given in the Technical Summary Section TS-6).

[14] The Brundtland Commission definition of sustainable development is used in this Assessment: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The same definition was used by the IPCC Working Group II Third Assessment and Third Assessment Synthesis Report.

Endbox 1. Definitions of key terms

Climate change in IPCC usage refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the Framework Convention on Climate Change, where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods.

Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Endbox 2. Communication of Uncertainty in the Working Group II Fourth Assessment

A set of terms to describe uncertainties in current knowledge is common to all parts of the IPCC Fourth Assessment.

Description of confidence
Authors have assigned a confidence level to the major statements in the Summary for Policymakers on the basis of their assessment of current knowledge, as follows:

Terminology	*Degree of confidence in being correct*
Very high confidence	At least 9 out of 10 chance of being correct
High confidence	About 8 out of 10 chance
Medium confidence	About 5 out of 10 chance
Low confidence	About 2 out of 10 chance
Very low confidence	Less than a 1 out of 10 chance

Description of likelihood
Likelihood refers to a probabilistic assessment of some well-defined outcome having occurred or occurring in the future, and may be based on quantitative analysis or an elicitation of expert views. In the Summary for Policymakers, when authors evaluate the likelihood of certain outcomes, the associated meanings are:

Terminology	*Likelihood of the occurrence/ outcome*
Virtually certain	>99% probability of occurrence
Very likely	90 to 99% probability
Likely	66 to 90% probability
About as likely as not	33 to 66% probability
Unlikely	10 to 33% probability
Very unlikely	1 to 10% probability
Exceptionally unlikely	<1% probability

Endbox 3. The Emissions Scenarios of the IPCC Special Report on Emissions Scenarios (SRES)

A1. The A1 storyline and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil intensive (A1FI), non fossil energy sources (A1T), or a balance across all sources (A1B) (where balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end use technologies).

A2. The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing population. Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented and slower than other storylines.

B1. The B1 storyline and scenario family describes a convergent world with the same global population, that peaks in mid-century and declines thereafter, as in the A1 storyline, but with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability, including improved equity, but without additional climate initiatives.

B2. The B2 storyline and scenario family describes a world in which the emphasis is on local solutions to economic, social and environmental sustainability. It is a world with continuously increasing global population, at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented towards environmental protection and social equity, it focuses on local and regional levels.

An illustrative scenario was chosen for each of the six scenario groups A1B, A1FI, A1T, A2, B1 and B2. All should be considered equally sound.

The SRES scenarios do not include additional climate initiatives, which means that no scenarios are included that explicitly assume implementation of the United Nations Framework Convention on Climate Change or the emissions targets of the Kyoto Protocol.

Technical Support Document: -
Social Cost of Carbon for Regulatory Impact Analysis -
Under Executive Order 12866 -

Interagency Working Group on Social Cost of Carbon, United States Government

With participation by

Council of Economic Advisers
Council on Environmental Quality
Department of Agriculture
Department of Commerce
Department of Energy
Department of Transportation
Environmental Protection Agency
National Economic Council
Office of Energy and Climate Change
Office of Management and Budget
Office of Science and Technology Policy
Department of the Treasury

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Executive Summary

Under Executive Order 12866, agencies are required, to the extent permitted by law, "to assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs." The purpose of the "social cost of carbon" (SCC) estimates presented here is to allow agencies to incorporate the social benefits of reducing carbon dioxide (CO_2) emissions into cost-benefit analyses of regulatory actions that have small, or "marginal," impacts on cumulative global emissions. The estimates are presented with an acknowledgement of the many uncertainties involved and with a clear understanding that they should be updated over time to reflect increasing knowledge of the science and economics of climate impacts.

The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change.

This document presents a summary of the interagency process that developed these SCC estimates. Technical experts from numerous agencies met on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key model inputs and assumptions. The main objective of this process was to develop a range of SCC values using a defensible set of input assumptions grounded in the existing scientific and economic literatures. In this way, key uncertainties and model differences transparently and consistently inform the range of SCC estimates used in the rulemaking process.

The interagency group selected four SCC values for use in regulatory analyses. Three values are based on the average SCC from three integrated assessment models, at discount rates of 2.5, 3, and 5 percent. The fourth value, which represents the 95^{th} percentile SCC estimate across all three models at a 3 percent discount rate, is included to represent higher-than-expected impacts from temperature change further out in the tails of the SCC distribution.

Social Cost of CO_2, 2010 – 2050 (in 2007 dollars)

Discount Rate Year	5% Avg	3% Avg	2.5% Avg	3% 95th
2010	4.7	21.4	35.1	64.9
2015	5.7	23.8	38.4	72.8
2020	6.8	26.3	41.7	80.7
2025	8.2	29.6	45.9	90.4
2030	9.7	32.8	50.0	100.0
2035	11.2	36.0	54.2	109.7
2040	12.7	39.2	58.4	119.3
2045	14.2	42.1	61.7	127.8
2050	15.7	44.9	65.0	136.2

I. Monetizing Carbon Dioxide Emissions

The "social cost of carbon" (SCC) is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services. We report estimates of the social cost of carbon in dollars per metric ton of carbon dioxide throughout this document.[1]

When attempting to assess the incremental economic impacts of carbon dioxide emissions, the analyst faces a number of serious challenges. A recent report from the National Academies of Science (NRC 2009) points out that any assessment will suffer from uncertainty, speculation, and lack of information about (1) future emissions of greenhouse gases, (2) the effects of past and future emissions on the climate system, (3) the impact of changes in climate on the physical and biological environment, and (4) the translation of these environmental impacts into economic damages. As a result, any effort to quantify and monetize the harms associated with climate change will raise serious questions of science, economics, and ethics and should be viewed as provisional.

Despite the serious limits of both quantification and monetization, SCC estimates can be useful in estimating the social benefits of reducing carbon dioxide emissions. Under Executive Order 12866, agencies are required, to the extent permitted by law, "to assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs." The purpose of the SCC estimates presented here is to make it possible for agencies to incorporate the social benefits from reducing carbon dioxide emissions into cost-benefit analyses of regulatory actions that have small, or "marginal," impacts on cumulative global emissions. Most federal regulatory actions can be expected to have marginal impacts on global emissions.

For such policies, the benefits from reduced (or costs from increased) emissions in any future year can be estimated by multiplying the change in emissions in that year by the SCC value appropriate for that year. The net present value of the benefits can then be calculated by multiplying each of these future benefits by an appropriate discount factor and summing across all affected years. This approach assumes that the marginal damages from increased emissions are constant for small departures from the baseline emissions path, an approximation that is reasonable for policies that have effects on emissions that are small relative to cumulative global carbon dioxide emissions. For policies that have a large (non-marginal) impact on global cumulative emissions, there is a separate question of whether the SCC is an appropriate tool for calculating the benefits of reduced emissions; we do not attempt to answer that question here.

An interagency group convened on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key inputs and assumptions in order to generate SCC estimates. Agencies that actively participated in the interagency process include the Environmental Protection

[1] In this document, we present all values of the SCC as the cost per metric ton of CO_2 emissions. Alternatively, one could report the SCC as the cost per metric ton of carbon emissions. The multiplier for translating between mass of CO_2 and the mass of carbon is 3.67 (the molecular weight of CO_2 divided by the molecular weight of carbon = 44/12 = 3.67).

Agency, and the Departments of Agriculture, Commerce, Energy, Transportation, and Treasury. This process was convened by the Council of Economic Advisers and the Office of Management and Budget, with active participation and regular input from the Council on Environmental Quality, National Economic Council, Office of Energy and Climate Change, and Office of Science and Technology Policy. The main objective of this process was to develop a range of SCC values using a defensible set of input assumptions that are grounded in the existing literature. In this way, key uncertainties and model differences can more transparently and consistently inform the range of SCC estimates used in the rulemaking process.

The interagency group selected four SCC estimates for use in regulatory analyses. For 2010, these estimates are $5, $21, $35, and $65 (in 2007 dollars). The first three estimates are based on the average SCC across models and socio-economic and emissions scenarios at the 5, 3, and 2.5 percent discount rates, respectively. The fourth value is included to represent the higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. For this purpose, we use the SCC value for the 95^{th} percentile at a 3 percent discount rate. The central value is the average SCC across models at the 3 percent discount rate. For purposes of capturing the uncertainties involved in regulatory impact analysis, we emphasize the importance and value of considering the full range. These SCC estimates also grow over time. For instance, the central value increases to $24 per ton of CO_2 in 2015 and $26 per ton of CO_2 in 2020. See Appendix A for the full range of annual SCC estimates from 2010 to 2050.

It is important to emphasize that the interagency process is committed to updating these estimates as the science and economic understanding of climate change and its impacts on society improves over time. Specifically, we have set a preliminary goal of revisiting the SCC values within two years or at such time as substantially updated models become available, and to continue to support research in this area. In the meantime, we will continue to explore the issues raised in this document and consider public comments as part of the ongoing interagency process.

II. Social Cost of Carbon Values Used in Past Regulatory Analyses

To date, economic analyses for Federal regulations have used a wide range of values to estimate the benefits associated with reducing carbon dioxide emissions. In the final model year 2011 CAFE rule, the Department of Transportation (DOT) used both a “domestic” SCC value of $2 per ton of CO_2 and a “global” SCC value of $33 per ton of CO_2 for 2007 emission reductions (in 2007 dollars), increasing both values at 2.4 percent per year. It also included a sensitivity analysis at $80 per ton of CO_2. A domestic SCC value is meant to reflect the value of damages in the United States resulting from a unit change in carbon dioxide emissions, while a global SCC value is meant to reflect the value of damages worldwide.

A 2008 regulation proposed by DOT assumed a domestic SCC value of $7 per ton CO_2 (in 2006 dollars) for 2011 emission reductions (with a range of $0-$14 for sensitivity analysis), also increasing at 2.4 percent per year. A regulation finalized by DOE in October of 2008 used a domestic SCC range of $0 to $20 per ton CO_2 for 2007 emission reductions (in 2007 dollars). In addition, EPA’s 2008 Advance Notice of Proposed Rulemaking for Greenhouse Gases identified what it described as “very preliminary” SCC estimates subject to revision. EPA’s global mean values were $68 and $40 per ton CO_2 for discount rates of approximately 2 percent and 3 percent, respectively (in 2006 dollars for 2007 emissions).

In 2009, an interagency process was initiated to offer a preliminary assessment of how best to quantify the benefits from reducing carbon dioxide emissions. To ensure consistency in how benefits are evaluated across agencies, the Administration sought to develop a transparent and defensible method, specifically designed for the rulemaking process, to quantify avoided climate change damages from reduced CO_2 emissions. The interagency group did not undertake any original analysis. Instead, it combined SCC estimates from the existing literature to use as interim values until a more comprehensive analysis could be conducted.

The outcome of the preliminary assessment by the interagency group was a set of five interim values: global SCC estimates for 2007 (in 2006 dollars) of $55, $33, $19, $10, and $5 per ton of CO_2. The $33 and $5 values represented model-weighted means of the published estimates produced from the most recently available versions of three integrated assessment models—DICE, PAGE, and FUND—at approximately 3 and 5 percent discount rates. The $55 and $10 values were derived by adjusting the published estimates for uncertainty in the discount rate (using factors developed by Newell and Pizer (2003)) at 3 and 5 percent discount rates, respectively. The $19 value was chosen as a central value between the $5 and $33 per ton estimates. All of these values were assumed to increase at 3 percent annually to represent growth in incremental damages over time as the magnitude of climate change increases.

These interim values represent the first sustained interagency effort within the U.S. government to develop an SCC for use in regulatory analysis. The results of this preliminary effort were presented in several proposed and final rules and were offered for public comment in connection with proposed rules, including the joint EPA-DOT fuel economy and CO_2 tailpipe emission proposed rules.

III. Approach and Key Assumptions

Since the release of the interim values, interagency group has reconvened on a regular basis to generate improved SCC estimates. Specifically, the group has considered public comments and further explored the technical literature in relevant fields. This section details the several choices and assumptions that underlie the resulting estimates of the SCC.

It is important to recognize that a number of key uncertainties remain, and that current SCC estimates should be treated as provisional and revisable since they will evolve with improved scientific and economic understanding. The interagency group also recognizes that the existing models are imperfect and incomplete. The National Academy of Science (2009) points out that there is tension between the goal of producing quantified estimates of the economic damages from an incremental ton of carbon and the limits of existing efforts to model these effects. Throughout this document, we highlight a number of concerns and problems that should be addressed by the research community, including research programs housed in many of the agencies participating in the interagency process to estimate the SCC.

The U.S. Government will periodically review and reconsider estimates of the SCC used for cost-benefit analyses to reflect increasing knowledge of the science and economics of climate impacts, as well as improvements in modeling. In this context, statements recognizing the limitations of the analysis and calling for further research take on exceptional significance. The interagency group offers the new SCC values with all due humility about the uncertainties embedded in them and with a sincere promise to continue work to improve them.

A. Integrated Assessment Models

We rely on three integrated assessment models (IAMs) commonly used to estimate the SCC: the FUND, DICE, and PAGE models.[2] These models are frequently cited in the peer-reviewed literature and used in the IPCC assessment. Each model is given equal weight in the SCC values developed through this process, bearing in mind their different limitations (discussed below).

These models are useful because they combine climate processes, economic growth, and feedbacks between the climate and the global economy into a single modeling framework. At the same time, they gain this advantage at the expense of a more detailed representation of the underlying climatic and economic systems. DICE, PAGE, and FUND all take stylized, reduced-form approaches (see NRC 2009 for a more detailed discussion; see Nordhaus 2008 on the possible advantages of this approach). Other IAMs may better reflect the complexity of the science in their modeling frameworks but do not link physical impacts to economic damages. There is currently a limited amount of research linking climate impacts to economic damages, which makes this exercise even more difficult. Underlying the three IAMs selected for this exercise are a number of simplifying assumptions and judgments reflecting the various modelers' best attempts to synthesize the available scientific and economic research characterizing these relationships.

The three IAMs translate emissions into changes in atmospheric greenhouse concentrations, atmospheric concentrations into changes in temperature, and changes in temperature into economic damages. The emissions projections used in the models are based on specified socio-economic (GDP and population) pathways. These emissions are translated into concentrations using the carbon cycle built into each model, and concentrations are translated into warming based on each model's simplified representation of the climate and a key parameter, climate sensitivity. Each model uses a different approach to translate warming into damages. Finally, transforming the stream of economic damages over time into a single value requires judgments about how to discount them.

Each model takes a slightly different approach to model how changes in emissions result in changes in economic damages. In PAGE, for example, the consumption-equivalent damages in each period are calculated as a fraction of GDP, depending on the temperature in that period relative to the pre-industrial average temperature in each region. In FUND, damages in each period also depend on the rate of temperature change from the prior period. In DICE, temperature affects both consumption and investment. We describe each model in greater detail here. In a later section, we discuss key gaps in how the models account for various scientific and economic processes (e.g. the probability of catastrophe, and the ability to adapt to climate change and the physical changes it causes).

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[2] The DICE (Dynamic Integrated Climate and Economy) model by William Nordhaus evolved from a series of energy models and was first presented in 1990 (Nordhaus and Boyer 2000, Nordhaus 2008). The PAGE (Policy Analysis of the Greenhouse Effect) model was developed by Chris Hope in 1991 for use by European decision-makers in assessing the marginal impact of carbon emissions (Hope 2006, Hope 2008). The FUND (Climate Framework for Uncertainty, Negotiation, and Distribution) model, developed by Richard Tol in the early 1990s, originally to study international capital transfers in climate policy. is now widely used to study climate impacts (e.g., Tol 2002a, Tol 2002b, Anthoff et al. 2009, Tol 2009).

The parameters and assumptions embedded in the three models vary widely. A key objective of the interagency process was to enable a consistent exploration of the three models while respecting the different approaches to quantifying damages taken by the key modelers in the field. An extensive review of the literature was conducted to select three sets of input parameters for these models: climate sensitivity, socio-economic and emissions trajectories, and discount rates. A probability distribution for climate sensitivity was specified as an input into all three models. In addition, the interagency group used a range of scenarios for the socio-economic parameters and a range of values for the discount rate. All other model features were left unchanged, relying on the model developers' best estimates and judgments. In DICE, these parameters are handled deterministically and represented by fixed constants; in PAGE, most parameters are represented by probability distributions. FUND was also run in a mode in which parameters were treated probabilistically.

The sensitivity of the results to other aspects of the models (e.g. the carbon cycle or damage function) is also important to explore in the context of future revisions to the SCC but has not been incorporated into these estimates. Areas for future research are highlighted at the end of this document.

The DICE Model

The DICE model is an optimal growth model based on a global production function with an extra stock variable (atmospheric carbon dioxide concentrations). Emission reductions are treated as analogous to investment in "natural capital." By investing in natural capital today through reductions in emissions—implying reduced consumption—harmful effects of climate change can be avoided and future consumption thereby increased.

For purposes of estimating the SCC, carbon dioxide emissions are a function of global GDP and the carbon intensity of economic output, with the latter declining over time due to technological progress. The DICE damage function links global average temperature to the overall impact on the world economy. It varies quadratically with temperature change to capture the more rapid increase in damages expected to occur under more extreme climate change, and is calibrated to include the effects of warming on the production of market and nonmarket goods and services. It incorporates impacts on agriculture, coastal areas (due to sea level rise), "other vulnerable market sectors" (based primarily on changes in energy use), human health (based on climate-related diseases, such as malaria and dengue fever, and pollution), non-market amenities (based on outdoor recreation), and human settlements and ecosystems. The DICE damage function also includes the expected value of damages associated with low probability, high impact "catastrophic" climate change. This last component is calibrated based on a survey of experts (Nordhaus 1994). The expected value of these impacts is then added to the other market and non-market impacts mentioned above.

No structural components of the DICE model represent adaptation explicitly, though it is included implicitly through the choice of studies used to calibrate the aggregate damage function. For example, its agricultural impact estimates assume that farmers can adjust land use decisions in response to changing climate conditions, and its health impact estimates assume improvements in healthcare over time. In addition, the small impacts on forestry, water systems, construction, fisheries, and outdoor recreation imply optimistic and costless adaptation in these sectors (Nordhaus and Boyer, 2000; Warren et al., 2006). Costs of resettlement due to sea level rise are incorporated into damage estimates, but their magnitude is not clearly reported. Mastrandrea's (2009) review concludes that "in general, DICE assumes very effective adaptation, and largely ignores adaptation costs."

Note that the damage function in DICE has a somewhat different meaning from the damage functions in FUND and PAGE. Because GDP is endogenous in DICE and because damages in a given year reduce investment in that year, damages propagate forward in time and reduce GDP in future years. In contrast, GDP is exogenous in FUND and PAGE, so damages in any given year do not propagate forward.[3]

The PAGE Model

PAGE2002 (version 1.4epm) treats GDP growth as exogenous. It divides impacts into economic, non-economic, and catastrophic categories and calculates these impacts separately for eight geographic regions. Damages in each region are expressed as a fraction of output, where the fraction lost depends on the temperature change in each region. Damages are expressed as power functions of temperature change. The exponents of the damage function are the same in all regions but are treated as uncertain, with values ranging from 1 to 3 (instead of being fixed at 2 as in DICE).

PAGE2002 includes the consequences of catastrophic events in a separate damage sub-function. Unlike DICE, PAGE2002 models these events probabilistically. The probability of a "discontinuity" (i.e., a catastrophic event) is assumed to increase with temperature above a specified threshold. The threshold temperature, the rate at which the probability of experiencing a discontinuity increases above the threshold, and the magnitude of the resulting catastrophe are all modeled probabilistically.

Adaptation is explicitly included in PAGE. Impacts are assumed to occur for temperature increases above some tolerable level (2°C for developed countries and 0°C for developing countries for economic impacts, and 0°C for all regions for non-economic impacts), but adaptation is assumed to reduce these impacts. Default values in PAGE2002 assume that the developed countries can ultimately eliminate up to 90 percent of all economic impacts beyond the tolerable 2°C increase and that developing countries can eventually eliminate 50 percent of their economic impacts. All regions are assumed to be able to mitigate 25 percent of the non-economic impacts through adaptation (Hope 2006).

The FUND Model

Like PAGE, the FUND model treats GDP growth as exogenous. It includes separately calibrated damage functions for eight market and nonmarket sectors: agriculture, forestry, water, energy (based on heating and cooling demand), sea level rise (based on the value of land lost and the cost of protection),

[3] Using the default assumptions in DICE 2007, this effect generates an approximately 25 percent increase in the SCC relative to damages calculated by fixing GDP. In DICE2007, the time path of GDP is endogenous. Specifically, the path of GDP depends on the rate of saving and level of abatement in each period chosen by the optimizing representative agent in the model. We made two modifications to DICE to make it consistent with EMF GDP trajectories (see next section): we assumed a fixed rate of savings of 20%, and we re-calibrated the exogenous path of total factor productivity so that DICE would produce GDP projections in the absence of warming that exactly matched the EMF scenarios.

ecosystems, human health (diarrhea, vector-borne diseases, and cardiovascular and respiratory mortality), and extreme weather. Each impact sector has a different functional form, and is calculated separately for sixteen geographic regions. In some impact sectors, the fraction of output lost or gained due to climate change depends not only on the absolute temperature change but also on the rate of temperature change and level of regional income.[4] In the forestry and agricultural sectors, economic damages also depend on CO_2 concentrations.

Tol (2009) discusses impacts not included in FUND, noting that many are likely to have a relatively small effect on damage estimates (both positive and negative). However, he characterizes several omitted impacts as "big unknowns": for instance, extreme climate scenarios, biodiversity loss, and effects on economic development and political violence. With regard to potentially catastrophic events, he notes, "Exactly what would cause these sorts of changes or what effects they would have are not well-understood, although the chance of any one of them happening seems low. But they do have the potential to happen relatively quickly, and if they did, the costs could be substantial. Only a few studies of climate change have examined these issues."

Adaptation is included both implicitly and explicitly in FUND. Explicit adaptation is seen in the agriculture and sea level rise sectors. Implicit adaptation is included in sectors such as energy and human health, where wealthier populations are assumed to be less vulnerable to climate impacts. For example, the damages to agriculture are the sum of three effects: (1) those due to the rate of temperature change (damages are always positive); (2) those due to the level of temperature change (damages can be positive or negative depending on region and temperature); and (3) those from CO_2 fertilization (damages are generally negative but diminishing to zero).

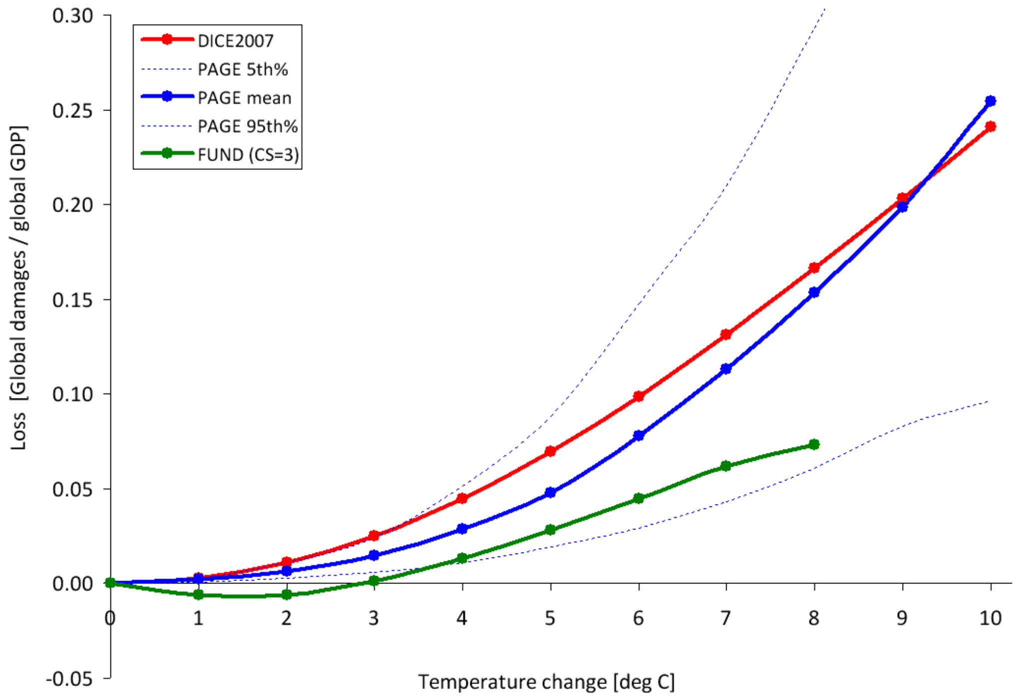
Adaptation is incorporated into FUND by allowing damages to be smaller if climate change happens more slowly. The combined effect of CO_2 fertilization in the agricultural sector, positive impacts to some regions from higher temperatures, and sufficiently slow increases in temperature across these sectors can result in negative economic damages from climate change.

Damage Functions

To generate revised SCC values, we rely on the IAM modelers' current best judgments of how to represent the effects of climate change (represented by the increase in global-average surface temperature) on the consumption-equivalent value of both market and non-market goods (represented as a fraction of global GDP). We recognize that these representations are incomplete and highly uncertain. But given the paucity of data linking the physical impacts to economic damages, we were not able to identify a better way to translate changes in climate into net economic damages, short of launching our own research program.

[4] In the deterministic version of FUND, the majority of damages are attributable to increased air conditioning demand, while reduced cold stress in Europe, North America, and Central and East Asia results in health benefits in those regions at low to moderate levels of warming (Warren et al., 2006).

Figure 1A: Annual Consumption Loss as a Fraction of Global GDP in 2100 Due to an Increase in Annual - Global Temperature in the DICE, FUND, and PAGE models[5]



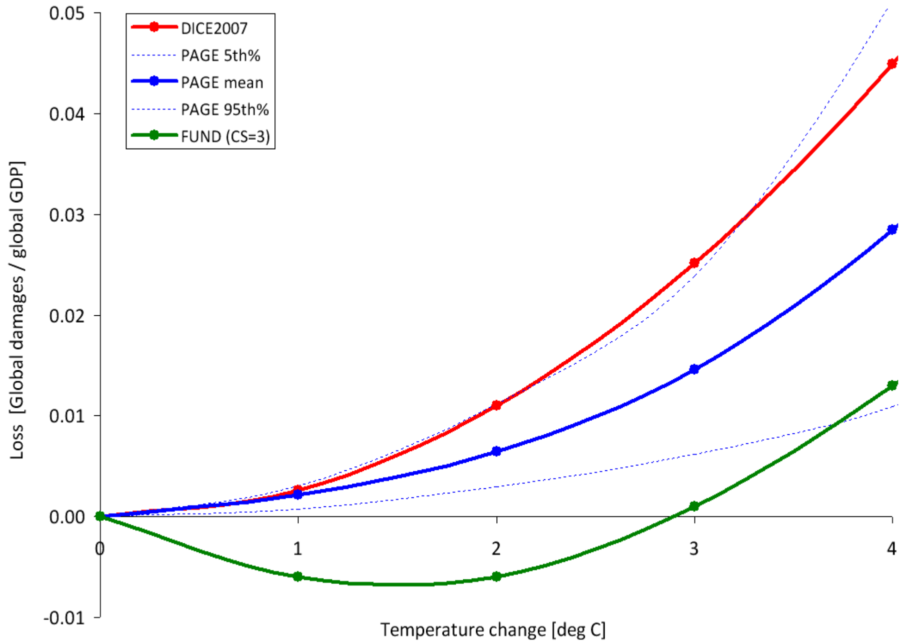
The damage functions for the three IAMs are presented in Figures 1A and 1B, using the modeler's default scenarios and mean input assumptions. There are significant differences between the three models both at lower (figure 1B) and higher (figure 1A) increases in global-average temperature.

The lack of agreement among the models at lower temperature increases is underscored by the fact that the damages from FUND are well below the 5th percentile estimated by PAGE, while the damages estimated by DICE are roughly equal to the 95th percentile estimated by PAGE. This is significant because at higher discount rates we expect that a greater proportion of the SCC value is due to damages in years with lower temperature increases. For example, when the discount rate is 2.5 percent, about 45 percent of the 2010 SCC value in DICE is due to damages that occur in years when the temperature is less than or equal to 3 °C. This increases to approximately 55 percent and 80 percent at discount rates of 3 and 5 percent, respectively.

These differences underscore the need for a thorough review of damage functions—in particular, how the models incorporate adaptation, technological change, and catastrophic damages. Gaps in the literature make modifying these aspects of the models challenging, which highlights the need for additional research. As knowledge improves, the Federal government is committed to exploring how these (and other) models can be modified to incorporate more accurate estimates of damages.

[5] The x-axis represents increases in annual, rather than equilibrium, temperature, while the y-axis represents the annual stream of benefits as a share of global GDP. Each specific combination of climate sensitivity, socio-economic, and emissions parameters will produce a different realization of damages for each IAM. The damage functions represented in Figures 1A and 1B are the outcome of default assumptions. For instance, under alternate assumptions, the damages from FUND may cross from negative to positive at less than or greater than 3 °C.

Figure 1B: Annual Consumption Loss for Lower Temperature Changes in DICE, FUND, and PAGE -



B. Global versus Domestic Measures of SCC

Because of the distinctive nature of the climate change problem, we center our current attention on a global measure of SCC. This approach is the same as that taken for the interim values, but it otherwise represents a departure from past practices, which tended to put greater emphasis on a domestic measure of SCC (limited to impacts of climate change experienced within U.S. borders). As a matter of law, consideration of both global and domestic values is generally permissible; the relevant statutory provisions are usually ambiguous and allow selection of either measure.[6]

Global SCC

Under current OMB guidance contained in Circular A-4, analysis of economically significant proposed and final regulations from the domestic perspective is required, while analysis from the international perspective is optional. However, the climate change problem is highly unusual in at least two respects. First, it involves a global externality: emissions of most greenhouse gases contribute to damages around the world even when they are emitted in the United States. Consequently, to address the global nature of the problem, the SCC must incorporate the full (global) damages caused by GHG emissions. Second, climate change presents a problem that the United States alone cannot solve. Even if the United States were to reduce its greenhouse gas emissions to zero, that step would be far from enough to avoid substantial climate change. Other countries would also need to take action to reduce emissions if

[6] It is true that federal statutes are presumed not to have extraterritorial effect, in part to ensure that the laws of the United States respect the interests of foreign sovereigns. But use of a global measure for the SCC does not give extraterritorial effect to federal law and hence does not intrude on such interests.

significant changes in the global climate are to be avoided. Emphasizing the need for a global solution to a global problem, the United States has been actively involved in seeking international agreements to reduce emissions and in encouraging other nations, including emerging major economies, to take significant steps to reduce emissions. When these considerations are taken as a whole, the interagency group concluded that a global measure of the benefits from reducing U.S. emissions is preferable.

When quantifying the damages associated with a change in emissions, a number of analysts (e.g., Anthoff, et al. 2009a) employ "equity weighting" to aggregate changes in consumption across regions. This weighting takes into account the relative reductions in wealth in different regions of the world. A per-capita loss of $500 in GDP, for instance, is weighted more heavily in a country with a per-capita GDP of $2,000 than in one with a per-capita GDP of $40,000. The main argument for this approach is that a loss of $500 in a poor country causes a greater reduction in utility or welfare than does the same loss in a wealthy nation. Notwithstanding the theoretical claims on behalf of equity weighting, the interagency group concluded that this approach would not be appropriate for estimating a SCC value used in domestic regulatory analysis.[7] For this reason, the group concluded that using the global (rather than domestic) value, without equity weighting, is the appropriate approach.

Domestic SCC

As an empirical matter, the development of a domestic SCC is greatly complicated by the relatively few region- or country-specific estimates of the SCC in the literature. One potential source of estimates comes from the FUND model. The resulting estimates suggest that the ratio of domestic to global benefits of emission reductions varies with key parameter assumptions. For example, with a 2.5 or 3 percent discount rate, the U.S. benefit is about 7-10 percent of the global benefit, on average, across the scenarios analyzed. Alternatively, if the fraction of GDP lost due to climate change is assumed to be similar across countries, the domestic benefit would be proportional to the U.S. share of global GDP, which is currently about 23 percent.[8]

On the basis of this evidence, the interagency workgroup determined that a range of values from 7 to 23 percent should be used to adjust the global SCC to calculate domestic effects. Reported domestic values should use this range. It is recognized that these values are approximate, provisional, and highly speculative. There is no a priori reason why domestic benefits should be a constant fraction of net global damages over time. Further, FUND does not account for how damages in other regions could affect the United States (e.g., global migration, economic and political destabilization). If more accurate methods for calculating the domestic SCC become available, the Federal government will examine these to determine whether to update its approach.

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[7] It is plausible that a loss of $X inflicts more serious harm on a poor nation than on a wealthy one, but development of the appropriate "equity weight" is challenging. Emissions reductions also impose costs, and hence a full account would have to consider that a given cost of emissions reductions imposes a greater utility or welfare loss on a poor nation than on a wealthy one. Even if equity weighting—for both the costs and benefits of emissions reductions—is appropriate when considering the utility or welfare effects of international action, the interagency group concluded that it should not be used in developing an SCC for use in regulatory policy at this time.

[8] Based on 2008 GDP (in current US dollars) from the *World Bank Development Indicators Report*.

C. Valuing Non-CO_2 Emissions

While CO_2 is the most prevalent greenhouse gas emitted into the atmosphere, the U.S. included five other greenhouse gases in its recent endangerment finding: methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. The climate impact of these gases is commonly discussed in terms of their 100-year global warming potential (GWP). GWP measures the ability of different gases to trap heat in the atmosphere (i.e., radiative forcing per unit of mass) over a particular timeframe relative to CO_2. However, because these gases differ in both radiative forcing and atmospheric lifetimes, their relative damages are not constant over time. For example, because methane has a short lifetime, its impacts occur primarily in the near term and thus are not discounted as heavily as those caused by longer-lived gases. Impacts other than temperature change also vary across gases in ways that are not captured by GWP. For instance, CO_2 emissions, unlike methane and other greenhouse gases, contribute to ocean acidification. Likewise, damages from methane emissions are not offset by the positive effect of CO_2 fertilization. Thus, transforming gases into CO_2-equivalents using GWP, and then multiplying the carbon-equivalents by the SCC, would not result in accurate estimates of the social costs of non-CO_2 gases.

In light of these limitations, and the significant contributions of non-CO_2 emissions to climate change, further research is required to link non-CO_2 emissions to economic impacts. Such work would feed into efforts to develop a monetized value of reductions in non-CO_2 greenhouse gas emissions. As part of ongoing work to further improve the SCC estimates, the interagency group hopes to develop methods to value these other greenhouse gases. The goal is to develop these estimates by the time we issue revised SCC estimates for carbon dioxide emissions.

D. Equilibrium Climate Sensitivity

Equilibrium climate sensitivity (ECS) is a key input parameter for the DICE, PAGE, and FUND models.[9] It is defined as the long-term increase in the annual global-average surface temperature from a doubling of atmospheric CO_2 concentration relative to pre-industrial levels (or stabilization at a concentration of approximately 550 parts per million (ppm)). Uncertainties in this important parameter have received substantial attention in the peer-reviewed literature.

The most authoritative statement about equilibrium climate sensitivity appears in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC):

> *Basing our assessment on a combination of several independent lines of evidence…including observed climate change and the strength of known feedbacks simulated in [global climate models], we conclude that the global mean equilibrium warming for doubling CO_2, or 'equilibrium climate*

[9] The equilibrium climate sensitivity includes the response of the climate system to increased greenhouse gas concentrations over the short to medium term (up to 100-200 years), but it does not include long-term feedback effects due to possible large-scale changes in ice sheets or the biosphere, which occur on a time scale of many hundreds to thousands of years (e.g. Hansen et al. 2007).

sensitivity', is likely to lie in the range 2 °C to 4.5 °C, with a most likely value of about 3 °C. Equilibrium climate sensitivity is very likely larger than 1.5 °C.[10]

For fundamental physical reasons as well as data limitations, values substantially higher than 4.5 °C still cannot be excluded, but agreement with observations and proxy data is generally worse for those high values than for values in the 2 °C to 4.5 °C range. (Meehl et al., 2007, p 799)

After consulting with several lead authors of this chapter of the IPCC report, the interagency workgroup selected four candidate probability distributions and calibrated them to be consistent with the above statement: Roe and Baker (2007), log-normal, gamma, and Weibull. Table 1 included below gives summary statistics for the four calibrated distributions.

Table 1: Summary Statistics for Four Calibrated Climate Sensitivity Distributions

	Roe & Baker	Log-normal	Gamma	Weibull
Pr(ECS < 1.5°C)	0.013	0.050	0.070	0.102
Pr(2°C < ECS < 4.5°C)	0.667	0.667	0.667	0.667
5th percentile	1.72	1.49	1.37	1.13
10th percentile	1.91	1.74	1.65	1.48
Mode	2.34	2.52	2.65	2.90
Median (50th percentile)	3.00	3.00	3.00	3.00
Mean	3.50	3.28	3.19	3.07
90th percentile	5.86	5.14	4.93	4.69
95th percentile	7.14	5.97	5.59	5.17

Each distribution was calibrated by applying three constraints from the IPCC:

(1) a median equal to 3°C, to reflect the judgment of "a most likely value of about 3 °C";[11]
(2) two-thirds probability that the equilibrium climate sensitivity lies between 2 and 4.5 °C; and
(3) zero probability that it is less than 0°C or greater than 10°C (see Hegerl et al. 2006, p. 721).

We selected the calibrated Roe and Baker distribution from the four candidates for two reasons. First, the Roe and Baker distribution is the only one of the four that is based on a theoretical understanding of the response of the climate system to increased greenhouse gas concentrations (Roe and Baker 2007,

[10] This is in accord with the judgment that it "is likely to lie in the range 2 °C to 4.5 °C" and the IPCC definition of "likely" as greater than 66 percent probability (Le Treut et al.2007). "Very likely" indicates a greater than 90 percent probability.

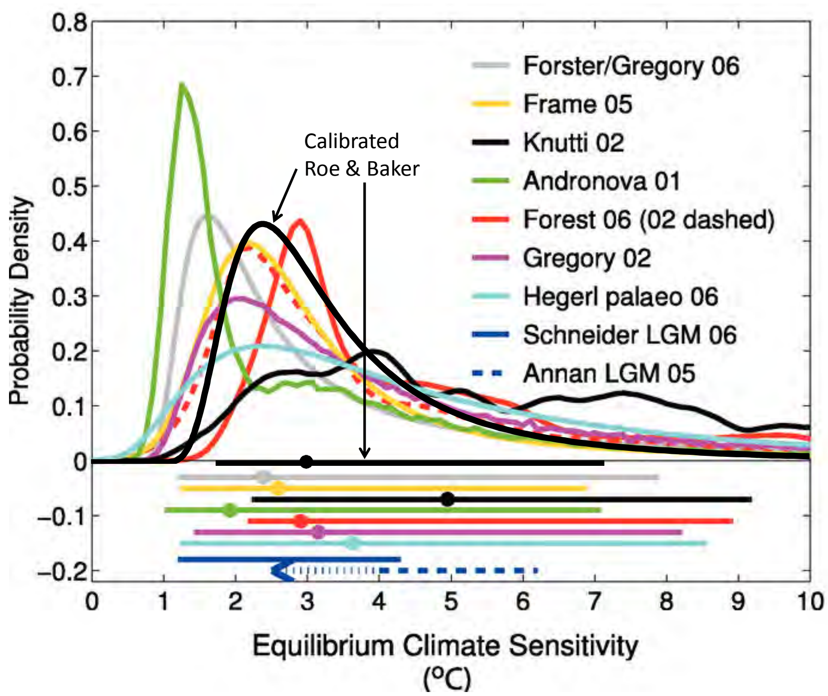
[11] Strictly speaking, "most likely" refers to the mode of a distribution rather than the median, but common usage would allow the mode, median, or mean to serve as candidates for the central or "most likely" value and the IPCC report is not specific on this point. For the distributions we considered, the median was between the mode and the mean. For the Roe and Baker distribution, setting the median equal to 3°C, rather than the mode or mean, gave a 95th percentile that is more consistent with IPCC judgments and the literature. For example, setting the mean and mode equal to 3°C produced 95th percentiles of 5.6 and 8.6 °C, respectively, which are in the lower and upper end of the range in the literature. Finally, the median is closer to 3°C than is the mode for the truncated distributions selected by the IPCC (Hegerl, et al., 2006); the average median is 3.1 °C and the average mode is 2.3 °C, which is most consistent with a Roe and Baker distribution with the median set equal to 3 °C.

Roe 2008). In contrast, the other three distributions are mathematical functions that are arbitrarily chosen based on simplicity, convenience, and general shape. The Roe and Baker distribution results from three assumptions about climate response: (1) absent feedback effects, the equilibrium climate sensitivity is equal to 1.2 °C; (2) feedback factors are proportional to the change in surface temperature; and (3) uncertainties in feedback factors are normally distributed. There is widespread agreement on the first point and the second and third points are common assumptions.

Second, the calibrated Roe and Baker distribution better reflects the IPCC judgment that "values substantially higher than 4.5°C still cannot be excluded." Although the IPCC made no quantitative judgment, the 95th percentile of the calibrated Roe & Baker distribution (7.1 °C) is much closer to the mean and the median (7.2 °C) of the 95th percentiles of 21 previous studies summarized by Newbold and Daigneault (2009). It is also closer to the mean (7.5 °C) and median (7.9 °C) of the nine truncated distributions examined by the IPCC (Hegerl, et al., 2006) than are the 95th percentiles of the three other calibrated distributions (5.2-6.0 °C).

Finally, we note the IPCC judgment that the equilibrium climate sensitivity "is very likely larger than 1.5°C." Although the calibrated Roe & Baker distribution, for which the probability of equilibrium climate sensitivity being greater than 1.5°C is almost 99 percent, is not inconsistent with the IPCC definition of "very likely" as "greater than 90 percent probability," it reflects a greater degree of certainty about very low values of ECS than was expressed by the IPCC.

Figure 2: Estimates of the Probability Density Function for Equilibrium Climate Sensitivity (°C)



To show how the calibrated Roe and Baker distribution compares to different estimates of the probability distribution function of equilibrium climate sensitivity in the empirical literature, Figure 2 (below) overlays it on Figure 9.20 from the IPCC Fourth Assessment Report. These functions are scaled to integrate to unity between 0 °C and 10 °C. The horizontal bars show the respective 5 percent to 95 percent ranges; dots indicate the median estimate.[12]

E. Socio-Economic and Emissions Trajectories

Another key issue considered by the interagency group is how to select the set of socio-economic and emissions parameters for use in PAGE, DICE, and FUND. Socio-economic pathways are closely tied to climate damages because, all else equal, more and wealthier people tend to emit more greenhouse gases and also have a higher (absolute) willingness to pay to avoid climate disruptions. For this reason, we consider how to model several input parameters in tandem: GDP, population, CO_2 emissions, and non-CO_2 radiative forcing. A wide variety of scenarios have been developed and used for climate change policy simulations (e.g., SRES 2000, CCSP 2007, EMF 2009). In determining which scenarios are appropriate for inclusion, we aimed to select scenarios that span most of the plausible ranges of outcomes for these variables.

To accomplish this task in a transparent way, we decided to rely on the recent Stanford Energy Modeling Forum exercise, EMF-22. EMF-22 uses ten well-recognized models to evaluate substantial, coordinated global action to meet specific stabilization targets. A key advantage of relying on these data is that GDP, population, and emission trajectories are internally consistent for each model and scenario evaluated. The EMF-22 modeling effort also is preferable to the IPCC SRES due to their age (SRES were developed in 1997) and the fact that 3 of 4 of the SRES scenarios are now extreme outliers in one or more variables. Although the EMF-22 scenarios have not undergone the same level of scrutiny as the SRES scenarios, they are recent, peer-reviewed, published, and publicly available.

To estimate the SCC for use in evaluating domestic policies that will have a small effect on global cumulative emissions, we use socio-economic and emission trajectories that span a range of plausible scenarios. Five trajectories were selected from EMF-22 (see Table 2 below). Four of these represent potential business-as-usual (BAU) growth in population, wealth, and emissions and are associated with CO_2 (only) concentrations ranging from 612 to 889 ppm in 2100. One represents an emissions pathway that achieves stabilization at 550 ppm CO_2e (i.e., CO_2-only concentrations of 425 – 484 ppm or a radiative forcing of 3.7 W/m^2) in 2100, a lower-than-BAU trajectory.[13] Out of the 10 models included in the EMF-22 exercise, we selected the trajectories used by MiniCAM, MESSAGE, IMAGE, and the optimistic scenario from MERGE. For the BAU pathways, we used the GDP, population, and emission trajectories from each of these four models. For the 550 ppm CO_2e scenario, we averaged the GDP, population, and emission trajectories implied by these same four models.

[12] The estimates based on instrumental data are from Andronova and Schlesinger (2001), Forest et al. (2002; dashed line, anthropogenic forcings only), Forest et al. (2006; solid line, anthropogenic and natural forcings), Gregory et al. (2002a), Knutti et al. (2002), Frame et al. (2005), and Forster and Gregory (2006). Hegerl et al. (2006) are based on multiple palaeoclimatic reconstructions of north hemisphere mean temperatures over the last 700 years. Also shown are the 5-95 percent approximate ranges for two estimates from the last glacial maximum (dashed, Annan et al. 2005; solid, Schneider von Deimling et al. 2006), which are based on models with different structural properties.

[13] Such an emissions path would be consistent with widespread action by countries to mitigate GHG emissions, though it could also result from technological advances. It was chosen because it represents the most stringent case analyzed by the EMF-22 where all the models converge: a 550 ppm, not to exceed, full participation scenario.

Table 2: Socioeconomic and Emissions Projections from Select EMF-22 Reference Scenarios -

Reference Fossil and Industrial CO_2 Emissions ($GtCO_2$/yr) -

EMF – 22 Based Scenarios	2000	2010	2020	2030	2050	2100
IMAGE	26.6	31.9	36.9	40.0	45.3	60.1
MERGE Optimistic	24.6	31.5	37.6	45.1	66.5	117.9
MESSAGE	26.8	29.2	37.6	42.1	43.5	42.7
MiniCAM	26.5	31.8	38.0	45.1	57.8	80.5
550 ppm average	26.2	31.1	33.2	32.4	20.0	12.8

Reference GDP (using market exchange rates in trillion 2005$)[14]

EMF – 22 Based Scenarios	2000	2010	2020	2030	2050	2100
IMAGE	38.6	53.0	73.5	97.2	156.3	396.6
MERGE Optimistic	36.3	45.9	59.7	76.8	122.7	268.0
MESSAGE	38.1	52.3	69.4	91.4	153.7	334.9
MiniCAM	36.1	47.4	60.8	78.9	125.7	369.5
550 ppm average	37.1	49.6	65.6	85.5	137.4	337.9

Global Population (billions)

EMF – 22 Based Scenarios	2000	2010	2020	2030	2050	2100
IMAGE	6.1	6.9	7.6	8.2	9.0	9.1
MERGE Optimistic	6.0	6.8	7.5	8.2	9.0	9.7
MESSAGE	6.1	6.9	7.7	8.4	9.4	10.4
MiniCAM	6.0	6.8	7.5	8.1	8.8	8.7
550 ppm average	6.1	6.8	7.6	8.2	8.7	9.1

We explore how sensitive the SCC is to various assumptions about how the future will evolve without prejudging what is likely to occur. The interagency group considered formally assigning probability weights to different states of the world, but this proved challenging to do in an analytically rigorous way given the dearth of information on the likelihood of a full range of future socio-economic pathways.

There are a number of caveats. First, EMF BAU scenarios represent the modelers' judgment of the most likely pathway absent mitigation policies to reduce greenhouse gas emissions, rather than the wider range of possible outcomes. Nevertheless, these views of the most likely outcome span a wide range,

[14] While the EMF-22 models used market exchange rates (MER) to calculate global GDP, it is also possible to use purchasing power parity (PPP). PPP takes into account the different price levels across countries, so it more accurately describes relative standards of living across countries. MERs tend to make low-income countries appear poorer than they actually are. Because many models assume convergence in per capita income over time, use of MER-adjusted GDP gives rise to projections of higher economic growth in low income countries. There is an ongoing debate about how much this will affect estimated climate impacts. Critics of the use of MER argue that it leads to overstated economic growth and hence a significant upward bias in projections of greenhouse gas emissions, and unrealistically high future temperatures (e.g., Castles and Henderson 2003). Others argue that convergence of the emissions-intensity gap across countries at least partially offset the overstated income gap so that differences in exchange rates have less of an effect on emissions (Holtsmark and Alfsen, 2005; Tol, 2006). Nordhaus (2007b) argues that the ideal approach is to use superlative PPP accounts (i.e., using cross-sectional PPP measures for relative incomes and outputs and national accounts price and quantity indexes for time-series extrapolations). However, he notes that it important to keep this debate in perspective; it is by no means clear that exchange-rate-conversion issues are as important as uncertainties about population, technological change, or the many geophysical uncertainties.

from the more optimistic (e.g. abundant low-cost, low-carbon energy) to more pessimistic (e.g. constraints on the availability of nuclear and renewables).[15] Second, the socio-economic trajectories associated with a 550 ppm CO_2e concentration scenario are not derived from an assessment of what policy is optimal from a benefit-cost standpoint. Rather, it is indicative of one possible future outcome. The emission trajectories underlying some BAU scenarios (e.g. MESSAGE's 612 ppm) also are consistent with some modest policy action to address climate change.[16] We chose not to include socio-economic trajectories that achieve even lower GHG concentrations at this time, given the difficulty many models had in converging to meet these targets.

For comparison purposes, the Energy Information Agency in its 2009 Annual Energy Outlook projected that global carbon dioxide emissions will grow to 30.8, 35.6, and 40.4 gigatons in 2010, 2020, and 2030, respectively, while world GDP is projected to be $51.8, $71.0 and $93.9 trillion (in 2005 dollars using market exchange rates) in 2010, 2020, and 2030, respectively. These projections are consistent with one or more EMF-22 scenarios. Likewise, the United Nations' 2008 Population Prospect projects population will grow from 6.1 billion people in 2000 to 9.1 billion people in 2050, which is close to the population trajectories for the IMAGE, MiniCAM, and MERGE models.

In addition to fossil and industrial CO_2 emissions, each EMF scenario provides projections of methane, nitrous oxide, fluorinated greenhouse gases, and net land use CO_2 emissions out to 2100. These assumptions also are used in the three models while retaining the default radiative forcings due to other factors (e.g. aerosols and other gases). See the Appendix for greater detail.

F. Discount Rate

The choice of a discount rate, especially over long periods of time, raises highly contested and exceedingly difficult questions of science, economics, philosophy, and law. Although it is well understood that the discount rate has a large influence on the current value of future damages, there is no consensus about what rates to use in this context. Because carbon dioxide emissions are long-lived, subsequent damages occur over many years. In calculating the SCC, we first estimate the future damages to agriculture, human health, and other market and non-market sectors from an additional unit of carbon dioxide emitted in a particular year in terms of reduced consumption (or consumption equivalents) due to the impacts of elevated temperatures, as represented in each of the three IAMs. Then we discount the stream of future damages to its present value in the year when the additional unit of emissions was released using the selected discount rate, which is intended to reflect society's marginal rate of substitution between consumption in different time periods.

For rules with both intra- and intergenerational effects, agencies traditionally employ constant discount rates of both 3 percent and 7 percent in accordance with OMB Circular A-4. As Circular A-4 acknowledges, however, the choice of discount rate for intergenerational problems raises distinctive

[15] For instance, in the MESSAGE model's reference case total primary energy production from nuclear, biomass, and non-biomass renewables is projected to increase from about 15 percent of total primary energy in 2000 to 54 percent in 2100. In comparison, the MiniCAM reference case shows 10 percent in 2000 and 21 percent in 2100.

[16] For example, MiniCAM projects if all non-US OECD countries reduce CO_2 emissions to 83 percent below 2005 levels by 2050 (per the G-8 agreement) but all other countries continue along a BAU path CO_2 concentrations in 2100 would drop from 794 ppmv in its reference case to 762 ppmv.

problems and presents considerable challenges. After reviewing those challenges, Circular A-4 states, "If your rule will have important intergenerational benefits or costs you might consider a further sensitivity analysis using a lower but positive discount rate in addition to calculating net benefits using discount rates of 3 and 7 percent." For the specific purpose of developing the SCC, we adapt and revise that approach here.

Arrow et al. (1996) outlined two main approaches to determine the discount rate for climate change analysis, which they labeled "descriptive" and "prescriptive." The descriptive approach reflects a positive (non-normative) perspective based on observations of people's actual choices—e.g., savings versus consumption decisions over time, and allocations of savings among more and less risky investments. Advocates of this approach generally call for inferring the discount rate from market rates of return "because of a lack of justification for choosing a social welfare function that is any different than what decision makers [individuals] actually use" (Arrow et al. 1996).

One theoretical foundation for the cost-benefit analyses in which the social cost of carbon will be used—the Kaldor-Hicks potential-compensation test—also suggests that market rates should be used to discount future benefits and costs, because it is the market interest rate that would govern the returns potentially set aside today to compensate future individuals for climate damages that they bear (e.g., Just et al. 2004). As some have noted, the word "potentially" is an important qualification; there is no assurance that such returns will actually be set aside to provide compensation, and the very idea of compensation is difficult to define in the intergenerational context. On the other hand, societies provide compensation to future generations through investments in human capital and the resulting increase in knowledge, as well as infrastructure and other physical capital.

The prescriptive approach specifies a social welfare function that formalizes the normative judgments that the decision-maker wants explicitly to incorporate into the policy evaluation—e.g., how inter-personal comparisons of utility should be made, and how the welfare of future generations should be weighed against that of the present generation. Ramsey (1928), for example, has argued that it is "ethically indefensible" to apply a positive pure rate of time preference to discount values across generations, and many agree with this view.

Other concerns also motivate making adjustments to descriptive discount rates. In particular, it has been noted that the preferences of future generations with regard to consumption versus environmental amenities may not be the same as those today, making the current market rate on consumption an inappropriate metric by which to discount future climate-related damages. Others argue that the discount rate should be below market rates to correct for market distortions and uncertainties or inefficiencies in intergenerational transfers of wealth, which in the Kaldor-Hicks logic are presumed to compensate future generations for damage (a potentially controversial assumption, as noted above) (Arrow et al. 1996, Weitzman 1999).

Further, a legitimate concern about both descriptive and prescriptive approaches is that they tend to obscure important heterogeneity in the population. The utility function that underlies the prescriptive approach assumes a representative agent with perfect foresight and no credit constraints. This is an artificial rendering of the real world that misses many of the frictions that characterize individuals' lives and indeed the available descriptive evidence supports this. For instance, many individuals smooth consumption by borrowing with credit cards that have relatively high rates. Some are unable to access traditional credit markets and rely on payday lending operations or other high cost forms of smoothing consumption. Whether one puts greater weight on the prescriptive or descriptive approach, the high interest rates that credit-constrained individuals accept suggest that some account should be given to the discount rates revealed by their behavior.

We draw on both approaches but rely primarily on the descriptive approach to inform the choice of discount rate. With recognition of its limitations, we find this approach to be the most defensible and transparent given its consistency with the standard contemporary theoretical foundations of benefit-cost analysis and with the approach required by OMB's existing guidance. The logic of this framework also suggests that market rates should be used for discounting future consumption-equivalent damages. Regardless of the theoretical approach used to derive the appropriate discount rate(s), we note the inherent conceptual and practical difficulties of adequately capturing consumption trade-offs over many decades or even centuries. While relying primarily on the descriptive approach in selecting specific discount rates, the interagency group has been keenly aware of the deeply normative dimensions of both the debate over discounting in the intergenerational context and the consequences of selecting one discount rate over another.

Historically Observed Interest Rates

In a market with no distortions, the return to savings would equal the private return on investment, and the market rate of interest would be the appropriate choice for the social discount rate. In the real world risk, taxes, and other market imperfections drive a wedge between the risk-free rate of return on capital and the consumption rate of interest. Thus, the literature recognizes two conceptual discount concepts—the consumption rate of interest and the opportunity cost of capital.

According to OMB's Circular A-4, it is appropriate to use the rate of return on capital when a regulation is expected to displace or alter the use of capital in the private sector. In this case, OMB recommends Agencies use a discount rate of 7 percent. When regulation is expected to primarily affect private consumption—for instance, via higher prices for goods and services—a lower discount rate of 3 percent is appropriate to reflect how private individuals trade-off current and future consumption.

The interagency group examined the economics literature and concluded that the consumption rate of interest is the correct concept to use in evaluating the benefits and costs of a marginal change in carbon emissions (see Lind 1990, Arrow et al 1996, and Arrow 2000). The consumption rate of interest also is appropriate when the impacts of a regulation are measured in consumption (-equivalent) units, as is done in the three integrated assessment models used for estimating the SCC.

Individuals use a variety of savings instruments that vary with risk level, time horizon, and tax characteristics. The standard analytic framework used to develop intuition about the discount rate typically assumes a representative agent with perfect foresight and no credit constraints. The risk-free rate is appropriate for discounting certain future benefits or costs, but the benefits calculated by IAMs are uncertain. To use the risk-free rate to discount uncertain benefits, these benefits first must be transformed into "certainty equivalents," that is the maximum certain amount that we would exchange for the uncertain amount. However, the calculation of the certainty-equivalent requires first estimating the correlation between the benefits of the policy and baseline consumption.

If the IAM projections of future impacts represent expected values (not certainty-equivalent values), then the appropriate discount rate generally does not equal the risk-free rate. If the benefits of the policy tend to be high in those states of the world in which consumption is low, then the certainty-equivalent benefits will be higher than the expected benefits (and vice versa). Since many (though not necessarily all) of the important impacts of climate change will flow through market sectors such as agriculture and energy, and since willingness to pay for environmental protections typically increases with income, we might expect a positive (though not necessarily perfect) correlation between the net benefits from climate policies and market returns. This line of reasoning suggests that the proper discount rate would exceed the riskless rate. Alternatively, a negative correlation between the returns to climate policies and market returns would imply that a discount rate below the riskless rate is appropriate.

This discussion suggests that both the post-tax riskless and risky rates can be used to capture individuals' consumption-equivalent interest rate. As a measure of the post-tax riskless rate, we calculate the average real return from Treasury notes over the longest time period available (those from Newell and Pizer 2003) and adjust for Federal taxes (the average marginal rate from tax years 2003 through 2006 is around 27 percent).[17] This calculation produces a real interest rate of about 2.7 percent, which is roughly consistent with Circular A-4's recommendation to use 3 percent to represent the consumption rate of interest.[18] A measure of the post-tax risky rate for investments whose returns are positively correlated with overall equity market returns can be obtained by adjusting pre-tax rates of household returns to risky investments (approximately 7 percent) for taxes yields a real rate of roughly 5 percent.[19]

The Ramsey Equation

Ramsey discounting also provides a useful framework to inform the choice of a discount rate. Under this approach, the analyst applies either positive or normative judgments in selecting values for the key parameters of the Ramsey equation: η (coefficient of relative risk aversion or elasticity of the marginal utility of consumption) and ρ (pure rate of time preference).[20] These are then combined with g (growth

[17] The literature argues for a risk-free rate on government bonds as an appropriate measure of the consumption rate of interest. Arrow (2000) suggests that it is roughly 3-4 percent. OMB cites evidence of a 3.1 percent pre-tax rate for 10-year Treasury notes in the A-4 guidance. Newell and Pizer (2003) find real interest rates between 3.5 and 4 percent for 30-year Treasury securities.

[18] The positive approach reflects how individuals make allocation choices across time, but it is important to keep in mind that we wish to reflect preferences for society as a whole, which generally has a longer planning horizon.

[19] Cambell et al (2001) estimates that the annual real return from stocks for 1900-1995 was about 7 percent. The annual real rate of return for the S&P 500 from 1950 – 2008 was about 6.8 percent. In the absence of a better way to population-weight the tax rates, we use the middle of the 20 – 40 percent range to derive a post-tax interest rate (Kotlikoff and Rapson 2006).

[20] The parameter ρ measures the *pure rate of time preference*: people's behavior reveals a preference for an increase in utility today versus the future. Consequently, it is standard to place a lower weight on utility in the future. The parameter η captures *diminishing marginal utility*: consumption in the future is likely to be higher than consumption today, so diminishing marginal utility of consumption implies that the same monetary damage will

rate of per-capita consumption) to equal the interest rate at which future monetized damages are discounted: $\rho + \eta \cdot g$.[21] In the simplest version of the Ramsey model, with an optimizing representative agent with perfect foresight, what we are calling the "Ramsey discount rate," $\rho + \eta \cdot g$, will be equal to the rate of return to capital, i.e., the market interest rate.

A review of the literature provides some guidance on reasonable parameter values for the Ramsey discounting equation, based on both prescriptive and descriptive approaches.

- η. Most papers in the climate change literature adopt values for η in the range of 0.5 to 3 (Weitzman cites plausible values as those ranging from 1 to 4), although not all authors articulate whether their choice is based on prescriptive or descriptive reasoning.[22] Dasgupta (2008) argues that η should be greater than 1 and may be as high as 3, since η equal to 1 suggests savings rates that do not conform to observed behavior.

- ρ. With respect to the pure rate of time preference, most papers in the climate change literature adopt values for ρ in the range of 0 to 3 percent per year. The very low rates tend to follow from moral judgments involving intergenerational neutrality. Some have argued that to use any value other than $\rho = 0$ would unjustly discriminate against future generations (e.g., Arrow et al. 1996, Stern et al. 2006). However, even in an inter-generational setting, it may make sense to use a small positive pure rate of time preference because of the small probability of unforeseen cataclysmic events (Stern et al. 2006).

- g. A commonly accepted approximation is around 2 percent per year. For the socio-economic scenarios used for this exercise, the EMF models assume that g is about 1.5-2 percent to 2100.

Some economists and non-economists have argued for constant discount rates below 2 percent based on the prescriptive approach. When grounded in the Ramsey framework, proponents of this approach have argued that a ρ of zero avoids giving preferential treatment to one generation over another. The choice of η has also been posed as an ethical choice linked to the value of an additional dollar in poorer

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cause a smaller reduction of utility for wealthier individuals, either in the future or in current generations. If $\eta = 0$, then a one dollar increase in income is equally valuable regardless of level of income; if $\eta = 1$, then a one percent increase in income is equally valuable no matter the level of income; and if $\eta > 1$, then a one percent increase in income is less valuable to wealthier individuals.

[21] In this case, g could be taken from the selected EMF socioeconomic scenarios or alternative assumptions about the rate of consumption growth.

[22] Empirical estimates of η span a wide range of values. A benchmark value of 2 is near the middle of the range of values estimated or used by Szpiro (1986), Hall and Jones (2007), Arrow (2007), Dasgupta (2006, 2008), Weitzman (2007, 2009), and Nordhaus (2008). However, Chetty (2006) developed a method of estimating η using data on labor supply behavior. He shows that existing evidence of the effects of wage changes on labor supply imposes a tight upper bound on the curvature of utility over wealth (CRRA < 2) with the mean implied value of 0.71 and concludes that the standard expected utility model cannot generate high levels of risk aversion without contradicting established facts about labor supply. Recent work has jointly estimated the components of the Ramsey equation. Evans and Sezer (2005) estimate $\eta = 1.49$ for 22 OECD countries. They also estimate $\rho = 1.08$ percent per year using data on mortality rates. Anthoff, et al. (2009b) estimate $\eta = 1.18$, and $\rho = 1.4$ percent. When they multiply the bivariate probability distributions from their work and Evans and Sezer (2005) together, they find $\eta = 1.47$, and $\rho = 1.07$.

countries compared to wealthier ones. Stern et al. (2006) applies this perspective through his choice of ρ = 0.1 percent per year, η = 1 and g = 1.3 percent per year, which yields an annual discount rate of 1.4 percent. In the context of permanent income savings behavior, however, Stern's assumptions suggest that individuals would save 93 percent of their income.[23]

Recently, Stern (2008) revisited the values used in Stern et al. (2006), stating that there is a case to be made for raising η due to the amount of weight lower values place on damages far in the future (over 90 percent of expected damages occur after 2200 with η = 1). Using Stern's assumption that ρ = 0.1 percent, combined with a η of 1.5 to 2 and his original growth rate, yields a discount rate greater 2 percent.

We conclude that arguments made under the prescriptive approach can be used to justify discount rates between roughly 1.4 and 3.1 percent. In light of concerns about the most appropriate value for η, we find it difficult to justify rates at the lower end of this range under the Ramsey framework.

Accounting for Uncertainty in the Discount Rate

While the consumption rate of interest is an important driver of the benefits estimate, it is uncertain over time. Ideally, we would formally model this uncertainty, just as we do for climate sensitivity. Weitzman (1998, 2001) showed theoretically and Newell and Pizer (2003) and Groom et al. (2006) confirm empirically that discount rate uncertainty can have a large effect on net present values. A main result from these studies is that if there is a persistent element to the uncertainty in the discount rate (e.g., the rate follows a random walk), then it will result in an effective (or certainty-equivalent) discount rate that declines over time. Consequently, lower discount rates tend to dominate over the very long term (see Weitzman 1998, 1999, 2001; Newell and Pizer 2003; Groom et al. 2006; Gollier 2008; Summers and Zeckhauser 2008; and Gollier and Weitzman 2009).

The proper way to model discount rate uncertainty remains an active area of research. Newell and Pizer (2003) employ a model of how long-term interest rates change over time to forecast future discount rates. Their model incorporates some of the basic features of how interest rates move over time, and its parameters are estimated based on historical observations of long-term rates. Subsequent work on this topic, most notably Groom et al. (2006), uses more general models of interest rate dynamics to allow for better forecasts. Specifically, the volatility of interest rates depends on whether rates are currently low or high and variation in the level of persistence over time.

While Newell and Pizer (2003) and Groom et al (2006) attempt formally to model uncertainty in the discount rate, others argue for a declining scale of discount rates applied over time (e.g., Weitzman 2001, and the UK's "Green Book" for regulatory analysis). This approach uses a higher discount rate

[23] Stern (2008) argues that building in a positive rate of exogenous technical change over time reduces the implied savings rate and that η at or above 2 are inconsistent with observed behavior with regard to equity. (At the same time, adding exogenous technical change—all else equal—would increase g as well.)

initially, but applies a graduated scale of lower discount rates further out in time.[24] A key question that has emerged with regard to both of these approaches is the trade-off between potential time inconsistency and giving greater weight to far future outcomes (see the EPA Science Advisory Board's recent comments on this topic as part of its review of their *Guidelines for Economic Analysis*).[25]

The Discount Rates Selected for Estimating SCC

In light of disagreement in the literature on the appropriate market interest rate to use in this context and uncertainty about how interest rates may change over time, we use three discount rates to span a plausible range of certainty-equivalent constant discount rates: 2.5, 3, and 5 percent per year. Based on the review in the previous sections, the interagency workgroup determined that these three rates reflect reasonable judgments under both descriptive and prescriptive approaches.

The central value, 3 percent, is consistent with estimates provided in the economics literature and OMB's Circular A-4 guidance for the consumption rate of interest. As previously mentioned, the consumption rate of interest is the correct discounting concept to use when future damages from elevated temperatures are estimated in consumption-equivalent units. Further, 3 percent roughly corresponds to the after-tax riskless interest rate. The upper value of 5 percent is included to represent the possibility that climate damages are positively correlated with market returns. Additionally, this discount rate may be justified by the high interest rates that many consumers use to smooth consumption across periods.

The low value, 2.5 percent, is included to incorporate the concern that interest rates are highly uncertain over time. It represents the average certainty-equivalent rate using the mean-reverting and random walk approaches from Newell and Pizer (2003) starting at a discount rate of 3 percent. Using this approach, the certainty equivalent is about 2.2 percent using the random walk model and 2.8 percent using the mean reverting approach.[26] Without giving preference to a particular model, the average of the two rates is 2.5 percent. Further, a rate below the riskless rate would be justified if climate investments are negatively correlated with the overall market rate of return. Use of this lower value also responds to certain judgments using the prescriptive or normative approach and to ethical objections that have been raised about rates of 3 percent or higher.

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[24] For instance, the UK applies a discount rate of 3.5 percent to the first 30 years; 3 percent for years 31 - 75; 2.5 percent for years 76 - 125; 2 percent for years 126 - 200; 1.5 percent for years 201 - 300; and 1 percent after 300 years. As a sensitivity, it recommends a discount rate of 3 percent for the first 30 years, also decreasing over time.

[25] Uncertainty in future damages is distinct from uncertainty in the discount rate. Weitzman (2008) argues that Stern's choice of a low discount rate was "right for the wrong reasons." He demonstrates how the damages from a low probability, catastrophic event far in the future dominate the effect of the discount rate in a present value calculation and result in an infinite willingness-to-pay for mitigation today. Newbold and Daigneault, (2009) and Nordhaus (2009) find that Weitzman's result is sensitive to the functional forms chosen for climate sensitivity, utility, and consumption. Summers and Zeckhauser (2008) argue that uncertainty in future damages can also work in the other direction by increasing the benefits of waiting to learn the appropriate level of mitigation required.

[26] Calculations done by Pizer et al. using the original simulation program from Newell and Pizer (2003).

IV. Revised SCC Estimates

Our general approach to estimating SCC values is to run the three integrated assessment models (FUND, DICE, and PAGE) using the following inputs agreed upon by the interagency group:

- A Roe and Baker distribution for the climate sensitivity parameter bounded between 0 and 10 with a median of 3 °C and a cumulative probability between 2 and 4.5 °C of two-thirds.
- Five sets of GDP, population and carbon emissions trajectories based on EMF-22.
- Constant annual discount rates of 2.5, 3, and 5 percent.

Because the climate sensitivity parameter is modeled probabilistically, and because PAGE and FUND incorporate uncertainty in other model parameters, the final output from each model run is a distribution over the SCC in year *t*.

For each of the IAMS, the basic computational steps for calculating the SCC in a particular year *t* are:

1. Input the path of emissions, GDP, and population from the selected EMF-22 scenarios, and the extrapolations based on these scenarios for post-2100 years.

2. Calculate the temperature effects and (consumption-equivalent) damages in each year resulting from the baseline path of emissions.

    a. In PAGE, the consumption-equivalent damages in each period are calculated as a fraction of the EMF GDP forecast, depending on the temperature in that period relative to the pre-industrial average temperature in each region.
    b. In FUND, damages in each period depend on both the level and the rate of temperature change in that period.
    c. In DICE, temperature affects both consumption and investment, so we first adjust the EMF GDP paths as follows: Using the Cobb-Douglas production function with the DICE2007 parameters, we extract the path of exogenous technical change implied by the EMF GDP and population paths, then we recalculate the baseline GDP path taking into account climate damages resulting from the baseline emissions path.

3. Add an additional unit of carbon emissions in year *t.* (The exact unit varies by model.)

4. Recalculate the temperature effects and damages expected in all years beyond *t* resulting from this adjusted path of emissions, as in step 2.

5. Subtract the damages computed in step 2 from those in step 4 in each year. (DICE is run in 10 year time steps, FUND in annual time steps, while the time steps in PAGE vary.)

6. Discount the resulting path of marginal damages back to the year of emissions using the agreed upon fixed discount rates.

7. Calculate the SCC as the net present value of the discounted path of damages computed in step 6, divided by the unit of carbon emissions used to shock the models in step 3.

8. Multiply by 12/44 to convert from dollars per ton of carbon to dollars per ton of CO_2 (2007 dollars) in DICE and FUND. (All calculations are done in tons of CO_2 in PAGE).

The steps above were repeated in each model for multiple future years to cover the time horizons anticipated for upcoming rulemaking analysis. To maintain consistency across the three IAMs, climate damages are calculated as lost consumption in each future year.

It is important to note that each of the three models has a different default end year. The default time horizon is 2200 for PAGE, 2595 for DICE, and 3000 for the latest version of FUND. This is an issue for the multi-model approach because differences in SCC estimates may arise simply due to the model time horizon. Many consider 2200 too short a time horizon because it could miss a significant fraction of damages under certain assumptions about the growth of marginal damages and discounting, so each model is run here through 2300. This step required a small adjustment in the PAGE model only. This step also required assumptions about GDP, population, and greenhouse gas emission trajectories after 2100, the last year for which these data are available from the EMF-22 models. (A more detailed discussion of these assumptions is included in the Appendix.)

This exercise produces 45 separate distributions of the SCC for a given year, the product of 3 models, 3 discount rates, and 5 socioeconomic scenarios. This is clearly too many separate distributions for consideration in a regulatory impact analysis.

To produce a range of plausible estimates that still reflects the uncertainty in the estimation exercise, the distributions from each of the models and scenarios are equally weighed and combined to produce three separate probability distributions for SCC in a given year, one for each assumed discount rate. These distributions are then used to define a range of point estimates for the global SCC. In this way, no integrated assessment model or socioeconomic scenario is given greater weight than another. Because the literature shows that the SCC is quite sensitive to assumptions about the discount rate, and because no consensus exists on the appropriate rate to use in an intergenerational context, we present SCCs based on the average values across models and socioeconomic scenarios for each discount rate.

The interagency group selected four SCC values for use in regulatory analyses. Three values are based on the average SCC across models and socio-economic and emissions scenarios at the 2.5, 3, and 5 percent discount rates. The fourth value is included to represent the higher-than-expected economic impacts from climate change further out in the tails of the SCC distribution. For this purpose, we use the SCC value for the 95th percentile at a 3 percent discount rate. (The full set of distributions by model and scenario combination is included in the Appendix.) As noted above, the 3 percent discount rate is the central value, and so the central value that emerges is the average SCC across models at the 3 percent discount rate. For purposes of capturing the uncertainties involved in regulatory impact analysis, we emphasize the importance and value of considering the full range.

As previously discussed, low probability, high impact events are incorporated into the SCC values through explicit consideration of their effects in two of the three models as well as the use of a probability density function for equilibrium climate sensitivity. Treating climate sensitivity probabilistically results in more high temperature outcomes, which in turn lead to higher projections of damages. Although FUND does not include catastrophic damages (in contrast to the other two models), its probabilistic treatment of the equilibrium climate sensitivity parameter will directly affect the non-catastrophic damages that are a function of the rate of temperature change.

In Table 3, we begin by presenting SCC estimates for 2010 by model, scenario, and discount rate to illustrate the variability in the SCC across each of these input parameters. As expected, higher discount rates consistently result in lower SCC values, while lower discount rates result in higher SCC values for each socioeconomic trajectory. It is also evident that there are differences in the SCC estimated across the three main models. For these estimates, FUND produces the lowest estimates, while PAGE generally produces the highest estimates.

Table 3: Disaggregated Social Cost of CO_2 Values by Model, Socio-Economic Trajectory, and Discount Rate for 2010 (in 2007 dollars)

	Discount rate:	**5%**	**3%**	**2.5%**	**3%**
Model	*Scenario*	Avg	Avg	Avg	95th
DICE	IMAGE	10.8	35.8	54.2	70.8
	MERGE	7.5	22.0	31.6	42.1
	Message	9.8	29.8	43.5	58.6
	MiniCAM	8.6	28.8	44.4	57.9
	550 Average	8.2	24.9	37.4	50.8
PAGE	IMAGE	8.3	39.5	65.5	142.4
	MERGE	5.2	22.3	34.6	82.4
	Message	7.2	30.3	49.2	115.6
	MiniCAM	6.4	31.8	54.7	115.4
	550 Average	5.5	25.4	42.9	104.7
FUND	IMAGE	-1.3	8.2	19.3	39.7
	MERGE	-0.3	8.0	14.8	41.3
	Message	-1.9	3.6	8.8	32.1
	MiniCAM	-0.6	10.2	22.2	42.6
	550 Average	-2.7	-0.2	3.0	19.4

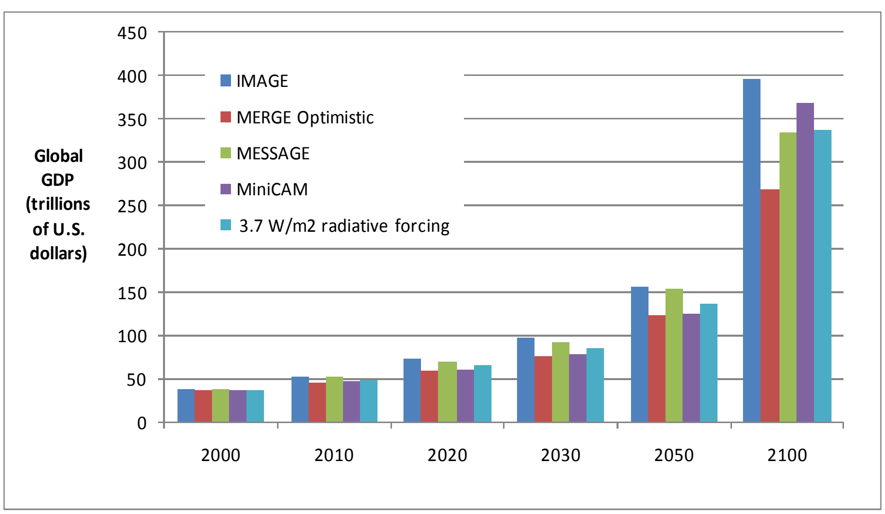
These results are not surprising when compared to the estimates in the literature for the latest versions of each model. For example, adjusting the values from the literature that were used to develop interim

SCC values to 2007 dollars for the year 2010 (assuming, as we did for the interim process, that SCC grows at 3 percent per year), FUND yields SCC estimates at or near zero for a 5 percent discount rate and around $9 per ton for a 3 percent discount rate. There are far fewer estimates using the latest versions of DICE and PAGE in the literature: Using similar adjustments to generate 2010 estimates, we calculate a SCC from DICE (based on Nordhaus 2008) of around $9 per ton for a 5 percent discount rate, and a SCC from PAGE (based on Hope 2006, 2008) close to $8 per ton for a 4 percent discount rate. Note that these comparisons are only approximate since the literature generally relies on Ramsey discounting, while we have assumed constant discount rates.[27]

The SCC estimates from FUND are sensitive to differences in emissions paths but relatively insensitive to differences in GDP paths across scenarios, while the reverse is true for DICE and PAGE. This likely occurs because of several structural differences among the models. Specifically in DICE and PAGE, the fraction of economic output lost due to climate damages increases with the level of temperature alone, whereas in FUND the fractional loss also increases with the rate of temperature change. Furthermore, in FUND increases in income over time decrease vulnerability to climate change (a form of adaptation), whereas this does not occur in DICE and PAGE. These structural differences among the models make FUND more sensitive to the path of emissions and less sensitive to GDP compared to DICE and PAGE.

Figure 3 shows that IMAGE has the highest GDP in 2100 while MERGE Optimistic has the lowest. The ordering of global GDP levels in 2100 directly corresponds to the rank ordering of SCC for PAGE and DICE. For FUND, the correspondence is less clear, a result that is to be expected given its less direct relationship between its damage function and GDP.

Figure 3: Level of Global GDP across EMF Scenarios



[27] Nordhaus (2008) runs DICE2007 with ρ = 1.5 and η = 2. The default approach in PAGE2002 (version 1.4epm) treats ρ and η as random parameters, specified using a triangular distribution such that the min, mode, and max = 0.1, 1, and 2 for ρ, and 0.5, 1, and 2 for η, respectively. The FUND default value for η is 1, and Tol generates SCC estimates for values of ρ = 0, 1, and 3 in many recent papers (e.g. Anthoff et al. 2009). The path of per-capita consumption growth, g, varies over time but is treated deterministically in two of the three models. In DICE, g is endogenous. Under Ramsey discounting, as economic growth slows in the future, the large damages from climate change that occur far out in the future are discounted at a lower rate than impacts that occur in the nearer term.

Table 4 shows the four selected SCC values in five year increments from 2010 to 2050. Values for 2010, 2020, 2040, and 2050 are calculated by first combining all outputs (10,000 estimates per model run) from all scenarios and models for a given discount rate. Values for the years in between are calculated using a simple linear interpolation.

Table 4: Social Cost of CO_2, 2010 – 2050 (in 2007 dollars)

Discount Rate Year	5% Avg	3% Avg	2.5% Avg	3% 95th
2010	4.7	21.4	35.1	64.9
2015	5.7	23.8	38.4	72.8
2020	6.8	26.3	41.7	80.7
2025	8.2	29.6	45.9	90.4
2030	9.7	32.8	50.0	100.0
2035	11.2	36.0	54.2	109.7
2040	12.7	39.2	58.4	119.3
2045	14.2	42.1	61.7	127.8
2050	15.7	44.9	65.0	136.2

The SCC increases over time because future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed in response to greater climatic change. Note that this approach allows us to estimate the growth rate of the SCC directly using DICE, PAGE, and FUND rather than assuming a constant annual growth rate as was done for the interim estimates (using 3 percent). This helps to ensure that the estimates are internally consistent with other modeling assumptions. Table 5 illustrates how the growth rate for these four SCC estimates varies over time. The full set of annual SCC estimates between 2010 and 2050 is reported in the Appendix.

Table 5: Changes in the Average Annual Growth Rates of SCC Estimates between 2010 and 2050

Average Annual Growth Rate (%)	**5%** Avg	**3%** Avg	**2.5%** Avg	**3.0%** 95th
2010-2020	3.6%	2.1%	1.7%	2.2%
2020-2030	3.7%	2.2%	1.8%	2.2%
2030-2040	2.7%	1.8%	1.6%	1.8%
2040-2050	2.1%	1.4%	1.1%	1.3%

While the SCC estimate grows over time, the future monetized value of emissions reductions in each year (the SCC in year *t* multiplied by the change in emissions in year *t*) must be discounted to the present to determine its total net present value for use in regulatory analysis. Damages from future emissions should be discounted at the same rate as that used to calculate the SCC estimates themselves to ensure internal consistency—i.e., future damages from climate change, whether they result from emissions today or emissions in a later year, should be discounted using the same rate. For example, climate damages in the year 2020 that are calculated using a SCC based on a 5 percent discount rate also should be discounted back to the analysis year using a 5 percent discount rate.[28]

V. Limitations of the Analysis

As noted, any estimate of the SCC must be taken as provisional and subject to further refinement (and possibly significant change) in accordance with evolving scientific, economic, and ethical understandings. During the course of our modeling, it became apparent that there are several areas in particular need of additional exploration and research. These caveats, and additional observations in the following section, are necessary to consider when interpreting and applying the SCC estimates.

Incomplete treatment of non-catastrophic damages. The impacts of climate change are expected to be widespread, diverse, and heterogeneous. In addition, the exact magnitude of these impacts is uncertain because of the inherent complexity of climate processes, the economic behavior of current and future populations, and our inability to accurately forecast technological change and adaptation. Current IAMs do not assign value to all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature (some of which are discussed above) because of lack of precise information on the nature of damages and because the science incorporated into these models understandably lags behind the most recent research. Our ability to quantify and monetize impacts will undoubtedly improve with time. But it is also likely that even in future applications, a number of potentially significant damage categories will remain non-monetized. (Ocean acidification is one example of a potentially large damage from CO_2 emissions not quantified by any of the three models. Species and wildlife loss is another example that is exceedingly difficult to monetize.)

Incomplete treatment of potential catastrophic damages. There has been considerable recent discussion of the risk of catastrophic impacts and how best to account for extreme scenarios, such as the collapse of the Atlantic Meridional Overturning Circulation or the West Antarctic Ice Sheet, or large releases of methane from melting permafrost and warming oceans. Weitzman (2009) suggests that catastrophic damages are extremely large—so large, in fact, that the damages from a low probability, catastrophic event far in the future dominate the effect of the discount rate in a present value calculation and result in an infinite willingness-to-pay for mitigation today. However, Nordhaus (2009) concluded that the conditions under which Weitzman's results hold "are limited and do not apply to a wide range of potential uncertain scenarios."

Using a simplified IAM, Newbold and Daigneault (2009) confirmed the potential for large catastrophe risk premiums but also showed that the aggregate benefit estimates can be highly sensitive to the shapes of both the climate sensitivity distribution and the damage function at high temperature changes. Pindyck (2009) also used a simplified IAM to examine high-impact low-probability risks, using a right-skewed gamma distribution for climate sensitivity as well as an uncertain damage coefficient, but in most cases found only a modest risk premium. Given this difference in opinion, further research in this area is needed before its practical significance can be fully understood and a reasonable approach developed to account for such risks in regulatory analysis. (The next section discusses the scientific evidence on catastrophic impacts in greater detail.)

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[28] However, it is possible that other benefits or costs of proposed regulations unrelated to CO_2 emissions will be discounted at rates that differ from those used to develop the SCC estimates.

Uncertainty in extrapolation of damages to high temperatures: The damage functions in these IAMs are typically calibrated by estimating damages at moderate temperature increases (e.g., DICE was calibrated at 2.5 °C) and extrapolated to far higher temperatures by assuming that damages increase as some power of the temperature change. Hence, estimated damages are far more uncertain under more extreme climate change scenarios.

Incomplete treatment of adaptation and technological change: Each of the three integrated assessment models used here assumes a certain degree of low- or no-cost adaptation. For instance, Tol assumes a great deal of adaptation in FUND, including widespread reliance on air conditioning ; so much so, that the largest single benefit category in FUND is the reduced electricity costs from not having to run air conditioning as intensively (NRC 2009).

Climate change also will increase returns on investment to develop technologies that allow individuals to cope with adverse climate conditions, and IAMs to do not adequately account for this directed technological change.[29] For example, scientists may develop crops that are better able to withstand higher and more variable temperatures. Although DICE and FUND have both calibrated their agricultural sectors under the assumption that farmers will change land use practices in response to climate change (Mastrandrea, 2009), they do not take into account technological changes that lower the cost of this adaptation over time. On the other hand, the calibrations do not account for increases in climate variability, pests, or diseases, which could make adaptation more difficult than assumed by the IAMs for a given temperature change. Hence, models do not adequately account for potential adaptation or technical change that might alter the emissions pathway and resulting damages. In this respect, it is difficult to determine whether the incomplete treatment of adaptation and technological change in these IAMs under or overstate the likely damages.

Risk aversion: A key question unanswered during this interagency process is what to assume about relative risk aversion with regard to high-impact outcomes. These calculations do not take into account the possibility that individuals may have a higher willingness to pay to reduce the likelihood of low-probability, high-impact damages than they do to reduce the likelihood of higher-probability but lower-impact damages with the same expected cost. (The inclusion of the 95th percentile estimate in the final set of SCC values was largely motivated by this concern.) If individuals do show such a higher willingness to pay, a further question is whether that fact should be taken into account for regulatory policy. Even if individuals are not risk-averse for such scenarios, it is possible that regulatory policy should include a degree of risk-aversion.

Assuming a risk-neutral representative agent is consistent with OMB's Circular A-4, which advises that the estimates of benefits and costs used in regulatory analysis are usually based on the average or the expected value and that "emphasis on these expected values is appropriate as long as society is 'risk neutral' with respect to the regulatory alternatives. While this may not always be the case, [analysts] should in general assume 'risk neutrality' in [their] analysis."

Nordhaus (2008) points to the need to explore the relationship between risk and income in the context of climate change across models and to explore the role of uncertainty regarding various parameters in

[29] However these research dollars will be diverted from whatever their next best use would have been in the absence of climate change (so productivity/GDP would have been still higher).

the results. Using FUND, Anthoff et al (2009) explored the sensitivity of the SCC to Ramsey equation parameter assumptions based on observed behavior. They conclude that “the assumed rate of risk aversion is at least as important as the assumed rate of time preference in determining the social cost of carbon.” Since Circular A-4 allows for a different assumption on risk preference in regulatory analysis if it is adequately justified, we plan to continue investigating this issue.

V. A Further Discussion of Catastrophic Impacts and Damage Functions

As noted above, the damage functions underlying the three IAMs used to estimate the SCC may not capture the economic effects of all possible adverse consequences of climate change and may therefore lead to underestimates of the SCC (Mastrandrea 2009). In particular, the models’ functional forms may not adequately capture: (1) potentially discontinuous “tipping point” behavior in Earth systems, (2) inter-sectoral and inter-regional interactions, including global security impacts of high-end warming, and (3) limited near-term substitutability between damage to natural systems and increased consumption.

It is the hope of the interagency group that over time researchers and modelers will work to fill these gaps and that the SCC estimates used for regulatory analysis by the Federal government will continue to evolve with improvements in modeling. In the meantime, we discuss some of the available evidence.

Extrapolation of climate damages to high levels of warming

The damage functions in the models are calibrated at moderate levels of warming and should therefore be viewed cautiously when extrapolated to the high temperatures found in the upper end of the distribution. Recent science suggests that there are a number of potential climatic “tipping points” at which the Earth system may exhibit discontinuous behavior with potentially severe social and economic consequences (e.g., Lenton et al, 2008, Kriegler et al., 2009). These tipping points include the disruption of the Indian Summer Monsoon, dieback of the Amazon Rainforest and boreal forests, collapse of the Greenland Ice Sheet and the West Antarctic Ice Sheet, reorganization of the Atlantic Meridional Overturning Circulation, strengthening of El Niño-Southern Oscillation, and the release of methane from melting permafrost. Many of these tipping points are estimated to have thresholds between about 3 °C and 5 °C (Lenton et al., 2008). Probabilities of several of these tipping points were assessed through expert elicitation in 2005–2006 by Kriegler et al. (2009); results from this study are highlighted in Table 6. Ranges of probability are averaged across core experts on each topic.

As previously mentioned, FUND does not include potentially catastrophic effects. DICE assumes a small probability of catastrophic damages that increases with increased warming, but the damages from these risks are incorporated as expected values (i.e., ignoring potential risk aversion). PAGE models catastrophic impacts in a probabilistic framework (see Figure 1), so the high-end output from PAGE potentially offers the best insight into the SCC if the world were to experience catastrophic climate change. For instance, at the 95th percentile and a 3 percent discount rate, the SCC estimated by PAGE across the five socio-economic and emission trajectories of \$113 per ton of CO_2 is almost double the value estimated by DICE, \$58 per ton in 2010. We cannot evaluate how well the three models account for catastrophic or non-catastrophic impacts, but this estimate highlights the sensitivity of SCC values in the tails of the distribution to the assumptions made about catastrophic impacts.

Table 6: Probabilities of Various Tipping Points from Expert Elicitation -

Possible Tipping Points	Duration before effect is fully realized (in years)	Additional Warming by 2100		
		0.5-1.5 C	1.5-3.0 C	3-5 C
Reorganization of Atlantic Meridional Overturning Circulation	about 100	0-18%	6-39%	18-67%
Greenland Ice Sheet collapse	at least 300	8-39%	33-73%	67-96%
West Antarctic Ice Sheet collapse	at least 300	5-41%	10-63%	33-88%
Dieback of Amazon rainforest	about 50	2-46%	14-84%	41-94%
Strengthening of El Niño-Southern Oscillation	about 100	1-13%	6-32%	19-49%
Dieback of boreal forests	about 50	13-43%	20-81%	34-91%
Shift in Indian Summer Monsoon	about 1	Not formally assessed		
Release of methane from melting permafrost	Less than 100	Not formally assessed.		

PAGE treats the possibility of a catastrophic event probabilistically, while DICE treats it deterministically (that is, by adding the expected value of the damage from a catastrophe to the aggregate damage function). In part, this results in different probabilities being assigned to a catastrophic event across the two models. For instance, PAGE places a probability near zero on a catastrophe at 2.5 °C warming, while DICE assumes a 4 percent probability of a catastrophe at 2.5 °C. By comparison, Kriegler et al. (2009) estimate a probability of at least 16-36 percent of crossing at least one of their primary climatic tipping points in a scenario with temperatures about 2-4 °C warmer than pre-Industrial levels in 2100.

It is important to note that crossing a climatic tipping point will not necessarily lead to an economic catastrophe in the sense used in the IAMs. A tipping point is a critical threshold across which some aspect of the Earth system starts to shifts into a qualitatively different state (for instance, one with dramatically reduced ice sheet volumes and higher sea levels). In the IAMs, a catastrophe is a low-probability environmental change with high economic impact.

Failure to incorporate inter-sectoral and inter-regional interactions

The damage functions do not fully incorporate either inter-sectoral or inter-regional interactions. For instance, while damages to the agricultural sector are incorporated, the effects of changes in food supply on human health are not fully captured and depend on the modeler's choice of studies used to calibrate the IAM. Likewise, the effects of climate damages in one region of the world on another region are not included in some of the models (FUND includes the effects of migration from sea level rise). These inter-regional interactions, though difficult to quantify, are the basis for climate-induced national and economic security concerns (e.g., Campbell et al., 2007; U.S. Department of Defense 2010) and are particularly worrisome at higher levels of warming. High-end warming scenarios, for instance, project water scarcity affecting 4.3-6.9 billion people by 2050, food scarcity affecting about 120 million additional people by 2080, and the creation of millions of climate refugees (Easterling et al., 2007; Campbell et al., 2007).

Imperfect substitutability of environmental amenities

Data from the geological record of past climate changes suggests that 6 °C of warming may have severe consequences for natural systems. For instance, during the Paleocene-Eocene Thermal Maximum about 55.5 million years ago, when the Earth experienced a geologically rapid release of carbon associated with an approximately 5 °C increase in global mean temperatures, the effects included shifts of about 400-900 miles in the range of plants (Wing et al., 2005), and dwarfing of both land mammals (Gingerich, 2006) and soil fauna (Smith et al., 2009).

The three IAMs used here assume that it is possible to compensate for the economic consequences of damages to natural systems through increased consumption of non-climate goods, a common assumption in many economic models. In the context of climate change, however, it is possible that the damages to natural systems could become so great that no increase in consumption of non-climate goods would provide complete compensation (Levy et al., 2005). For instance, as water supplies become scarcer or ecosystems become more fragile and less bio-diverse, the services they provide may become increasingly more costly to replace. Uncalibrated attempts to incorporate the imperfect substitutability of such amenities into IAMs (Sterner and Persson, 2008) indicate that the optimal degree of emissions abatement can be considerably greater than is commonly recognized.

VI. Conclusion

The interagency group selected four SCC estimates for use in regulatory analyses. For 2010, these estimates are $5, $21, $35, and $65 (in 2007 dollars). The first three estimates are based on the average SCC across models and socio-economic and emissions scenarios at the 5, 3, and 2.5 percent discount rates, respectively. The fourth value is included to represent the higher-than-expected impacts from temperature change further out in the tails of the SCC distribution. For this purpose, we use the SCC value for the 95th percentile at a 3 percent discount rate. The central value is the average SCC across models at the 3 percent discount rate. For purposes of capturing the uncertainties involved in regulatory impact analysis, we emphasize the importance and value of considering the full range. These SCC estimates also grow over time. For instance, the central value increases to $24 per ton of CO_2 in 2015 and $26 per ton of CO_2 in 2020.

We noted a number of limitations to this analysis, including the incomplete way in which the integrated assessment models capture catastrophic and non-catastrophic impacts, their incomplete treatment of adaptation and technological change, uncertainty in the extrapolation of damages to high temperatures, and assumptions regarding risk aversion. The limited amount of research linking climate impacts to economic damages makes this modeling exercise even more difficult. It is the hope of the interagency group that over time researchers and modelers will work to fill these gaps and that the SCC estimates used for regulatory analysis by the Federal government will continue to evolve with improvements in modeling.

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Appendix

Table A1: Annual SCC Values: 2010–2050 (in 2007 dollars)

Discount Rate Year	5% Avg	3% Avg	2.5% Avg	3% 95th
2010	4.7	21.4	35.1	64.9
2011	4.9	21.9	35.7	66.5
2012	5.1	22.4	36.4	68.1
2013	5.3	22.8	37.0	69.6
2014	5.5	23.3	37.7	71.2
2015	5.7	23.8	38.4	72.8
2016	5.9	24.3	39.0	74.4
2017	6.1	24.8	39.7	76.0
2018	6.3	25.3	40.4	77.5
2019	6.5	25.8	41.0	79.1
2020	6.8	26.3	41.7	80.7
2021	7.1	27.0	42.5	82.6
2022	7.4	27.6	43.4	84.6
2023	7.7	28.3	44.2	86.5
2024	7.9	28.9	45.0	88.4
2025	8.2	29.6	45.9	90.4
2026	8.5	30.2	46.7	92.3
2027	8.8	30.9	47.5	94.2
2028	9.1	31.5	48.4	96.2
2029	9.4	32.1	49.2	98.1
2030	9.7	32.8	50.0	100.0
2031	10.0	33.4	50.9	102.0
2032	10.3	34.1	51.7	103.9
2033	10.6	34.7	52.5	105.8
2034	10.9	35.4	53.4	107.8
2035	11.2	36.0	54.2	109.7
2036	11.5	36.7	55.0	111.6
2037	11.8	37.3	55.9	113.6
2038	12.1	37.9	56.7	115.5
2039	12.4	38.6	57.5	117.4
2040	12.7	39.2	58.4	119.3
2041	13.0	39.8	59.0	121.0
2042	13.3	40.4	59.7	122.7
2043	13.6	40.9	60.4	124.4
2044	13.9	41.5	61.0	126.1
2045	14.2	42.1	61.7	127.8
2046	14.5	42.6	62.4	129.4
2047	14.8	43.2	63.0	131.1
2048	15.1	43.8	63.7	132.8
2049	15.4	44.4	64.4	134.5
2050	15.7	44.9	65.0	136.2

This Appendix also provides additional technical information about the non-CO_2 emission projections used in the modeling and the method for extrapolating emissions forecasts through 2300, and shows the full distribution of 2010 SCC estimates by model and scenario combination.

1. Other (non-CO_2) gases

In addition to fossil and industrial CO_2 emissions, each EMF scenario provides projections of methane (CH_4), nitrous oxide (N_2O), fluorinated gases, and net land use CO_2 emissions to 2100. These assumptions are used in all three IAMs while retaining each model's default radiative forcings (RF) due to other factors (e.g., aerosols and other gases). Specifically, to obtain the RF associated with the non-CO_2 EMF emissions only, we calculated the RF associated with the EMF atmospheric CO_2 concentrations and subtracted them from the EMF total RF.[30] This approach respects the EMF scenarios as much as possible and at the same time takes account of those components not included in the EMF projections. Since each model treats non-CO_2 gases differently (e.g., DICE lumps all other gases into one composite exogenous input), this approach was applied slightly differently in each of the models.

<u>FUND</u>: Rather than relying on RF for these gases, the actual emissions from each scenario were used in FUND. The model default trajectories for CH_4, N_20, SF_6, and the CO_2 emissions from land were replaced with the EMF values.

<u>PAGE</u>: PAGE models CO_2, CH_4, sulfur hexafluoride (SF_6), and aerosols and contains an "excess forcing" vector that includes the RF for everything else. To include the EMF values, we removed the default CH_4 and SF_6 factors[31], decomposed the excess forcing vector, and constructed a new excess forcing vector that includes the EMF RF for CH_4, N_20, and fluorinated gases, as well as the model default values for aerosols and other factors. Net land use CO_2 emissions were added to the fossil and industrial CO_2 emissions pathway.

<u>DICE</u>: DICE presents the greatest challenge because all forcing due to factors other than industrial CO_2 emissions is embedded in an exogenous non-CO_2 RF vector. To decompose this exogenous forcing path into EMF non-CO_2 gases and other gases, we relied on the references in DICE2007 to the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report (AR4) and the discussion of aerosol forecasts in the IPCC's Third Assessment Report (TAR) and in AR4, as explained below. In DICE2007, Nordhaus assumes that exogenous forcing from all non-CO_2 sources is -0.06 W/m^2 in 2005, as reported in AR4, and increases linearly to 0.3 W/m^2 in 2105, based on GISS projections, and then stays constant after that time.

[30] Note EMF did not provide CO_2 concentrations for the IMAGE reference scenario. Thus, for this scenario, we fed the fossil, industrial and land CO_2 emissions into MAGICC (considered a "neutral arbiter" model, which is tuned to emulate the major global climate models) and the resulting CO_2 concentrations were used. Note also that MERGE assumes a neutral biosphere so net land CO_2 emissions are set to zero for all years for the MERGE Optimistic reference scenario, and for the MERGE component of the average 550 scenario (i.e., we add up the land use emissions from the other three models and divide by 4).

[31] Both the model default CH_4 emissions and the initial atmospheric CH_4 is set to zero to avoid double counting the effect of past CH_4 emissions.

According to AR4, the RF in 2005 from CH_4, N_20, and halocarbons (approximately similar to the F-gases in the EMF-22 scenarios) was 0.48 + 0.16 + 0.34 = 0.98 W/m^2 and RF from total aerosols was -1.2 W/m^2. Thus, the -.06 W/m^2 non-CO_2 forcing in DICE can be decomposed into: 0.98 W/m^2 due to the EMF non-CO_2 gases, -1.2 W/m^2 due to aerosols, and the remainder, 0.16 W/m^2, due to other residual forcing.

For subsequent years, we calculated the DICE default RF from aerosols and other non-CO_2 gases based on the following two assumptions:

(1) RF from aerosols declines linearly from 2005 to 2100 at the rate projected by the TAR and then stays constant thereafter, and
(2) With respect to RF from non-CO_2 gases not included in the EMF-22 scenarios, the share of non-aerosol RF matches the share implicit in the AR4 summary statistics cited above and remains constant over time.

Assumption (1) means that the RF from aerosols in 2100 equals 66 percent of that in 2000, which is the fraction of the TAR projection of total RF from aerosols (including sulfates, black carbon, and organic carbon) in 2100 vs. 2000 under the A1B SRES emissions scenario. Since the SRES marker scenarios were not updated for the AR4, the TAR provides the most recent IPCC projection of aerosol forcing. We rely on the A1B projection from the TAR because it provides one of the lower aerosol forecasts among the SRES marker scenarios and is more consistent with the AR4 discussion of the post-SRES literature on aerosols:

> *Aerosols have a net cooling effect and the representation of aerosol and aerosol precursor emissions, including sulphur dioxide, black carbon and organic carbon, has improved in the post-SRES scenarios. Generally, these emissions are projected to be lower than reported in SRES. {WGIII 3.2, TS.3, SPM}.*[32]

Assuming a simple linear decline in aerosols from 2000 to 2100 also is more consistent with the recent literature on these emissions. For example, Figure A1 shows that the sulfur dioxide emissions peak over the short-term of some SRES scenarios above the upper bound estimates of the more recent scenarios.[33] Recent scenarios project sulfur emissions to peak earlier and at lower levels compared to the SRES in part because of new information about present and planned sulfur legislation in some developing countries, such as India and China.[34] The lower bound projections of the recent literature have also shifted downward slightly compared to the SRES scenario (IPCC 2007).

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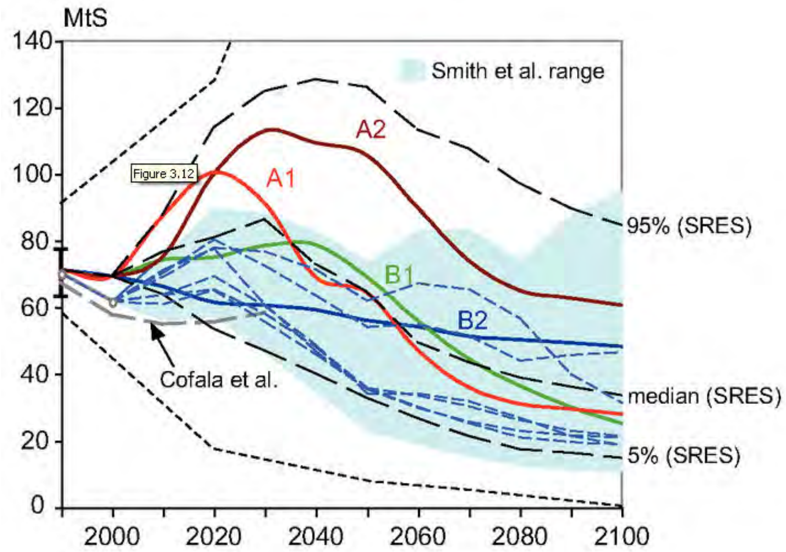
[32] AR4 Synthesis Report, p. 44, http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf

[33] See Smith, S.J., R. Andres, E. Conception, and J. Lurz, 2004: Historical sulfur dioxide emissions, 1850-2000: methods and results. Joint Global Research Institute, College Park, 14 pp.

[34] See Carmichael, G., D. Streets, G. Calori, M. Amann, M. Jacobson, J. Hansen, and H. Ueda, 2002: Changing trends in sulphur emissions in Asia: implications for acid deposition, air pollution, and climate. Environmental Science and Technology, 36(22):4707- 4713; Streets, D., K. Jiang, X. Hu, J. Sinton, X.-Q. Zhang, D. Xu, M. Jacobson, and J. Hansen, 2001: Recent reductions in China's greenhouse gas emissions. Science, 294(5548): 1835-1837.

With these assumptions, the DICE aerosol forcing changes from -1.2 in 2005 to -0.792 in 2105 W/m^2; forcing due to other non-CO_2 gases not included in the EMF scenarios declines from 0.160 to 0.153 W/m^2.

Figure A1: Sulphur Dioxide Emission Scenarios -



Notes: Thick colored lines depict the four SRES marker scenarios and black dashed lines show the median, 5th and 95th percentile of the frequency distribution for the full ensemble of 40 SRES scenarios. The blue area (and the thin dashed lines in blue) illustrates individual scenarios and the range of Smith et al. (2004). Dotted lines indicate the minimum and maximum of SO_2 emissions scenarios developed pre-SRES.
Source: IPCC (2007), AR4 WGIII 3.2, http://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch3-ens3-2-2-4.html.

Although other approaches to decomposing the DICE exogenous forcing vector are possible, initial sensitivity analysis suggests that the differences among reasonable alternative approaches are likely to be minor. For example, adjusting the TAR aerosol projection above to assume that aerosols will be maintained at 2000 levels through 2100 reduces average SCC values (for 2010) by approximately 3 percent (or less than \$2); assuming all aerosols are phased out by 2100 increases average 2010 SCC values by 6-7 percent (or \$0.50-\$3)–depending on the discount rate. These differences increase slightly for SCC values in later years but are still well within 10 percent of each other as far out as 2050.

Finally, as in PAGE, the EMF net land use CO_2 emissions are added to the fossil and industrial CO_2 emissions pathway.

2. - Extrapolating Emissions Projections to 2300

To run each model through 2300 requires assumptions about GDP, population, greenhouse gas emissions, and radiative forcing trajectories after 2100, the last year for which these projections are available from the EMF-22 models. These inputs were extrapolated from 2100 to 2300 as follows:

1. Population growth rate declines linearly, reaching zero in the year 2200.
2. GDP/ per capita growth rate declines linearly, reaching zero in the year 2300.
3. The decline in the fossil and industrial carbon intensity (CO_2/GDP) growth rate over 2090-2100 is maintained from 2100 through 2300.
4. Net land use CO_2 emissions decline linearly, reaching zero in the year 2200.
5. Non-CO_2 radiative forcing remains constant after 2100.

Long run stabilization of GDP per capita was viewed as a more realistic simplifying assumption than a linear or exponential extrapolation of the pre-2100 economic growth rate of each EMF scenario. This is based on the idea that increasing scarcity of natural resources and the degradation of environmental sinks available for assimilating pollution from economic production activities may eventually overtake the rate of technological progress. Thus, the overall rate of economic growth may slow over the very long run. The interagency group also considered allowing an exponential decline in the growth rate of GDP per capita. However, since this would require an additional assumption about how close to zero the growth rate would get by 2300, the group opted for the simpler and more transparent linear extrapolation to zero by 2300.

The population growth rate is also assumed to decline linearly, reaching zero by 2200. This assumption is reasonably consistent with the United Nations long run population forecast, which estimates global population to be fairly stable after 2150 in the medium scenario (UN 2004).[35] The resulting range of EMF population trajectories (Figure A2) also encompass the UN medium scenario forecasts through 2300 – global population of 8.5 billion by 2200, and 9 billion by 2300.

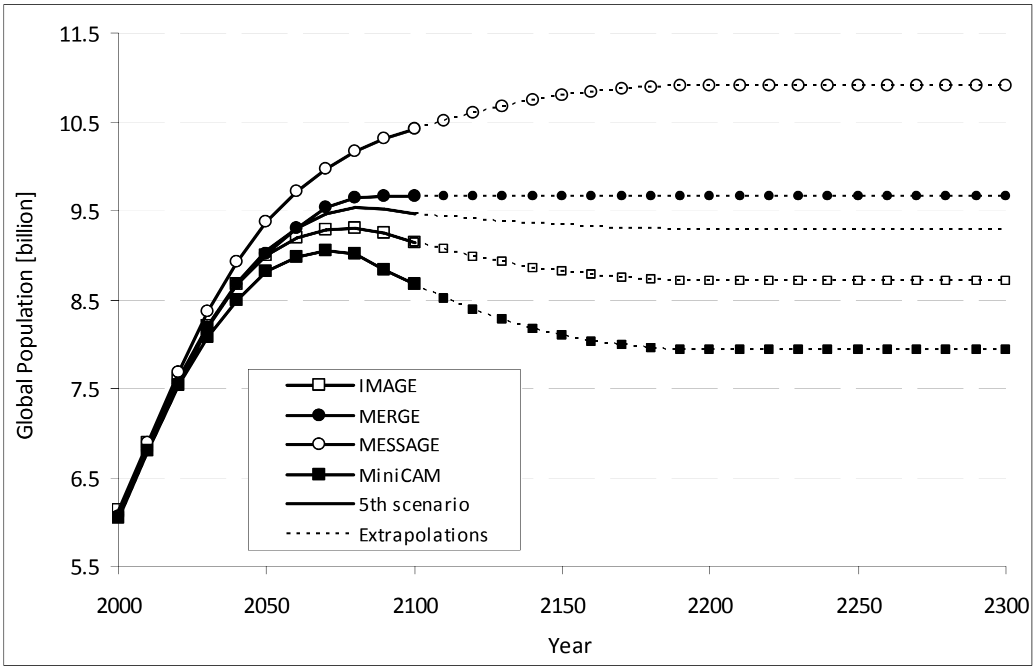
Maintaining the decline in the 2090-2100 carbon intensity growth rate (i.e., CO_2 per dollar of GDP) through 2300 assumes that technological improvements and innovations in the areas of energy efficiency and other carbon reducing technologies (possibly including currently unavailable methods) will continue to proceed at roughly the same pace that is projected to occur towards the end of the forecast period for each EMF scenario. This assumption implies that total cumulative emissions in 2300 will be between 5,000 and 12,000 GtC, which is within the range of the total potential global carbon stock estimated in the literature.

Net land use CO_2 emissions are expected to stabilize in the long run, so in the absence of any post 2100 projections, the group assumed a linear decline to zero by 2200. Given no a priori reasons for assuming a long run increase or decline in non-CO_2 radiative forcing, it is assumed to remain at the 2100 levels for each EMF scenario through 2300.

Figures A2-A7 show the paths of global population, GDP, fossil and industrial CO_2 emissions, net land CO_2 emissions, non-CO_2 radiative forcing, and CO_2 intensity (fossil and industrial CO_2 emissions/GDP) resulting from these assumptions.

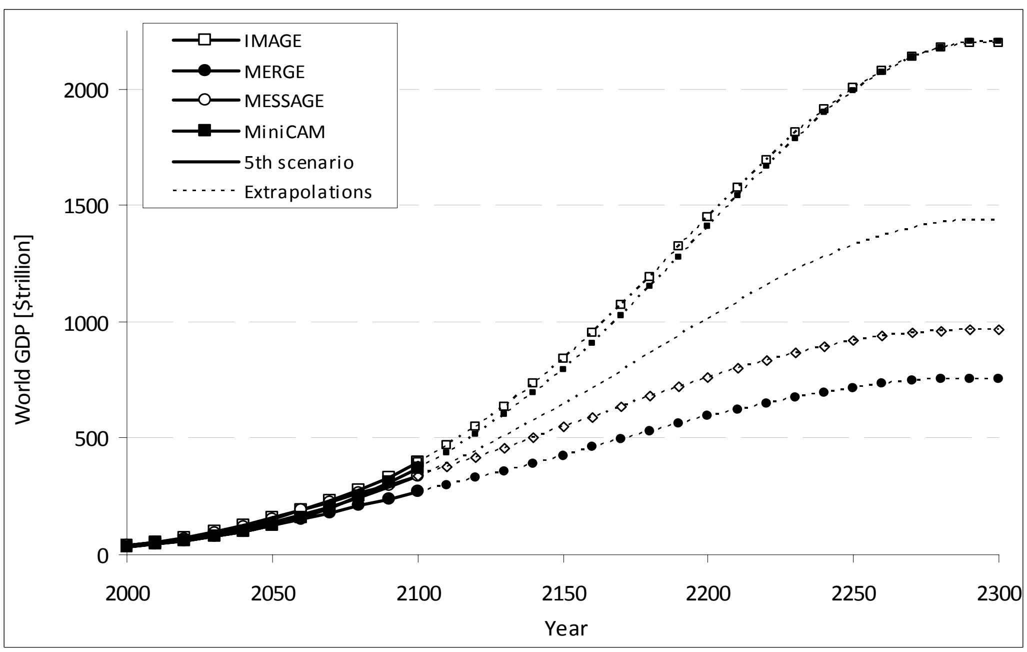
[35] United Nations. 2004. *World Population to 2300*.
http://www.un.org/esa/population/publications/longrange2/worldpop2300final.pdf

Figure A2. Global Population, 2000-2300 (Post-2100 extrapolations assume the population growth - rate changes linearly to reach a zero growth rate by 2200.) -



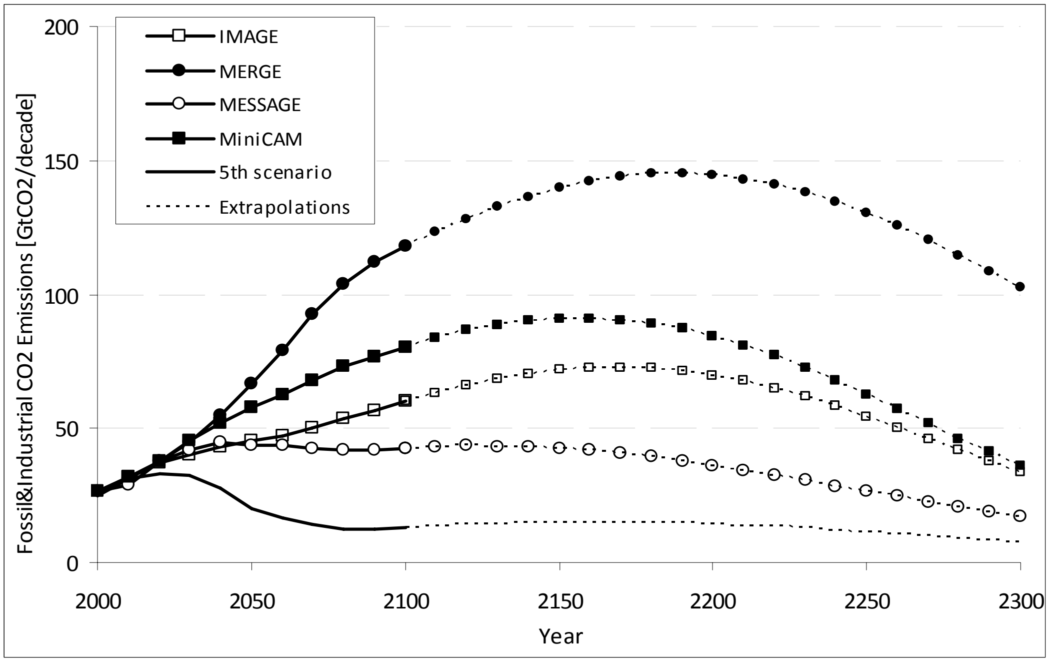
Note: In the fifth scenario, 2000-2100 population is equal to the average of the population under the 550 ppm CO_2e, full-participation, not-to-exceed scenarios considered by each of the four models.

Figure A3. World GDP, 2000-2300 (Post-2100 extrapolations assume GDP per capita growth declines linearly, reaching zero in the year 2300)



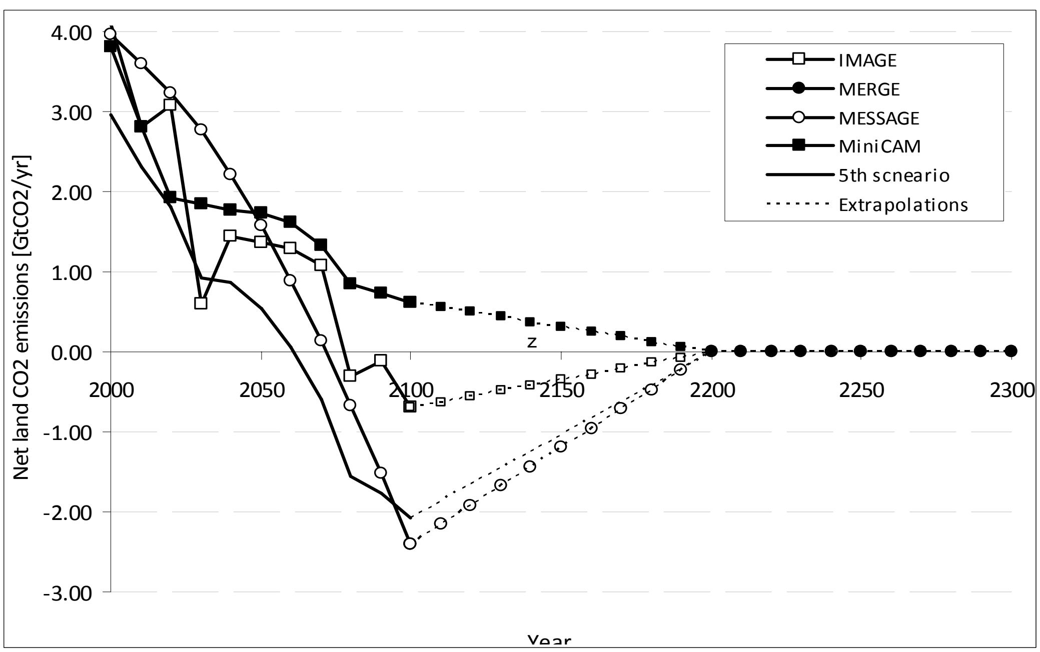
Note: In the fifth scenario, 2000-2100 GDP is equal to the average of the GDP under the 550 ppm CO_2e, full-participation, not-to-exceed scenarios considered by each of the four models.

Figure A4. Global Fossil and Industrial CO_2 Emissions, 2000-2300 (Post-2100 extrapolations assume growth rate of CO_2 intensity (CO_2/GDP) over 2090-2100 is maintained through 2300.)



Note: In the fifth scenario, 2000-2100 emissions are equal to the average of the emissions under the 550 ppm CO2e, full-participation, not-to-exceed scenarios considered by each of the four models.

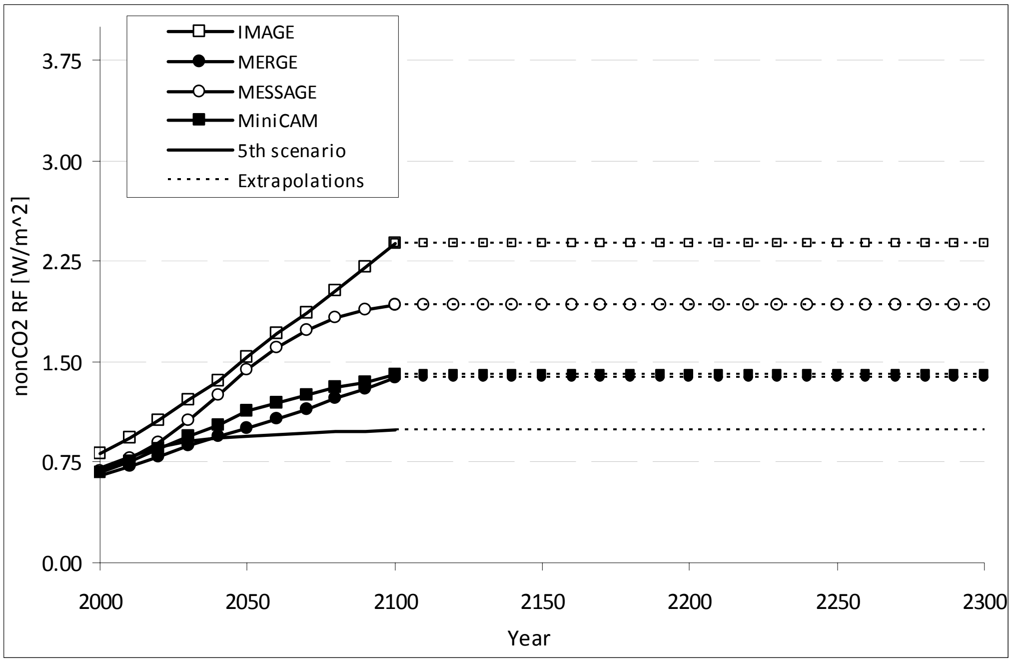
Figure A5. Global Net Land Use CO_2 Emissions, 2000-2300 (Post-2100 extrapolations assume emissions decline linearly, reaching zero in the year 2200)[36]



Note: In the fifth scenario, 2000-2100 emissions are equal to the average of the emissions under the 550 ppm CO2e, full-participation, not-to-exceed scenarios considered by each of the four models.

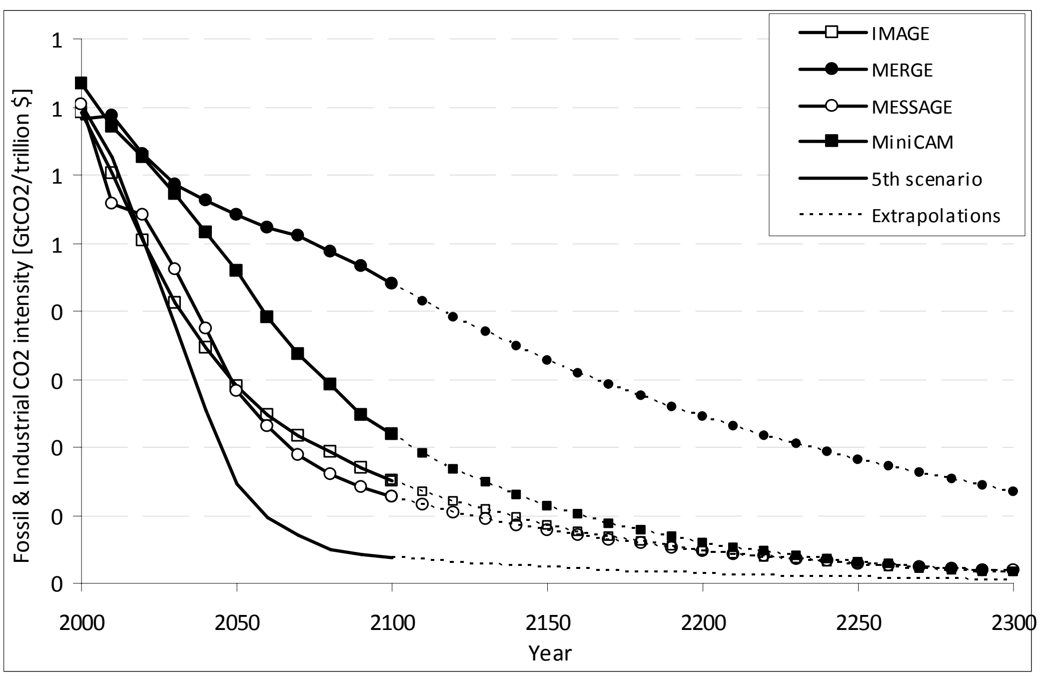
[36] MERGE assumes a neutral biosphere so net land CO_2 emissions are set to zero for all years for the MERGE Optimistic reference scenario, and for the MERGE component of the average 550 scenario (i.e., we add up the land use emissions from the other three models and divide by 4).

Figure A6. Global Non-CO_2 Radiative Forcing, 2000-2300 (Post-2100 extrapolations assume constant non-CO_2 radiative forcing after 2100.)



Note: In the fifth scenario, 2000-2100 emissions are equal to the average of the emissions under the 550 ppm CO2e, full-participation, not-to-exceed scenarios considered by each of the four models.

Figure A7. Global CO_2 Intensity (fossil & industrial CO_2 emissions/GDP), 2000-2300 (Post-2100 extrapolations assume decline in CO_2/GDP growth rate over 2090-2100 is maintained through 2300.)



Note: In the fifth scenario, 2000-2100 emissions are equal to the average of the emissions under the 550 ppm CO_2e, full-participation, not-to-exceed scenarios considered by each of the four models.

Table A2. 2010 Global SCC Estimates at 2.5 Percent Discount Rate (2007$/ton CO_2)

Percentile	1st	5th	10th	25th	50th	Avg	75th	90th	95th	99th
Scenario					**PAGE**					
IMAGE	3.3	5.9	8.1	13.9	28.8	65.5	68.2	147.9	239.6	563.8
MERGE optimistic	1.9	3.2	4.3	7.2	14.6	34.6	36.2	79.8	124.8	288.3
Message	2.4	4.3	5.8	9.8	20.3	49.2	50.7	114.9	181.7	428.4
MiniCAM base	2.7	4.6	6.4	11.2	22.8	54.7	55.7	120.5	195.3	482.3
5th scenario	2.0	3.5	4.7	8.1	16.3	42.9	41.5	103.9	176.3	371.9
Scenario					**DICE**					
IMAGE	16.4	21.4	25	33.3	46.8	54.2	69.7	96.3	111.1	130.0
MERGE optimistic	9.7	12.6	14.9	19.7	27.9	31.6	40.7	54.5	63.5	73.3
Message	13.5	17.2	20.1	27	38.5	43.5	55.1	75.8	87.9	103.0
MiniCAM base	13.1	16.7	19.8	26.7	38.6	44.4	56.8	79.5	92.8	109.3
5th scenario	10.8	14	16.7	22.2	32	37.4	47.7	67.8	80.2	96.8
Scenario					**FUND**					
IMAGE	-33.1	-18.9	-13.3	-5.5	4.1	19.3	18.7	43.5	67.1	150.7
MERGE optimistic	-33.1	-14.8	-10	-3	5.9	14.8	20.4	43.9	65.4	132.9
Message	-32.5	-19.8	-14.6	-7.2	1.5	8.8	13.8	33.7	52.3	119.2
MiniCAM base	-31.0	-15.9	-10.7	-3.4	6	22.2	21	46.4	70.4	152.9
5th scenario	-32.2	-21.6	-16.7	-9.7	-2.3	3	6.7	20.5	34.2	96.8

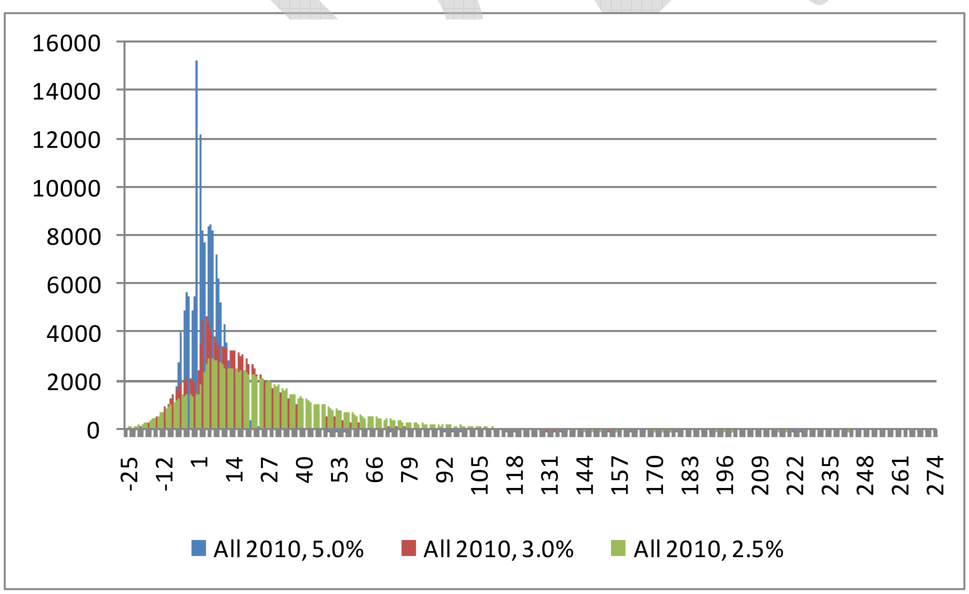
Table A3. 2010 Global SCC Estimates at 3 Percent Discount Rate (2007$/ton CO_2)

Percentile	1st	5th	10th	25th	50th	Avg	75th	90th	95th	99th
Scenario					**PAGE**					
IMAGE	2.0	3.5	4.8	8.1	16.5	39.5	41.6	90.3	142.4	327.4
MERGE optimistic	1.2	2.1	2.8	4.6	9.3	22.3	22.8	51.3	82.4	190.0
Message	1.6	2.7	3.6	6.2	12.5	30.3	31	71.4	115.6	263.0
MiniCAM base	1.7	2.8	3.8	6.5	13.2	31.8	32.4	72.6	115.4	287.0
5th scenario	1.3	2.3	3.1	5	9.6	25.4	23.6	62.1	104.7	222.5
Scenario					**DICE**					
IMAGE	11.0	14.5	17.2	22.8	31.6	35.8	45.4	61.9	70.8	82.1
MERGE optimistic	7.1	9.2	10.8	14.3	19.9	22	27.9	36.9	42.1	48.8
Message	9.7	12.5	14.7	19	26.6	29.8	37.8	51.1	58.6	67.4
MiniCAM base	8.8	11.5	13.6	18	25.2	28.8	36.9	50.4	57.9	67.8
5th scenario	7.9	10.1	11.8	15.6	21.6	24.9	31.8	43.7	50.8	60.6
Scenario					**FUND**					
IMAGE	-25.2	-15.3	-11.2	-5.6	0.9	8.2	10.4	25.4	39.7	90.3
MERGE optimistic	-24.0	-12.4	-8.7	-3.6	2.6	8	12.2	27	41.3	85.3
Message	-25.3	-16.2	-12.2	-6.8	-0.5	3.6	7.7	20.1	32.1	72.5
MiniCAM base	-23.1	-12.9	-9.3	-4	2.4	10.2	12.2	27.7	42.6	93.0
5th scenario	-24.1	-16.6	-13.2	-8.3	-3	-0.2	2.9	11.2	19.4	53.6

Table A4. 2010 Global SCC Estimates at 5 Percent Discount Rate (2007\$/ton CO_2)

Percentile	1st	5th	10th	25th	50th	Avg	75th	90th	95th	99th
Scenario						**PAGE**				
IMAGE	0.5	0.8	1.1	1.8	3.5	8.3	8.5	19.5	31.4	67.2
MERGE optimistic	0.3	0.5	0.7	1.2	2.3	5.2	5.4	12.3	19.5	42.4
Message	0.4	0.7	0.9	1.6	3	7.2	7.2	17	28.2	60.8
MiniCAM base	0.3	0.6	0.8	1.4	2.7	6.4	6.6	15.9	24.9	52.6
5th scenario	0.3	0.6	0.8	1.3	2.3	5.5	5	12.9	22	48.7
Scenario						**DICE**				
IMAGE	4.2	5.4	6.2	7.6	10	10.8	13.4	16.8	18.7	21.1
MERGE optimistic	2.9	3.7	4.2	5.3	7	7.5	9.3	11.7	12.9	14.4
Message	3.9	4.9	5.5	7	9.2	9.8	12.2	15.4	17.1	18.8
MiniCAM base	3.4	4.2	4.7	6	7.9	8.6	10.7	13.5	15.1	16.9
5th scenario	3.2	4	4.6	5.7	7.6	8.2	10.2	12.8	14.3	16.0
Scenario						**FUND**				
IMAGE	-11.7	-8.4	-6.9	-4.6	-2.2	-1.3	0.7	4.1	7.4	17.4
MERGE optimistic	-10.6	-7.1	-5.6	-3.6	-1.3	-0.3	1.6	5.4	9.1	19.0
Message	-12.2	-8.9	-7.3	-4.9	-2.5	-1.9	0.3	3.5	6.5	15.6
MiniCAM base	-10.4	-7.2	-5.8	-3.8	-1.5	-0.6	1.3	4.8	8.2	18.0
5th scenario	-10.9	-8.3	-7	-5	-2.9	-2.7	-0.8	1.4	3.2	9.2

Figure A8. Histogram of Global SCC Estimates in 2010 (2007\$/ton CO_2), by discount rate



* The distribution of SCC values ranges from -\$5,192 to \$66,116 but the X-axis has been truncated at approximately the 1st and 99th percentiles to better show the data.

Table A5. Additional Summary Statistics of 2010 Global SCC Estimates -

Discount rate:	5%				3%				2.5%			
Scenario	Mean	Variance	Skewness	Kurtosis	Mean	Variance	Skewness	Kurtosis	Mean	Variance	Skewness	Kurtosis
DICE	9.0	13.1	0.8	0.2	28.3	209.8	1.1	0.9	42.2	534.9	1.2	1.1
PAGE	6.5	136.0	6.3	72.4	29.8	3,383.7	8.6	151.0	49.3	9,546.0	8.7	143.8
FUND	-1.3	70.1	28.2	1,479.0	6.0	16,382.5	128.0	18,976.5	13.6	150,732.6	149.0	23,558.3

VALUING WATER SUPPLY RELIABILITY

RONALD C. GRIFFIN AND JAMES W. MJELDE

Instead of creating water supply systems that fully insulate mankind from climate-imposed water deficiencies, it is possible that for municipal water systems a nonzero probability of water supply shortfall is efficient. Perfect water supply reliability, meaning no chance of future shortfall, is not optimal when water development costs are high. Designing an efficient strategy requires an assessment of consumer preferences pertaining to the reliability of water supply. Contingent valuations of both current and future shortfalls are reported. The consistency of these measures is gauged using an expected utility model.

Key words: reliability, water demand, water policy.

An important dimension of the water scarcity problem is the management of water supply risk, especially as it relates to drought. The traditional management practice for controlling urban water supply risk has been one of avoidance, that is, to develop a sufficiently large water supply that the probability of any tangible shortfall is very small. In light of the high and growing costs of water development, it may be sensible to revise the water planning paradigm, so that periodic shortfalls are regarded as acceptable, even planned, events.

In the municipal water use sector, there is an innate tendency to size the water supply system for severe droughts of low probability (Howe and Smith). Water is usually supplied by an entity that faces no competition and has the legal ability to pass all reasonable costs to consumers. Moreover, water supply systems are operated by people whose performance is gauged by their ability to deliver a dependable, steady, and problem-free water supply. They are not judged by their ability to deliver water that has value in excess of its costs. Consequently, the reliability[1] of water systems may be too high, water supplies dedicated to municipal use may be too great, and infrastructure costs may be too large.

Given that available water is physically limited in many regions, when municipalities increase water system reliability, they are shifting risk to nonmunicipal sectors. Obviously, some water users must incur the shortfall during drought situations. Traditionally, risk has been progressively shifted to the riparian and estuary habitat systems. These natural resource systems have become the residual claimants, possessing only what is left after man has diverted water to satisfy his wants. Recently, public policy emphasis on streamflow protection has begun to reverse this tradition (MacDonnell and Rice). One result may be the redistribution of water supply risk back toward municipalities, thereby increasing the importance of risk-attentive water supply planning.

Three dimensions of reliability analysis are addressed here. First, policy options and consumer behavior relevant to water system reliability are discussed. Second, the theory of optimizing water system reliability is briefly restated and refined. This basic theory outlines a method for optimizing reliability and identifies informational needs. Finally and primarily, contingent valuation analyses of modified reliability are presented.

Reliability Policy and Consumer Behavior

To affect water system reliability, managers can (*a*) adjust the long-run supply of water, (*b*) enhance the short-run supply of water during a shortfall event, (*c*) influence the long-run demand for water by consumers, and (*d*) lessen water demand during a shortfall. Rather than being viewed as substitute approaches, the appropriate planning goal is to develop an efficient package of all options.

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[1] The reliability of a water supply system is commonly regarded as inversely related to the probability of a system shortfall (demand > supply).

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On the supply side, both physical and paper components of a water supply can be adjusted. While the physical components are generally well acknowledged, various paper components (such as water rights, storage permits, contracts with other water suppliers, and dry-year options) represent an increasingly important dimension of planning tools. Either physical or paper components can be modified to adjust long-run water supply reliability, but these supply-side tools are limited for short-run water supply adjustments. Only rapidly executable leases with water right holders or contracts with other water suppliers are practical short-run tools.

Demand management tools have substantial relevance as both long- and short-term measures. Long-run policy options include regulations (e.g., plumbing codes requiring the installation of water-conserving fixtures), education programs, and water pricing. Short-run demand tools involve contingency policies such as water use regulations (e.g., alternate day watering), prohibitions, and pricing. Because of the relative impracticality of most supply policies during shortfall events, demand-based options have enhanced relevance in the short run.

In response to both long-run and short-run policies, consumers make decisions that are broader than merely how much water to consume. Households choose additions to and replacements of their water-using durables. The major durables of consequence are plumbing fixtures, appliances, pools, sprinklers, and lawn/landscaping. These durables are available in different sizes, models, and properties that influence water use and the ability of consumers to continue using durables during water supply shortfalls. Water use associated with a given durable is largely a fixed multiple of its operating time, so important determinants of household water use become less flexible when the household commits to the purchase/installation of each water-using durable. Long-run demand management policies influence these commitments (Dubin, Wirl).

Lawns and landscape plants are unique with respect to their interrelationship with water supply reliability. Lawns and landscaping are durables established for visual and aesthetic satisfaction. This satisfaction flows to residents continually, rising or falling according to the condition of the lawn/landscape. Long water supply shortfalls can depreciate or extinguish lawns and landscaping, thereby lowering their future net benefits. This implies that there may be instances in which consumers attach high value to avoiding a severe, yet transitory shortfall, because they wish to avoid diminished present and future net benefits.

These simple observations disclose important interrelationships among water supply reliability, the value of reliability, water-using durables, and the value of these durables. When making commitments to specific durables, the consumer is implicitly mindful of water price and supply policy. Consumers likely form expectations of future price and reliability based on recent experience and, perhaps, trends. Once a set of durables is acquired by the household, prospective increases in reliability offer little short-run value because the durable base is fixed. On the other hand, decreased reliability constrains the satisfaction available from the accumulated durable base. Thus, consumers have asymmetric attitudes toward increases and decreases in reliability. The change in value for an increase in reliability can be expected to be less, in absolute value, than the change in value for an equivalently measured reliability fall. This asymmetry is likely to be more pronounced in the short run where, by definition, the durable base is fixed. For this reason, as well as the wealth effect, it should be expected that equivalent surplus exceeds compensating surplus for reliability improvements.

Optimizing Reliability

Although interest in water supply reliability is increasing (Lund), there are few empirical studies of the value households associate with the reliability of their water supply. Using a mailed survey in three Colorado cities, Howe et al. asked open-ended willingness-to-pay (WTP) and willingness-to-accept (WTA) questions about modifications to the frequency of a standard annual shortage event (SASE). They define a SASE to be a supply shortfall sufficient to cause the temporary use of a specific lawn watering restriction. An advantage of this approach is that the SASE offers a very tangible and known situation for the surveyed population.

Barakat & Chamberlin, Inc. report a WTP analysis of increased reliability performed for ten California water utilities. This contingent valuation study uses a combination mail–telephone survey to obtain double-bounded dichotomous choice data. Households are asked if they would pay a specified amount per month to eliminate future shortfalls of a specified strength and frequency. Because the elimination of shortfalls is not a realistic planning scenario, the Barakat & Chamberlin, Inc. findings should be interpreted as upper bounds for consumer valuations pertaining to modified shortfall scenarios.

Howe and Smith et al. present some basic theory outlining the optimal selection of water supply level. A noteworthy observation about their theory, which distinguishes it from leading theory regarding optimal energy supply reliability, is that it sets aside the potential role of price in managing excess demand during shortfall events (Crew and Kleindorfer 1976, 1978, Marino, Meyer). The energy research on optimal reliability addresses the collaborative role of pricing and investment for achieving an optimal policy. The absence of price control in the Howe and Smith et al. theory can be criticized, but water managers remain far more concerned about appropriate concrete and pipe solutions than they are about establishing proper prices. Moreover, for stochastic settings, resource allocation by price may be economically inferior to quantity-based policy such as rationing rules (Weitzman).

A theoretical model offered by Howe and Smith et al. focuses on the concept of SASE. This model posits that the probability of occurrence for the SASE in period t is a decreasing function of supply-side investment I:

$$(1)\quad \text{Prob}\{\text{SASE}_t\} = P_t(I).$$

The objective is to determine a level of investment that minimizes investment costs plus the expected losses caused by the occurrence of the SASE. Let $A(I)$ denote annualized investment costs and let $E[L(P_t)]$ be the expected loss due to excess demand in period t. The expected value of L is an increasing function of $P_t(I)$. The optimization problem is then

$$(2)\quad \min_I [A(I) + E[L(P_t(I))]].$$

This problem yields the first order condition

$$(3)\quad \frac{dA}{dI} = -\frac{dE[L]}{dI}$$

indicating that the marginal cost of investment should equal the negative of the marginal expected losses. Howe and Smith et al. do not optimize I, but they do compare changes in A and in $E[L]$ where the changes are accomplished by sales or purchases of surface water rights.

A deficiency of this theory is its emphasis of a single type of shortage, the SASE (Lund). Nothing is conveyed about the selection of water supply capacity for addressing more moderate or extreme shortage events. Because supply investments alter the frequencies of all degrees of shortage, not just the SASE, this omission is important. To obtain a more broadly applicable theory (also initiated by Howe and Smith et al.), suppose that aggregate water demand D is an increasing function of some short-term climate index which we will call aridity "a." Water supply S is a decreasing function of aridity and an increasing function of investment I. Water price is assumed to be fixed.

When demand exceeds supply for a given aridity level in period t, the loss suffered is $\ell_t(D_t - S_t)$. Otherwise, the loss is zero. The overall loss function can be stated as

$$(4)\quad L_t(I, a_t) = \begin{cases} 0 & \text{if } D_t(a_t) \le S_t(I, a_t) \\ \ell_t\big(D_t(a_t) - S_t(I, a_t)\big) & \\ \quad\quad \text{if } D_t(a_t) > S_t(I, a_t). \end{cases}$$

If f_t is the probability distribution function for the random variable a_t, then expected losses are

$$(5)\quad E[L_t(I, a_t)] = \int_{a_t^0}^{\infty} L_t(I, a_t) f_t(a_t)\, da_t$$

where a_t^0 is the level of aridity for which $D_t(a_t) = S_t(I, a_t)$.

Assuming the social problem is to minimize the sum of investment costs and the expected welfare loss due to water supply shortfall, the following criterion for investment choice is obtained:

$$(6)\quad \min_I \left[I + \sum_t \int_{a_t^0}^{\infty} L_t(I, a_t) f_t(a_t)\, da_t \right].$$

Discounting may be added explicitly to this model or it may be viewed as implicit in the definition of L_t. After differentiating the objective function with respect to I and simplifying, the first order condition becomes

$$(7)\quad 1 = \sum_t \int_{a_t^0}^{\infty} \ell_t'(\cdots) \frac{\partial S_t}{\partial I} f_t(a_t)\, da_t.$$

The left hand side of this condition is the marginal cost of investment. The right hand side is investment's marginal benefit.

This basic theory has four informational requirements that must be met prior to application. First, an aridity index must be constructed for which a probability distribution function can be determined and which can be used as an argument of demand and supply functions. Second and third, $D(a)$ and $S(I, a)$ are needed. Finally, the function giving the value of loss due to shortfall, $\ell_t(D_t - S_t)$, must be obtained. The latter requirement is the focus of the research reported here.

Survey Design and Procedures

Two lines of inquiry are pursued here using contingent valuation methods. First, the value of current water supply shortfalls—existing shortages of known strength and duration—is addressed. Second, an inquiry into the value of future shortfalls is presented. The latter are probabilistic shortages of differing frequency, strength, and duration.

A questionnaire was mailed to 4,856 households in seven Texas cities.[2] For two of the seven surveyed cities, there were a priori indications of experience with water supply shortfalls. There may be some bias in reliability valuation if assessments are sought solely from shortfall-inexperienced households. Experienced households may attach lower values to reliability for three general reasons. First, inexperience with water supply shortfalls may support an artificially high, physiological objection to an unfamiliar event. Once this unknown is removed, the consumer may have a "that wasn't so bad" reaction. Second, the learning of new water use behaviors is likely to be pronounced during shortfalls. As the consumer becomes more proficient with coping strategies, the value of shortfall-created inconveniences may decline. Third, as discussed previously, if households are accustomed to a highly dependable water supply, they are more likely to have assembled a water-intensive set of water-using durables.

Each questionnaire includes two contingent valuation questions. Paired with each of these questions is a question designed to ferret out protest responses. The first contingent valuation question is a closed-ended WTP question concerning a hypothetical current shortfall. This question establishes an "immediate and known" water supply shortfall of X% of the community's water demand expected to have a duration of Y summer days. The respondent is then asked if he/she would pay a one-time fee of $\$Z$ to be exempt from the outdoor water use restrictions the city would impose during this shortfall. Thirty-six different X-Y-Z combinations are used, and a logit model is fitted with the resulting data.

The second contingent valuation question is an open-ended WTP or WTA question concerning a hypothetical increase or decrease in future water supply reliability. This question poses an initial situation in which approximately once every U years a shortfall of V% would occur with a duration of W days. The question then poses a potential improvement or decline in one of the U or V parameters with the other being unchanged. Shortfall duration W varies among questionnaires, but it is constant in a given questionnaire. In the case of reliability improvements, the respondent is asked for a maximum WTP where this amount is expressed as a permanent increase in monthly water bills. In the case of reliability declines, the respondent is asked for a similarly expressed minimum WTA. Thirty-six distinct before and after regimes (U-V-W combinations) are used. Thus, there are thirty-six WTP questions and, by reversing the before and after components, thirty-six WTA questions. Each survey contains only one of these seventy-two variants. Respondents therefore answer either a WTP or WTA question concerning future shortfalls, but not both. Resulting data are used to estimate two tobit models, one for WTP and one for WTA.

Because there are thirty-six different constructions for the current shortfall question and seventy-two different constructions for the future shortfall questions, each of the current shortfall question variants are employed with two of the future shortfall question's scenarios. These assignments were made randomly.

The future shortfall question is more definitive in that it incorporates frequency information regarding prospective supply shortfalls, and it involves both WTP and WTA formats. However, it also presents a more perplexing proposition to respondents,

[2] Each mailing included a preaddressed and postage-paid return envelope. After two weeks, nonrespondents were mailed a reminder postcard. After three to four additional weeks, individualized surveys were again prepared for nonrespondents and were mailed with a new cover letter and a return envelope.

and there is justifiable concern that this question might overwhelm people. In the health risk valuation literature, it has been observed that probabilistic risk information is difficult to communicate to respondents and that many people may have difficulty processing this information (Loomis and duVair, Smith and Desvousges). The survey's current shortfall question poses a simpler, more comprehensible, and less challenging query for surveyed households. Inclusion of two general question styles offers the possibility of checking the consistency of survey results with expected utility theory.

A WTA version of the current shortfall question is not investigated because of the reduced information provided by close-ended questions (thereby necessitating larger datasets to achieve a given level of explanatory power). Moreover, the normative, status quo foundation of the reliability issue is closer to one where consumers do not possess entitlements to particular reliability positions.

Because water supply reliability is an unusual item for individuals to value, it is important to provide households with a solid informational context. Therefore, the individual questionnaire relayed summary information about the household's own water use patterns and bills. Because water supply shortfalls generally occur during summer months, the survey also includes information regarding the cyclical nature of the household's water use. To accomplish this, monthly 1995 information from city utilities was obtained for every household in the survey sample, and these data were used to calculate personalized information provided on each survey. The calculated information could have been electronically merged into the survey instrument prior to printing, but hand writing of this information into surveys was selected to emphasize the customized nature of the entries.[3] On the questionnaire the customized personal information is preceded and followed by additional contextual information regarding the importance and meaning of water supply reliability. The contextual information is replicated in the Appendix of this paper.

[3] The personalized information includes: total 1995 water use (gallons), peak water use month, water use in peak month (gallons), water and wastewater bill for peak month ($), low water use month, water use in low month (gallons), water and wastewater bill for low month ($), total bill for 1995 water use ($), total bill for 1995 wastewater service ($), and average monthly water and wastewater bill ($).

Overall, 30% of the survey recipients had responded prior to remailing of the survey. The overall survey response is 43%. Across the seven cities, the response rate varies from a low of 32% to a high of 45.8%. These percentages include all surveys returned with at least one question answered. Respondent and nonrespondent water use characteristics are similar, and none of the differences in the water use characteristics are statistically significant.

WTP to Avoid a Current Shortfall

A representative sample of the thirty-six editions of the current shortfall WTP question is as follows:

> Suppose that a community in which you live is facing an immediate and known shortfall of 10% that is expected to last for the next 14 *summer* days. This means that water supply is 10% less than demand. To correct this shortfall, the community is planning to restrict outdoor water use until the problem has passed. The Survey Residence can get a one-time exception from these water-use restrictions if you pay a one-time fee of $10.00.

Would you pay this one-time fee for this one-time exemption at the Survey Residence?

☐ Yes ☐ No ☐ Don't Know

Over all thirty-six scenarios, 437 respondents indicated they would be willing to pay the fee, whereas 1,595 indicated they would not be willing to pay the additional fee or did not know. Of these 1,595 respondents, 171 constituted nonprotest bids. Nonprotest bids are defined to be those meeting one of the following criteria: (*a*) any respondent answering yes to this question, or (*b*) any respondent answering no or don't know to the question *and* indicating the fee was too high to justify the payment in the subsequent protest filtering question. More than one-fourth of the 1,595 selected "Don't Know." The large number of protest bids appears to be partly a consequence of the good being valued. Some respondents indicated in hand-written notes something to the effect that "water is a god-given right and should not be valued economically." Such public perspectives often confound water policy research because "access to water is regarded as a moral right, and discriminating among claimants to water on the basis of wealth or position is in many places regarded as immoral" (Martin et al., p. 28).

Current Shortfall Model

Because of the structure of the current shortfall question, the following logistic model is estimated using maximum likelihood techniques:

$$(8)\quad F[\beta'\mathbf{x}] = \frac{e^{\beta'\mathbf{x}}}{1 + e^{\beta'\mathbf{x}}}$$

where $F[\beta'\mathbf{x}]$ is the cumulative density function associated with the logistic function, $\mathbf{x}$ is a matrix of explanatory variables, and β is a vector of associated coefficients to be estimated (Judge et al., p. 591). Explanatory variables are:

- rain — mean annual rainfall by city (National Climatic Data Center),
- summer — mean July plus August rainfall divided by the mean annual rainfall for each city,
- price — respondent's total annual water bill divided by total water use,
- fee — fee the respondent must pay to avoid the water use restrictions,
- shortfall — percent shortfall the respondent's community is facing,
- duration — number of days the shortfall will last,
- income — income level of the respondent (five categorical levels correspond to the categories on the survey; the first level is dropped to avoid a singular matrix),
- activities — respondent's preferences toward water use activities[4] (this variable is the sum of a linear index of the importance attached by the respondent to lawn and landscaping, fruit and vegetable gardening, and car washing),
- people — total number of people living at the residence,
- rent — 0/1 dummy variable with a 1 indicating the respondent rents the survey residence from another person or business,
- live — 0/1 dummy variable with a 1 indicating the respondent lives at the survey residence, and
- experience — 0/1 dummy variable with a 1 indicating the respondent has experienced water use restrictions in the past five years.

Surveys from all cities are combined into a single dataset for estimation purposes. City-by-city examinations of the data are available in an expanded report (Griffin and Mjelde). Estimation of the logit model with dummy variables for each city indicated no statistical differences in the probabilities of paying the fee between respondents in different cities. Further, simple correlation coefficients and auxiliary regression equations indicate multicollinearity is not a problem in the dataset.

Estimated coefficients for the logit model are presented in table 1. A chi-squared value of 161 is obtained for the statistical test that

Table 1. Current Shortfall Value Logit Model Coefficients, 508 Observations

Variable	Estimated Coefficient	Standard Error	p-value
Intercept	−2.12	2.36	0.37
Summer	5.99	7.34	0.41
Rain	0.0325	0.0382	0.39
Price	−0.132	0.0594	0.03
Fee	−0.104	0.0135	< 0.01
Shortfall	0.0221	0.0168	0.19
Duration	0.0358	0.0237	0.13
Inc2	0.997	0.325	< 0.01
Inc3	1.81	0.347	< 0.01
Inc4	1.80	0.443	< 0.01
Inc5	2.80	0.567	< 0.01
Activities	0.0126	0.0494	0.80
People	−0.0626	0.0679	0.36
Rent	0.201	0.408	0.62
Live	1.07	0.729	0.14
Experience	0.255	0.323	0.43

[4] Instead of asking respondents for an inventory of their water-using durables, they were asked to select one of five levels of "importance" for each of three water activity categories. This preference-based approach avoids the impracticality of obtaining water consumption features of individual durables (e.g., area, condition, species of grass lawns), but it does not enable a testing of the role of durables in determining reliability values.

all coefficients are equal to zero. For this level, the null hypothesis is rejected at a p-value < 0.01, indicating the variables help to explain the probability of choosing to pay the fee to avoid water use restrictions. As the fee increases, respondents are less likely to pay to avoid the restrictions. Respondents are more likely to pay to avoid the restrictions as the duration and/or strength increases. All three coefficients associated with these variables are significant at p-values of 0.20 or less with fee being significant at the 0.01 level. As the respondent's average water price increases, the respondent is less likely to pay to avoid the restrictions. The coefficient associated with water price is significant at the 0.03 level.

Of the variables associated with the respondent's individual characteristics, income is highly significant with respondents in higher income categories generally more likely to pay the fee than respondents with lower incomes. The one exception to this observation is that the fourth income category's estimated coefficient is slightly less than the third income category's coefficient. Respondents who live at the survey residences are more likely to pay the fee than respondent landlords who do not live at the residence. The remaining variables are insignificant at the 0.20 level of significance.

Current Shortfall Valuation

The typical approach to obtaining valuations from such models is to determine the fee amount corresponding to a Prob[Yes] = 0.5, that is, the fee level that the average respondent would find agreeable (Hanemann). Here, this fee level is the value the average household is willing to pay to avoid a current shortfall. Using mean levels of exogenous variables, a low income household would be willing to pay a one-time fee of $17.19 to avoid a current shortfall, and a high income household would be willing to pay $44.04. If shortfall parameters are varied across the questionnaire scenarios and income is varied across the five groupings, the predicted WTPs range from $12.99 to $48.88.

WTPs to avoid current shortfalls of various strengths and durations are presented in table 2. All other variables, including income class binary variables, are set at their means in the calculation of these values. As indicated earlier, WTP to avoid current water supply shortfalls increases with the anticipated strength and duration of the shortfall. For the average respondent, $29.86 is the avoidance value for a three-week current shortfall of 20%. Changes in shortfall parameters affect this value as follows. A one-week increase (decrease) in shortfall duration increases (decreases) this value by $2.41. Every 10% increase (decrease) in shortfall strength increases (decreases) this value by $2.12.

Table 2. Current Shortfall Values (WTP)

		Shortfall Duration		
		14 days	21 days	28 days
	10%	$25.34	$27.75	$30.15
Shortfall	20%	$27.46	$29.86	$32.27
strength	30%	$29.58	$31.98	$34.39

WTP/WTA to Modify Future Reliability

An example of the thirty-six future shortfall WTP questions is as follows:

Current: For your community, suppose that water demand will exceed supply once every 10 years. This shortfall will have an average length of 14 days. Typically, water restrictions will be used in the years of shortfall to decrease demand 20% as needed to manage this shortfall.

Future: Suppose that your community is considering an expansion of its water supply system to improve reliability. Subsequently, water demand will exceed supply once every 15 years. This shortfall will have an average length of 14 days. Typically, water restrictions will be used in times of shortfall to decrease demand 20% as needed to manage this shortfall.

To Summarize:	*Current*	*Future*	
Shortfall Frequency is once every	*10*	*15*	years.
Shortfall Length will average	*14*	*14*	days.
Shortfall Amount is	*20*	*20*	% of the city's demand.

Please consider the next questions carefully.

What is the largest increase in your average water bill of $ ___ per month that you would be willing to pay each and every month to obtain this reliability improvement at the Survey Residence?

$___ per month

The first blank was precompleted with the respondent's average monthly water bill, so the respondent only needed to state WTP. Bids of $0 for this question may be protests. A nonprotest $0 bid is defined here as one in which the respondent either (*a*) checked "the reliability improvement wouldn't help me much" in the accompanying protest filter question or (*b*) did not provide any responses to the protest filter.

Households receiving a future shortfall WTA survey encountered a boxed summary nearly identical to that above followed by this question:

> **What reduction in your average water bill of $___ per month is the minimum you would be willing to accept each and every month in exchange for this reliability reduction at the Survey Residence?**
>
> **$___ per month**

Nonprotest bids are defined to be those who selected the following response to the paired protest filtering question: "My answer is about right for the added inconvenience."

Future Shortfall Estimation Procedures

Both the WTP and WTA open-ended questions result in a censored sample; that is "... some observations on the dependent variable corresponding to known sets of independent variables are not observed" (Judge et al., p. 609). In the WTP and WTA samples, the observable range of WTP and WTA range from zero to the highest bid. In such cases, ordinary least squares estimators are biased and inconsistent (Judge et al., p. 615). Consequently, tobit analysis is used here.

The underlying tobit model for this study is

$$(9)\quad y_i^* = \beta'\mathbf{x}_i + \varepsilon_i$$

where $\mathbf{x}_i$ are the independent variables for observation i, y_i is the dependent variable, β's are coefficients to be estimated, and ε_i is an error term. Also, $\varepsilon_i \sim N[0, \sigma^2]$; if $y_i^* \leq 0$, then $y_i = 0$; and if $y_i^* > 0$, then, $y_i = \beta'\mathbf{x}_i + \varepsilon_i$. This model is estimated using maximum likelihood techniques (Greene). Conditional means (prediction) from the tobit model are

$$(10)\quad E[y|\mathbf{x}_i] = \Phi(\hat\beta'\mathbf{x}_i/\hat\sigma)\hat\beta'\mathbf{x}_i + \hat\sigma\phi(\hat\beta'\mathbf{x}_i/\hat\sigma)$$

where Φ represents the cumulative standard normal distribution function, ϕ represents the standard normal density function, $\hat\sigma$ is the estimated standard error for the error term, and $\hat\beta$ is the vector of estimated coefficients.

Independent variables used in the estimation procedure for both the WTP and WTA models are the same. These variables are defined equivalently to those used in the current shortfall logit model previously presented with the exception of new variables defining water reliability. The two new variables are:

- severity — the initial severity of the water shortfall, defined as probability of shortfall occurring in any given year times shortfall strength, and
- shortype — a binary variable which equals zero if the proposed change affects the probability of a shortfall occurring and equals one if the proposed change affects shortfall strength.

By design, the number of usable responses for the WTP and WTA questions will be less than the value of current shortfall question. Four hundred and sixty-six usable observations are available for estimation of the WTP model, whereas 240 observations are usable from the WTA surveys. The difference between WTP and WTA usable responses may pertain to two factors. First, water is better understood as a good for which one pays rather than as a good for which one might receive a payment. The unfamiliar WTA perspective may have caused some confusion. Second, the wording of the WTA question is more confusing than the WTP question. A large number of respondents checked "I don't understand the question" in the protest filter.

Of the 466 usable responses in the WTP data set, 21.4% (100/466) of the respondents indicated a monthly WTP equal to zero. Using dollar intervals of 0.01–1, 1–5, 5–10, 10–15, and 15 +, the percent of responses in each interval are 1.7%, 22.1%, 21.7%, 17.8%, and 15.2%. The WTA sample is less censored, with only 5.4% (13/240) of the respondents indicating a WTA equal to zero. Also, 0%, 12.9%, 25.4%, 23.8%, and 32.5% of the respondents lie in the dollar intervals 0.01–1, 1–5, 5–10, 10–15, and 15+.

WTP for Reliability Enhancements

Presented in table 3 are the estimated coefficients and statistics for the WTP model.

Table 3. Future Shortfall Value Tobit Model Coefficients

	WTP Model 466 Observations		WTA Model 240 Observations	
Variable	Estimated Coefficient	p-value	Estimated Coefficient	p-value
Intercept	47.8	0.00	27.3	0.08
Summer	−42.5	0.32	5.97	0.90
Rain	−0.751	< 0.01	−0.643	0.01
Price	−0.113	0.78	−1.09	0.09
Severity	−0.527	0.23	−0.178	0.83
Shortype	0.618	0.67	2.18	0.13
Duration	−0.0711	0.57	0.0222	0.86
Inc2	5.03	0.01	−2.50	0.22
Inc3	3.70	0.10	−4.79	0.02
Inc4	4.17	0.11	−2.76	0.34
Inc5	8.45	< 0.01	0.207	0.94
People	1.22	0.05	0.716	0.19
Activities	−0.104	0.73	0.946	< 0.01
Rent	2.23	0.37	−0.684	0.78
Live	−8.28	0.03	3.08	0.49
Experience	−6.18	< 0.01	−0.882	0.65
σ	14.7		10.8	

The Wald chi-squared test that all coefficients are jointly significantly different from zero is rejected at a p-value below 0.01. The water reliability variables are all insignificant at p-values less than 0.23. Insignificance of the severity variable suggests that consumer valuations are unaffected by dimensions of the initially posed shortfall. The insignificance of the shortype variable indicates respondents did not value improvements in shortfall frequency or shortfall strength differently. These results corroborate the "threshold" nature of valuations suggested by Barakat & Chamberlin, Inc.:

> ...respondents regard even a mild shortage scenario as an inconvenience that they want to avoid. They may make a greater distinction between "shortage" and "no shortage" than between different sizes or frequencies of shortages (p. 15).

Individual income levels are significant at p-values of 0.11 or less. Respondents in income categories two through five (inc2–inc5) are willing to pay more for reliability increases than respondents in income category one (incl—the base which is omitted from the model). Rain is significant at the 0.01 level with respondents in cities with higher rainfall willing to pay less than respondents in drier cities.

In contrast to the value of a current shortfall, individual characteristics appear to help explain WTP bid levels. Live, experience, and people are highly significant. As the number of people living at a residence increases, the respondent is willing to pay more for the reliability enhancement. Respondents who have experienced water shortfalls in the last five years are on average willing to pay less for the reliability increase than those who have not experienced a shortfall. The signs associated with the live variable are different than prior expectations. It was expected that respondents who do not live at the survey residence would be willing to pay less than respondents who do. One possible explanation for this discrepancy is that the variables are not picking up the desired impact. By far the majority of respondents live at and own the survey residence. In the usable dataset only sixteen observations fall into the "don't live at the residence" category; mean WTP for these sixteen is \$14.56, whereas the mean WTP for the remaining observations is \$8.25. Remaining variables are insignificant at p-values below 0.20.

WTA for Reliability Declines

Also presented in table 3 are the estimated coefficients and standard errors from the WTA estimation. The Wald chi-squared test that all coefficients are jointly equal to zero is rejected. The magnitudes, signs, and significance of the estimated coefficients differ between the WTA and WTP models. As in the WTP model, rain's impact is negative and significant at the 0.01 level. Summer and rent are insignificant in both the WTP and WTA models. In contrast to the WTP model, both water price and water activities are significant in the WTA model. The signs and significance of the income categories change, weakening results relative to the WTP model. Similarly, variables for experience and live are insignificant in the WTA model.

As with the WTP model, the coefficients associated with initial severity and duration are insignificant. The coefficient associated with shortype is, however, significant at a p-value of 0.13. The coefficient implies that mean WTA is approximately $2.00 higher for an increase in shortfall strength than an increase in shortfall frequency.

Future Shortfall Valuations

WTP and WTA measures can be obtained as means from survey responses, or they can be calculated as means of the in-sample predicted values from the tobit models using the conditional means equation presented earlier. Both methods are employed here. Presented in table 4 are summary statistics associated with the monthly WTP and WTA measures. Mean data WTP is $8.47, whereas the predicted WTP is $9.76. These WTP measures constitute 22.2% and 25.6% of the respondents' mean monthly water bills. These values compare with means of $11.63 to $16.92 (depending on initial shortfall frequency) reported by Barakat & Chamberlin, Inc. for the complete elimination of future Californian shortfalls. Consistent with earlier discussion regarding consumer behavior, both the predicted and data mean WTA are larger than the WTP mean values. Mean WTA is $12.66 and $13.20 for the raw data and predicted values, respectively. These mean WTAs are 32.4% and 33.8% of mean monthly water bills.

Consistency of Results

A useful inquiry pertains to whether obtained future shortfall valuations are consistent with the current shortfall valuations reported earlier. That is, are consumer valuations of modified shortfall probabilities compatible with the values they assign to avoiding current shortfalls?

The future shortfall WTP question asks respondents to state a payment p to accompany a lowered shortfall frequency such that the new state would be viewed indifferently to the initial state. Adopting the expected utility model, this means that initial expected utility must equal subsequent expected utility. Therefore,

$$\text{(11)} \quad b \cdot U(y - v) + (1 - b) \cdot U(y) = c \cdot U(y - v - p) + (1 - c) \cdot U(y - p)$$

where b is initial shortfall probability, c is subsequent shortfall probability, $U()$ is the utility function, y is income, and v is the value of a known (current) shortfall. This equality implicitly relates future shortfall value p to current shortfall value v.

The utility function is assumed to be locally given by the constant absolute risk aversion form $U(w) = n - me^{-rw}$, where n, m, and r are constant preference parameters. With this assumption, an explicit function can be obtained for p:

$$\text{(12)} \quad p = \frac{1}{r} \ln \left[\frac{be^{rv} + 1 - b}{ce^{rv} + 1 - c} \right]$$

where r is the Arrow–Pratt risk aversion coefficient. For demonstrative purposes, we employ two coefficients, $r = 0.01$ and $r = 0.05$. Both of these values lie at the high end

Table 4. Summary Statistics on Willingness-to-Pay and Willingness-to-Accept Using Individual Observations ($/Month).

	Data				Predicted			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
WTP	8.47	12.90	0.00	100.00	9.76	2.90	2.77	28.41
WTA	12.66	11.12	0.00	60.00	13.20	3.53	2.20	24.19

of empirically estimated ranges—indicative of a high degree of risk aversion (Raskin and Cochran). For before and after shortfall probabilities, we use the two scenarios posed in the WTP versions of the survey: $\langle b = 1/10, c = 1/5\rangle$ and $\langle b = 1/5, c = 1/10\rangle$.

Table 5 contains the results of calculating future shortfall values based on current shortfall values and the above methodology. For example, a household willing to pay \$30 to avoid a current shortfall and having a risk aversion coefficient of 0.05 should be willing to pay a one-time fee of \$1.80 to support a project that alters shortfall frequency from 1/10 to 1/15. The same household should be willing to pay \$4.59 for a project that alters shortfall frequency from 1/5 to 1/10. Our respondents provided average indications of being willing to pay larger amounts than these each and every month. Consequently, the future shortfall values reported here appear inconsistent with the reported current shortfall values.

One is inclined to look to the future shortfall valuation work for the source of the discrepancy because (a) the context of the current shortfall valuation offers a firm and well understood platform for respondents, (b) this platform is not confused by the added dimension of frequencies or probabilities, and (c) the resulting logit model performs well. Several potential reasons for the incompatible current and future shortfall valuations can be hypothesized. First, respondents may not have understood the future shortfall query well. Even though only one parameter was altered, we may have parameterized shortfalls beyond common comprehension. Second, using frequency to convey probabilistic information may be a bad idea because of scaling problems. When shortfall frequency is altered from one out of ten years to one out of fifteen, the change in probability is quite minor (0.033). In retrospect, we wonder whether respondents could grasp the smallness of this change. Third, perhaps respondents place some value on the convenience or social fairness of regular payments to achieve high system reliability as opposed to one-time payments to sidestep temporary shortfall policies. These hypotheses may be useful suggestions for the conduct of future research in this arena.

Conclusions

If economists are to contribute policy advice concerning water system reliability, we must establish and refine a guiding theory, understand the behavior and reactions of managers and consumers, and investigate the values associated with probabilistic shortfalls. The research reported here builds upon prior contributions in each of these areas.

The theoretical development offers modest improvements and questions the use of a "standardized shortage event" in theoretical or applied research. Given the range of potential water shortfalls, in terms of probability, strength, and duration, it is important to examine empirical options for obtaining shortfall values as a function of shortfall parameters. Such pursuits promise to be a challenging departure from the valuation of a standardized shortfall.

Whereas prior research has acknowledged the attitudes of water managers toward system shortfall, important features of consumer behavior have not been examined. When consumers are considered, it becomes evident that their accumulated bundles of water-using durables influence their actions as well as the values they assign to shortfalls. There is noteworthy feedback here too. The potential for shortfalls affects the selection of durables

Table 5. Consistent Future Shortfall Values (p).

	Δ Frequency: $b \to c \equiv \frac{1}{10} \to \frac{1}{15}$		Δ Frequency: $b \to c \equiv \frac{1}{5} \to \frac{1}{10}$	
Current Value (v)	$r = 0.01$	$r = 0.05$	$r = 0.01$	$r = 0.05$
\$10	\$0.35	\$0.41	\$1.04	\$1.18
\$20	\$0.72	\$1.00	\$2.14	\$2.74
\$30	\$1.14	\$1.80	\$3.32	\$4.59
\$40	\$1.57	\$2.78	\$4.58	\$6.58
\$50	\$2.05	\$3.87	\$5.91	\$8.48

by consumers. Another crucial observation is that durable fixity in the short run gives rise to asymmetric values for reliability improvements and reliability declines.

When contingent valuation methods are employed to assess consumer losses due to shortfall, the contingent valuation analysis can address either the value of avoiding a current shortfall or the value of changing the character of probabilistically defined future shortfalls. The probabilistic information necessary for future shortfall surveys confounds respondents and reduces data quantity and quality. A demonstrated option is to employ expected utility theory in conjunction with assessments of current shortfalls to calculate implied future shortfall values. This alternative eliminates the need to convey probabilistic information to respondents but requires additional assumptions regarding consumer risk preferences. Moreover, current shortfall values can be directly used to specify the loss function, $l_t(D_t - S_t)$, needed to ascertain optimal water supply. Given these findings, future research should concentrate on refining the value of current shortfalls rather than pursuing contingent valuation of probabilistically specified future shortfalls.

Even in the absence of probabilistically defined contingent valuation scenarios, there are pitfalls for the nonmarket valuation of shortfall losses. Two such pitfalls can be encountered in other arenas, but they are certainly pronounced for water issues. These are the "birthright" perspective and consumers' lack of personal consumption information. With respect to birthright, water is popularly thought of as a public good to which people have some inalienable entitlement. Many see water bills as a tax rather than as an invoice for the on-demand delivery of treated, pressurized tap water. Consequently, there is a strong tendency for respondents to protest proposed WTP scenarios. Overcoming this pitfall appears extremely difficult at this time, but some redress may be achieved through very carefully worded survey prefaces. The analyst's burden is high here.

With respect to the second pitfall, most households are not aware of their actual water use or their water bills. Not only is water a low budget share item for most households, thus failing to motivate much attention, but water bills are lumped into utility bills that may include electricity, natural gas, and solid waste components. This lack of consumer information also raises the burden for survey instruments. Our instrument's inclusion of consumer-specific data is a novel approach worthy of use, and perhaps testing, by future research.

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Appendix: Background Information

The questionnaire's introduction included contextual information highlighting four key points:

- A temporary water supply shortfall is when water supply is less than water demand. During a temporary water supply shortfall, households usually experience a drop in water pressure, NOT the loss of all water.
- A water pressure drop causes water to flow more slowly through pipes. Sinks and bathtubs take longer to fill. Water-using appliances such as washing machines take longer to operate. Outdoor sprinklers operate more slowly, and the sprinklers will not spray as far.
- Usually, water supply shortfalls occur during the summer months. Average Texas households use 40% less water in December/January than in July/August.
- During a shortfall, your community may employ voluntary or mandatory outdoor water use restrictions (such as restrictions on lawn watering or car washing) to reduce use.

After the customized household data, the questionnaire includes two short paragraphs containing basic details about why shortages tend to occur during the summer and about the important tradeoffs this creates.

> In Texas, water use and water supply change seasonally. Water demand is highest during the summer because of outdoor uses like lawn watering. This is also the season when water supply may be the lowest.
>
> Texas water utilities have traditionally designed their water supply systems to reliably provide peak summertime needs. The full capacity of these systems may be utilized only a few days a year. A portion of water supply systems costs and the rates you pay are therefore for capacity which is used only part of the year. On the other hand, this service capacity also offers Texas communities some insurance against short-term droughts and unexpected water system failures.

Survey of Professional Forecasters

Release Date: February 15, 2013

FIRST QUARTER 2013

Forecasters Predict Stronger Labor Market

The outlook for growth in the U.S. economy over the next three years looks mostly unchanged from that of three months ago, according to 46 forecasters surveyed by the Federal Reserve Bank of Philadelphia. The panel expects real GDP to grow at an annual rate of 2.1 percent this quarter and 2.3 percent next quarter and to rise to 2.7 percent in the first quarter of 2014. On an annual-average over annual-average basis, the forecasters see real GDP growing 1.9 percent in 2013, down slightly from the previous estimate of 2.0 percent. The forecasters predict real GDP will grow 2.8 percent in 2014, 2.9 percent in 2015, and 3.0 percent in 2016.

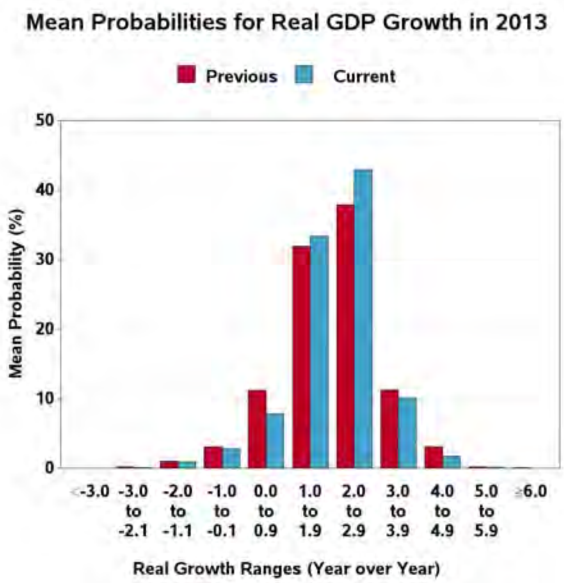
Healthier conditions in the labor market accompany the nearly stable outlook for real output. The forecasters predict that the unemployment rate will be an annual average of 7.7 percent in 2013, before falling to 7.2 percent in 2014, 6.7 percent in 2015, and 6.3 percent in 2016. These projections are below those of the last survey.

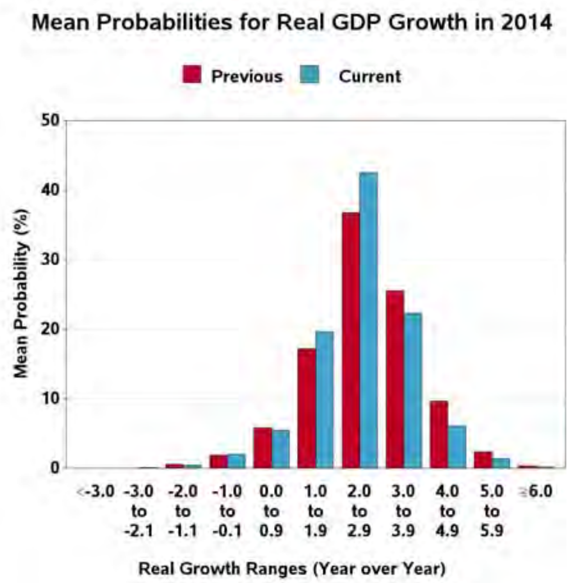
The forecasters are also more optimistic about the employment front. They have revised upward their estimates of the growth in jobs in the next four quarters. The forecasters see nonfarm payroll employment growing at a rate of 165,300 jobs per month this quarter and 154,200 jobs per month next quarter. The forecasters' projections for the annual-average level of nonfarm payroll employment suggest job gains at a monthly rate of 164,100 in 2013 and 176,800 in 2014, as the table below shows. (These annual-average estimates are computed as the year-to-year change in the annual-average level of nonfarm payroll employment, converted to a monthly rate.)

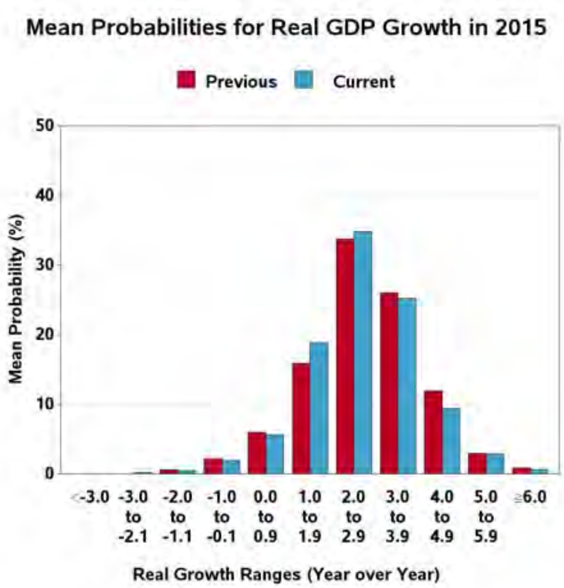
Median Forecasts for Selected Variables in the Current and Previous Surveys

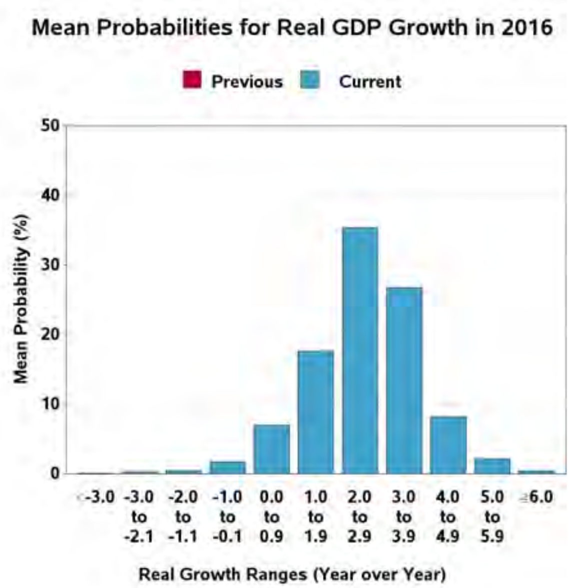
	Real GDP (%)		*Unemployment Rate (%)*		*Payrolls (000s/month)*	
	Previous	*New*	*Previous*	*New*	*Previous*	*New*
Quarterly data:						
2013:Q1	1.7	2.1	7.9	7.8	127.4	165.3
2013:Q2	2.0	2.3	7.8	7.7	146.1	154.2
2013:Q3	2.7	2.6	7.8	7.6	170.2	172.0
2013:Q4	2.8	2.5	7.6	7.5	178.3	180.4
2014:Q1	N.A.	2.7	N.A.	7.4	N.A.	171.5
Annual data (projections are based on annual-average levels):						
2013	2.0	1.9	7.8	7.7	143.3	164.1
2014	2.7	2.8	7.4	7.2	N.A.	176.8
2015	2.9	2.9	6.9	6.7	N.A.	N.A.
2016	N.A.	3.0	N.A.	6.3	N.A.	N.A.

The charts below provide some insight into the degree of uncertainty the forecasters have about their projections for the rate of growth in the annual-average level of real GDP. Each chart presents the forecasters' previous and current estimates of the probability that growth will fall into each of 11 ranges. The forecasters have revised upward their estimate of the probability that growth will fall into the range of 2.0 to 2.9 percent in 2013, 2014, and 2015.

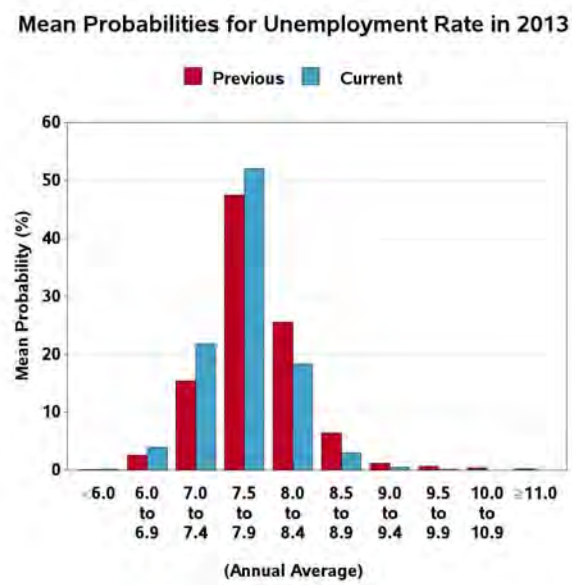


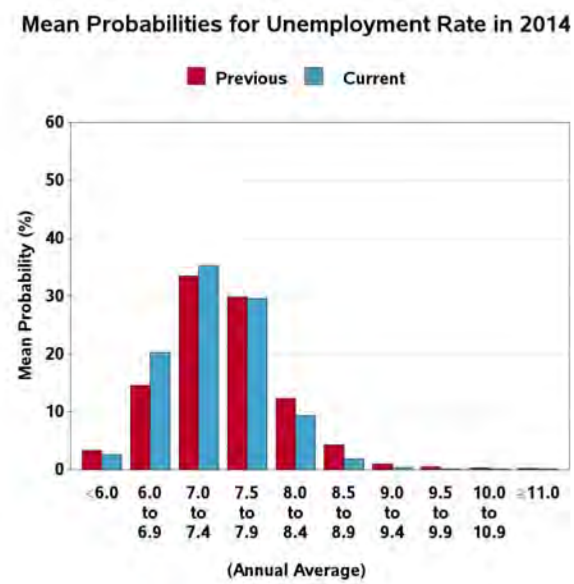


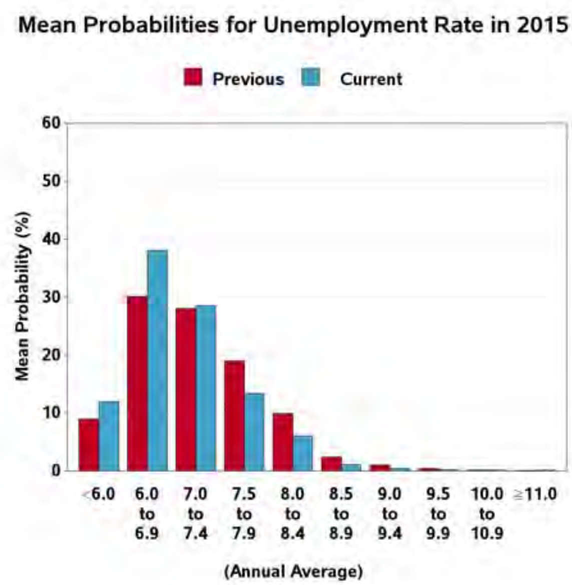


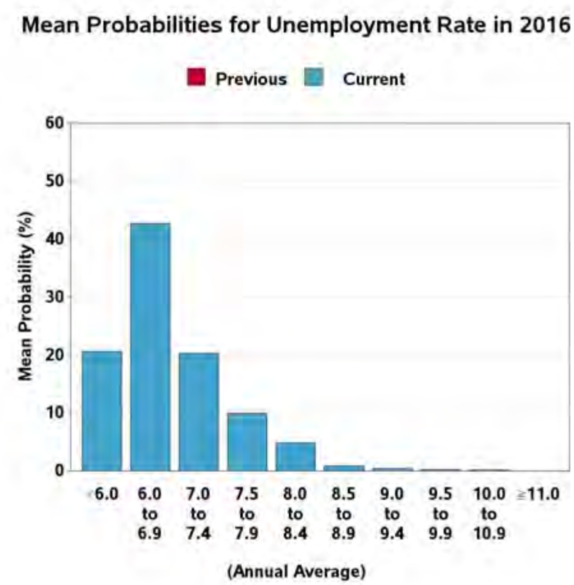


The forecasters' density projections, as shown in the charts below, shed light on the odds of a recovery in the labor market over the next four years. Each chart for unemployment presents the forecasters' previous and current estimates of the probability that unemployment will fall into each of 10 ranges. Consistent with their more optimistic point forecasts on unemployment, the forecasters have revised upward their estimate of the probability that unemployment will fall below 7.5 percent in 2013, 2014, and 2015.









Forecasters See Lower Near-Term Inflation

The forecasters expect current-quarter headline CPI inflation to average 1.8 percent, lower than the last survey's estimate of 2.1 percent. The forecasters predict current-quarter headline PCE inflation of 1.4 percent, lower than the prediction of 1.8 percent from the survey of three months ago.

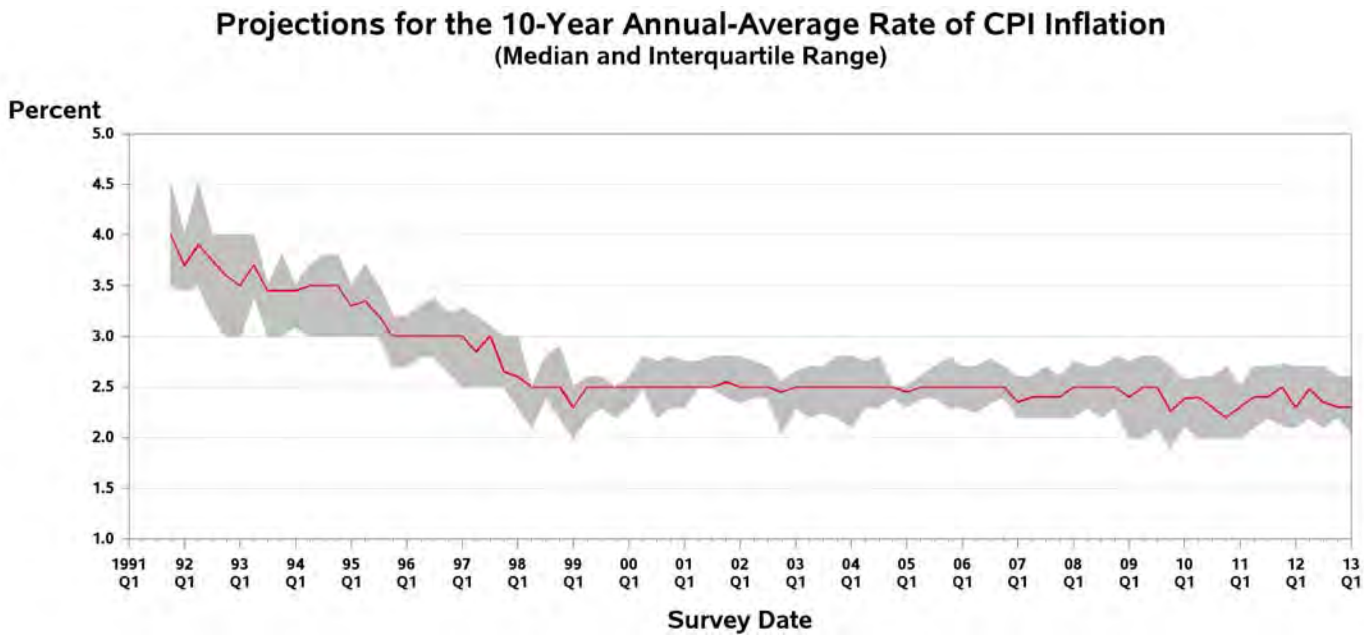
The forecasters also see lower headline and core measures of CPI and PCE inflation during the next two years. Measured on a fourth-quarter over fourth-quarter basis, headline CPI inflation is expected to average 2.0 percent in 2013, down from 2.2 percent in the last survey, and 2.2 percent in 2014, down 0.1 percentage point from the previous estimate. Forecasters expect fourth-quarter over fourth-quarter headline PCE inflation to average 1.8 percent in 2013, down from 2.0 percent in the last survey, and 2.0 percent in 2014, down 0.2 percentage point from the previous estimate.

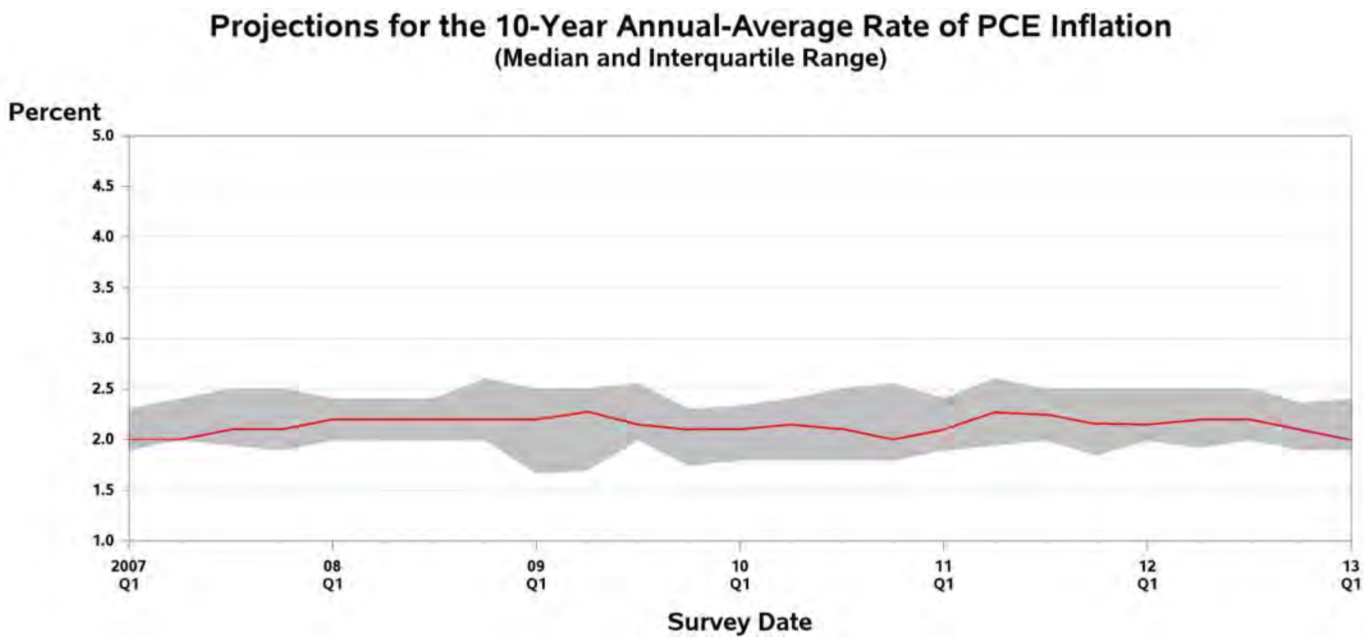
Over the next 10 years, 2013 to 2022, the forecasters expect headline CPI inflation to average 2.3 percent at an annual rate. The corresponding estimate for 10-year annual-average PCE inflation is 2.0 percent.

Median Short-Run and Long-Run Projections for Inflation (Annualized Percentage Points)

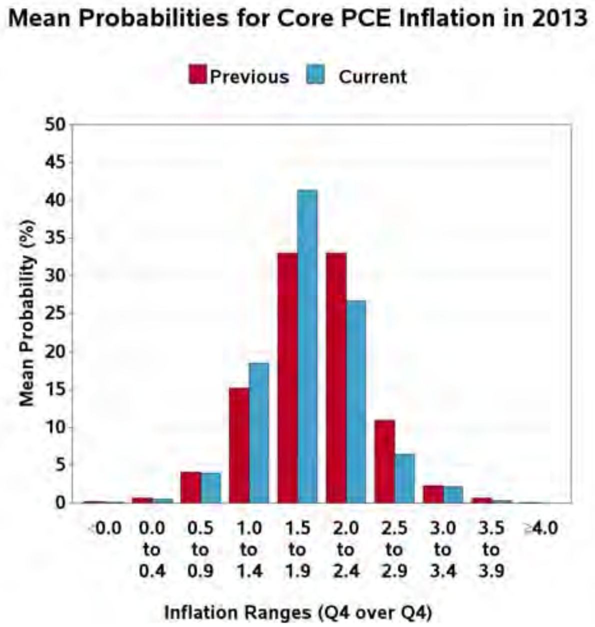
	Headline CPI		Core CPI		Headline PCE		Core PCE	
	Previous	Current	Previous	Current	Previous	Current	Previous	Current
Quarterly								
2013:Q1	2.1	1.8	1.9	1.8	1.8	1.4	1.8	1.4
2013:Q2	2.2	2.1	2.0	2.0	2.0	1.9	1.9	1.7
2013:Q3	2.2	2.1	2.0	2.0	2.0	1.9	1.9	1.8
2013:Q4	2.3	2.1	2.0	2.0	2.1	1.9	1.9	1.7
2014:Q1	N.A.	2.1	N.A.	2.0	N.A.	2.0	N.A.	1.8
Q4/Q4 Annual Averages								
2013	2.2	2.0	2.0	1.9	2.0	1.8	1.9	1.6
2014	2.3	2.2	2.2	2.1	2.2	2.0	2.0	1.9
2015	N.A.	2.3	N.A.	2.2	N.A.	2.0	N.A.	1.9
Long-Term Annual Averages								
2012-2016	2.28	N.A.	N.A.	N.A.	2.00	N.A.	N.A.	N.A.
2013-2017	N.A.	2.30	N.A.	N.A.	N.A.	2.00	N.A.	N.A.
2012-2021	2.30	N.A.	N.A.	N.A.	2.10	N.A.	N.A.	N.A.
2013-2022	N.A.	2.30	N.A.	N.A.	N.A.	2.00	N.A.	N.A.

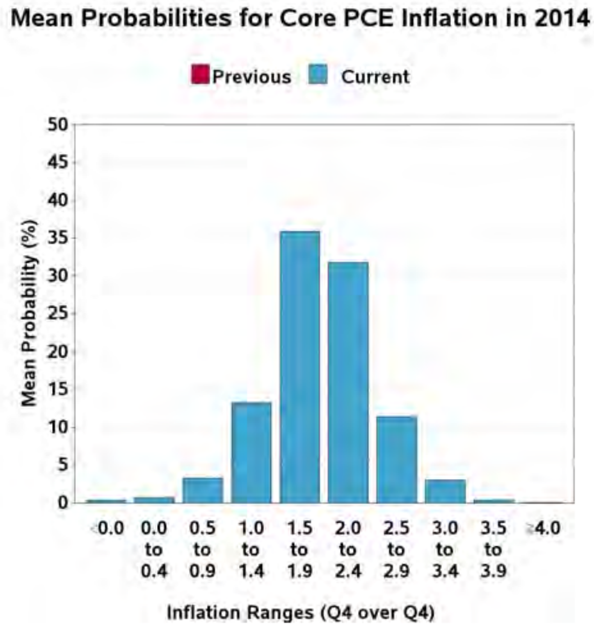
The charts below show the median projections (the red line) and the associated interquartile ranges (the gray area around the red line) for the projections for the 10-year annual-average CPI and PCE inflation. The top panel shows the unchanged long-term projection for CPI inflation, at 2.3 percent. The bottom panel highlights the slightly lower 10-year forecast for PCE inflation at 2.0 percent.





The figures below show the probabilities that the forecasters are assigning to the possibility that fourth-quarter over fourth-quarter core PCE inflation in 2013 and 2014 will fall into each of 10 ranges. For 2013, the forecasters assign a higher chance than previously that core PCE inflation will fall in the range of 1.0 to 1.9 percent (and a lower probability that inflation will exceed 1.9 percent).





Lower Risk of a Negative Quarter

The forecasters have revised downward the chance of a contraction in real GDP in any of the next four quarters. For the current quarter, they predict a 15.3 percent chance of negative growth, down from 23.0 percent in the survey of three months ago. As the table below shows, the panelists have also made downward revisions to their forecasts for the following three quarters.

Risk of a Negative Quarter (%)

Quarterly data:	*Previous*	*New*
2013: Q1	23.0	15.3
2013: Q2	21.7	18.0
2013: Q3	17.9	15.2
2013: Q4	16.4	13.6
2014: Q1	N.A.	13.2

Forecasters State Their Views on House Prices

In this survey, a special question asked panelists to provide their forecasts for fourth-quarter over fourth-quarter growth in house prices, as measured by a number of alternative indices. The panelists were allowed to choose from a provided list of indices or to write in their own index. For each index of their choosing, the panelists provided forecasts of growth in 2013 and 2014.

Thirty-one panelists answered the special question. Some panelists provided projections for more than one index. The table below provides a summary of the forecasters' responses. For some indices, the number of responses (N) is very small. The median estimates for the six house-price indices listed in the table below range from 2.0 percent to 9.2 percent in 2013 and 3.9 percent to 7.8 percent in 2014.

Projections for Growth in Various Indices of House Prices
Q4/Q4, Percentage Points

Index	2013 (Q4/Q4 Percent Change)			2014 (Q4/Q4 Percent Change)		
	N	Mean	Median	N	Mean	Median
S&P/Case-Shiller: U.S. National	15	3.5	3.3	15	3.5	4.0
S&P/Case-Shiller: Composite 20	6	4.8	4.5	6	4.6	3.9
FHFA: U.S. Total	9	2.6	2.0	9	4.4	4.0
FHFA: Purchase Only	4	2.7	2.8	4	4.1	3.9
CoreLogic: National HPI, incl Distressed Sales (Single Family Combined)	7	4.8	5.0	7	4.6	4.8
NAR Median: Total Existing	4	8.1	9.2	4	7.4	7.8

Forecasters Reduce Estimates for Long-Run Growth in Output and Productivity and Returns on Financial Assets

In first-quarter surveys, the forecasters provide their long-run projections for an expanded set of variables, including growth in output and productivity, as well as returns on financial assets.

As the table below shows, the forecasters have reduced their long-run estimates for the annual-average rate of growth in real GDP. Currently, the forecasters expect real GDP to grow 2.50 percent per year over the next 10 years, down from 2.64 percent in the survey of 2012 Q1.

Similarly, productivity growth is now expected to average 1.80 percent, down from 1.85 percent. Downward revisions to the return on financial assets accompany the current outlook. The forecasters see the S&P 500 returning an annual-average 6.13 percent per year over the next 10 years, down from 6.80 percent. The forecasters expect 10-year Treasuries to return 3.83 percent per year over the next 10 years, down from 4.00 percent. Three-month Treasury bills will return 2.40 percent, down from 2.50 percent.

Long-Term (10-year) Forecasts (%)

	First Quarter 2012	*Current Survey*
Real GDP Growth	2.64	2.50
Productivity Growth	1.85	1.80
Stock Returns (S&P 500)	6.80	6.13
Bond Returns (10-year)	4.00	3.83
Bill Returns (3-month)	2.50	2.40

The Federal Reserve Bank of Philadelphia thanks the following forecasters for their participation in recent surveys:

Scott Anderson, Bank of the West (BNP Paribas Group); **Robert J. Barbera**, Johns Hopkins University Center for Financial Economics; **Peter Bernstein**, RCF Economic and Financial Consulting, Inc.; **Christine Chmura, Ph.D.** and **Xiaobing Shuai, Ph.D.**, Chmura Economics & Analytics; **Gary Ciminero, CFA**, GLC Financial Economics; **Julia Coronado**, BNP Paribas; **David Crowe**, National Association of Home Builders; **Nathaniel Curtis**, EconLit LLC; **Rajeev Dhawan**, Georgia State University; **Shawn Dubravac**, Consumer Electronics Association; **Michael R. Englund**, Action Economics, LLC; **Timothy Gill**, NEMA; **James Glassman**, JPMorgan Chase & Co.; **Daniel Hanson**, LTZF Economics; **Keith Hembre**, Nuveen Asset Management; **Peter Hooper**, Deutsche Bank Securities, Inc.; **IHS Global Insight**; **Fred Joutz**, Benchmark Forecasts and Research Program on Forecasting, George Washington University; **N. Karp**, BBVA Compass; **Walter Kemmsies**, Moffatt & Nichol; **Jack Kleinhenz,** Kleinhenz & Associates, Inc.; **Thomas Lam**, OSK Group/DMG & Partners; **L. Douglas Lee**, Economics from Washington; **Allan R. Leslie**, Economic Consultant; **John Lonski**, Moody's Capital Markets Group; **Macroeconomic Advisers, LLC**; **Dean Maki**, Barclays Capital; **Jim Meil** and **Arun Raha**, Eaton Corporation; **Anthony Metz**, Pareto Optimal Economics; **Michael Moran**, Daiwa Capital Markets America; **Joel L. Naroff**, Naroff Economic Advisors; **Mark Nielson, Ph.D.**, MacroEcon Global Advisors; **Michael P. Niemira**, International Council of Shopping Centers; **Luca Noto**, Anima Sgr; **Brendon Ogmundson**, BC Real Estate Association; **Martin A. Regalia**, U.S. Chamber of Commerce; **Philip Rothman**, East Carolina University; **Chris Rupkey**, Bank of Tokyo-Mitsubishi UFJ; **John Silvia**, Wells Fargo; **Allen Sinai**, Decision Economics, Inc; **Tara M. Sinclair**, Research Program on Forecasting, George Washington University; **David Sloan**, Thomson Reuters; **Sean M. Snaith, Ph.D.**, University of Central Florida; **Constantine G. Soras, Ph.D.**, CGS Economic Consulting; **Neal Soss**, Credit Suisse; **Stephen Stanley**, Pierpont Securities; **Charles Steindel**, New Jersey Department of the Treasury; **Susan M. Sterne**, Economic Analysis Associates, Inc.; **Thomas Kevin Swift**, American Chemistry Council; **Andrew Tilton**, Goldman Sachs; **Lea Tyler**, Oxford Economics USA, Inc.; **Jay N. Woodworth**, Woodworth Holdings, Ltd.; **Richard Yamarone**, Bloomberg, LP; **Mark Zandi**, Moody's Analytics; **Ellen Zentner**, Nomura Securities.

This is a partial list of participants. We also thank those who wish to remain anonymous.

SUMMARY TABLE
SURVEY OF PROFESSIONAL FORECASTERS
MAJOR MACROECONOMIC INDICATORS

	2013 Q1	2013 Q2	2013 Q3	2013 Q4	2014 Q1	2013 (YEAR-OVER-YEAR)	2014 (YEAR-OVER-YEAR)	2015 (YEAR-OVER-YEAR)	2016 (YEAR-OVER-YEAR)
PERCENT GROWTH AT ANNUAL RATES									
1. REAL GDP (BILLIONS, CHAIN WEIGHTED)	2.1	2.3	2.6	2.5	2.7	1.9	2.8	2.9	3.0
2. GDP PRICE INDEX (PERCENT CHANGE)	1.7	1.9	2.1	1.7	2.0	1.7	2.1	N.A.	N.A.
3. NOMINAL GDP ($ BILLIONS)	4.0	4.2	4.4	4.3	5.0	3.6	4.7	N.A.	N.A.
4. NONFARM PAYROLL EMPLOYMENT									
(PERCENT CHANGE)	1.5	1.4	1.5	1.6	1.5	1.5	1.6	N.A.	N.A.
(AVG MONTHLY CHANGE)	165.3	154.2	172.0	180.4	171.5	164.1	176.8	N.A.	N.A.
VARIABLES IN LEVELS									
5. UNEMPLOYMENT RATE (PERCENT)	7.8	7.7	7.6	7.5	7.4	7.7	7.2	6.7	6.3
6. 3-MONTH TREASURY BILL (PERCENT)	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.6	1.7
7. 10-YEAR TREASURY BOND (PERCENT)	1.9	2.0	2.1	2.3	2.5	2.1	2.6	3.3	3.8

	2013 Q1	2013 Q2	2013 Q3	2013 Q4	2014 Q1	2013 (Q4-OVER-Q4)	2014 (Q4-OVER-Q4)	2015 (Q4-OVER-Q4)
INFLATION INDICATORS								
8. CPI (ANNUAL RATE)	1.8	2.1	2.1	2.1	2.1	2.0	2.2	2.3
9. CORE CPI (ANNUAL RATE)	1.8	2.0	2.0	2.0	2.0	1.9	2.1	2.2
10. PCE (ANNUAL RATE)	1.4	1.9	1.9	1.9	2.0	1.8	2.0	2.0
11. CORE PCE (ANNUAL RATE)	1.4	1.7	1.8	1.7	1.8	1.6	1.9	1.9

THE FIGURES ON EACH LINE ARE MEDIANS OF 46 INDIVIDUAL FORECASTERS.

SOURCE: RESEARCH DEPARTMENT, FEDERAL RESERVE BANK OF PHILADELPHIA.
SURVEY OF PROFESSIONAL FORECASTERS, FIRST QUARTER 2013.

SURVEY OF PROFESSIONAL FORECASTERS

First Quarter 2013

Tables

Note: Data in these tables listed as "actual" are the data that were available to the forecasters when they were sent the survey questionnaire on January 30; the tables do not reflect subsequent revisions to the data. All forecasts were received on or before February 11, 2013.

TABLE ONE
MAJOR MACROECONOMIC INDICATORS
MEDIANS OF FORECASTER PREDICTIONS

	NUMBER OF FORECASTERS	ACTUAL 2012 Q4	FORECAST 2013 Q1	2013 Q2	2013 Q3	2013 Q4	2014 Q1	ACTUAL 2012 ANNUAL	FORECAST 2013 ANNUAL	2014 ANNUAL	2015 ANNUAL	2016 ANNUAL
1. GROSS DOMESTIC PRODUCT (GDP) ($ BILLIONS)	42	15829	15986	16150	16325	16499	16700	15676	16239	16997	N.A.	N.A.
2. GDP PRICE INDEX (2005=100)	43	115.98	116.47	117.02	117.63	118.14	118.72	115.36	117.32	119.79	N.A.	N.A.
3. CORPORATE PROFITS AFTER TAXES ($ BILLIONS)	21	N.A.	1536.0	1545.8	1577.1	1587.5	1612.1	N.A.	1570.6	1669.8	N.A.	N.A.
4. UNEMPLOYMENT RATE (PERCENT)	44	7.8	7.8	7.7	7.6	7.5	7.4	8.1	7.7	7.2	6.7	6.3
5. NONFARM PAYROLL EMPLOYMENT (THOUSANDS)	38	133864	134360	134822	135338	135879	136394	133241	135210	137332	N.A.	N.A.
6. INDUSTRIAL PRODUCTION (2007=100)	39	97.6	98.3	99.1	100.0	100.8	101.7	97.2	99.5	102.9	N.A.	N.A.
7. NEW PRIVATE HOUSING STARTS (ANNUAL RATE, MILLIONS)	41	0.90	0.92	0.95	0.98	1.03	1.09	0.78	0.97	1.17	N.A.	N.A.
8. 3-MONTH TREASURY BILL RATE (PERCENT)	42	0.09	0.10	0.10	0.10	0.10	0.11	0.09	0.10	0.16	0.55	1.69
9. AAA CORPORATE BOND YIELD (PERCENT)	34	3.54	3.73	3.80	3.90	4.04	4.15	3.67	3.85	4.30	N.A.	N.A.
10. BAA CORPORATE BOND YIELD (PERCENT)	33	4.57	4.80	4.82	4.96	5.05	5.17	4.94	4.91	5.52	N.A.	N.A.
11. 10-YEAR TREASURY BOND YIELD (PERCENT)	42	1.71	1.91	2.00	2.14	2.29	2.45	1.80	2.10	2.60	3.25	3.75
12. REAL GDP (BILLIONS, CHAIN WEIGHTED)	45	13648	13720	13799	13888	13973	14067	13589	13847	14229	14640	15072
13. TOTAL CONSUMPTION EXPENDITURE (BILLIONS, CHAIN WEIGHTED)	43	9671.9	9710.5	9757.0	9813.6	9872.7	9937.7	9605.3	9789.2	10023.5	N.A.	N.A.
14. NONRESIDENTIAL FIXED INVESTMENT (BILLIONS, CHAIN WEIGHTED)	41	1506.2	1518.9	1539.3	1564.3	1587.6	1608.1	1483.8	1553.3	1646.7	N.A.	N.A.
15. RESIDENTIAL FIXED INVESTMENT (BILLIONS, CHAIN WEIGHTED)	41	384.3	396.1	408.8	421.3	434.5	450.1	366.6	415.5	466.3	N.A.	N.A.
16. FEDERAL GOVERNMENT C & I (BILLIONS, CHAIN WEIGHTED)	40	1004.4	1004.3	1002.9	1003.0	998.0	995.3	1024.0	1001.6	992.8	N.A.	N.A.
17. STATE AND LOCAL GOVT C & I (BILLIONS, CHAIN WEIGHTED)	40	1460.2	1458.8	1458.7	1460.1	1463.1	1463.0	1462.4	1459.5	1469.0	N.A.	N.A.
18. CHANGE IN PRIVATE INVENTORIES (BILLIONS, CHAIN WEIGHTED)	40	20.0	36.9	41.1	43.7	45.0	45.0	44.6	42.5	44.5	N.A.	N.A.
19. NET EXPORTS (BILLIONS, CHAIN WEIGHTED)	41	-404.0	-404.3	-404.2	-410.0	-411.1	-409.2	-405.6	-406.3	-408.8	N.A.	N.A.

SOURCE: RESEARCH DEPARTMENT, FEDERAL RESERVE BANK OF PHILADELPHIA. SURVEY OF PROFESSIONAL FORECASTERS, FIRST QUARTER 2013.

TABLE TWO
MAJOR MACROECONOMIC INDICATORS
PERCENTAGE CHANGES AT ANNUAL RATES

	NUMBER OF FORECASTERS	Q4 2012 TO Q1 2013	Q1 2013 TO Q2 2013	Q2 2013 TO Q3 2013	Q3 2013 TO Q4 2013	Q4 2013 TO Q1 2014	2012 TO 2013	2013 TO 2014	2014 TO 2015	2015 TO 2016
1. GROSS DOMESTIC PRODUCT (GDP) ($ BILLIONS)	42	4.0	4.2	4.4	4.3	5.0	3.6	4.7	N.A.	N.A.
2. GDP PRICE INDEX (2005=100)	43	1.7	1.9	2.1	1.7	2.0	1.7	2.1	N.A.	N.A.
3. CORPORATE PROFITS AFTER TAXES ($ BILLIONS)	21	5.7	2.6	8.4	2.7	6.3	5.3	6.3	N.A.	N.A.
4. UNEMPLOYMENT RATE (PERCENT)	44	0.0	-0.1	-0.1	-0.1	-0.1	-0.4	-0.4	-0.5	-0.5
5. NONFARM PAYROLL EMPLOYMENT										
(PERCENT CHANGE)	38	1.5	1.4	1.5	1.6	1.5	1.5	1.6	N.A.	N.A.
(AVG MONTHLY CHANGE)	38	165.3	154.2	172.0	180.4	171.5	164.1	176.8	N.A.	N.A.
6. INDUSTRIAL PRODUCTION (2007=100)	39	3.0	3.3	3.6	3.4	3.4	2.4	3.3	N.A.	N.A.
7. NEW PRIVATE HOUSING STARTS (ANNUAL RATE, MILLIONS)	41	9.2	14.7	13.2	22.0	23.2	24.6	20.2	N.A.	N.A.
8. 3-MONTH TREASURY BILL RATE (PERCENT)	42	0.01	0.00	0.00	0.00	0.01	0.01	0.06	0.39	1.14
9. AAA CORPORATE BOND YIELD (PERCENT)	34	0.19	0.07	0.10	0.15	0.11	0.18	0.45	N.A.	N.A.
10. BAA CORPORATE BOND YIELD (PERCENT)	33	0.23	0.02	0.14	0.09	0.12	-0.04	0.61	N.A.	N.A.
11. 10-YEAR TREASURY BOND YIELD (PERCENT)	42	0.19	0.10	0.14	0.16	0.16	0.30	0.50	0.65	0.50
12. REAL GDP (BILLIONS, CHAIN WEIGHTED)	45	2.1	2.3	2.6	2.5	2.7	1.9	2.8	2.9	3.0
13. TOTAL CONSUMPTION EXPENDITURE (BILLIONS, CHAIN WEIGHTED)	43	1.6	1.9	2.3	2.4	2.7	1.9	2.4	N.A.	N.A.
14. NONRESIDENTIAL FIXED INVESTMENT (BILLIONS, CHAIN WEIGHTED)	41	3.4	5.5	6.7	6.1	5.3	4.7	6.0	N.A.	N.A.
15. RESIDENTIAL FIXED INVESTMENT (BILLIONS, CHAIN WEIGHTED)	41	12.9	13.4	12.9	13.1	15.2	13.4	12.2	N.A.	N.A.
16. FEDERAL GOVERNMENT C & I (BILLIONS, CHAIN WEIGHTED)	40	-0.0	-0.6	0.0	-2.0	-1.1	-2.2	-0.9	N.A.	N.A.
17. STATE AND LOCAL GOVT C & I (BILLIONS, CHAIN WEIGHTED)	40	-0.4	-0.0	0.4	0.8	-0.0	-0.2	0.6	N.A.	N.A.
18. CHANGE IN PRIVATE INVENTORIES (BILLIONS, CHAIN WEIGHTED)	40	16.9	4.2	2.6	1.3	0.0	-2.1	2.0	N.A.	N.A.
19. NET EXPORTS (BILLIONS, CHAIN WEIGHTED)	41	-0.3	0.1	-5.8	-1.1	1.9	-0.7	-2.5	N.A.	N.A.

NOTE: FIGURES FOR UNEMPLOYMENT RATE, TREASURY BILL RATE, AAA CORPORATE BOND YIELD, BAA CORPORATE BOND YIELD, AND 10-YEAR TREASURY BOND YIELD ARE CHANGES IN THESE RATES, IN PERCENTAGE POINTS.
FIGURES FOR CHANGE IN PRIVATE INVENTORIES AND NET EXPORTS ARE CHANGES IN BILLIONS OF CHAIN-WEIGHTED DOLLARS.
ALL OTHERS ARE PERCENTAGE CHANGES AT ANNUAL RATES.

SOURCE: RESEARCH DEPARTMENT, FEDERAL RESERVE BANK OF PHILADELPHIA. SURVEY OF PROFESSIONAL FORECASTERS, FIRST QUARTER 2013.

TABLE THREE
MAJOR PRICE INDICATORS
MEDIANS OF FORECASTER PREDICTIONS

	NUMBER OF FORECASTERS	ACTUAL 2012 Q4	FORECAST(Q/Q) 2013 Q1	FORECAST(Q/Q) 2013 Q2	FORECAST(Q/Q) 2013 Q3	FORECAST(Q/Q) 2013 Q4	FORECAST(Q/Q) 2014 Q1	ACTUAL 2012 ANNUAL	FORECAST(Q4/Q4) 2013 ANNUAL	FORECAST(Q4/Q4) 2014 ANNUAL	FORECAST(Q4/Q4) 2015 ANNUAL
1. CONSUMER PRICE INDEX (ANNUAL RATE)	43	2.1	1.8	2.1	2.1	2.1	2.1	1.9	2.0	2.2	2.3
2. CORE CONSUMER PRICE INDEX (ANNUAL RATE)	41	1.6	1.8	2.0	2.0	2.0	2.0	1.9	1.9	2.1	2.2
3. PCE PRICE INDEX (ANNUAL RATE)	38	1.2	1.4	1.9	1.9	1.9	2.0	1.5	1.8	2.0	2.0
4. CORE PCE PRICE INDEX (ANNUAL RATE)	39	0.9	1.4	1.7	1.8	1.7	1.8	1.5	1.6	1.9	1.9

SOURCE: RESEARCH DEPARTMENT, FEDERAL RESERVE BANK OF PHILADELPHIA. SURVEY OF PROFESSIONAL FORECASTERS, FIRST QUARTER 2013.

TABLE FOUR
ESTIMATED PROBABILITY OF DECLINE IN REAL GDP

ESTIMATED PROBABILITY (CHANCES IN 100)	Q4 2012 TO Q1 2013	Q1 2013 TO Q2 2013	Q2 2013 TO Q3 2013	Q3 2013 TO Q4 2013	Q4 2013 TO Q1 2014
	NUMBER OF FORECASTERS				
10 OR LESS	22	12	13	21	22
11 TO 20	8	16	22	15	15
21 TO 30	8	9	5	4	2
31 TO 40	2	4	1	1	2
41 TO 50	1	0	0	0	0
51 TO 60	0	0	0	0	0
61 TO 70	0	0	0	0	0
71 TO 80	0	0	0	0	0
81 TO 90	0	0	0	0	0
91 AND OVER	0	0	0	0	0
NOT REPORTING	5	5	5	5	5
MEAN AND MEDIAN					
MEDIAN PROBABILITY	10.00	16.00	15.00	10.00	10.00
MEAN PROBABILITY	15.32	17.99	15.21	13.64	13.16

NOTE: TOTAL NUMBER OF FORECASTERS REPORTING IS 41.
SOURCE: RESEARCH DEPARTMENT, FEDERAL RESERVE BANK OF PHILADELPHIA.
SURVEY OF PROFESSIONAL FORECASTERS, FIRST QUARTER 2013.

TABLE FIVE
MEAN PROBABILITIES

MEAN PROBABILITY ATTACHED TO POSSIBLE
CIVILIAN UNEMPLOYMENT RATES:
(ANNUAL AVERAGE)

	2013	2014	2015	2016
11.0 PERCENT OR MORE	0.00	0.13	0.16	0.00
10.0 TO 10.9 PERCENT	0.01	0.15	0.18	0.18
9.5 TO 9.9 PERCENT	0.18	0.16	0.19	0.20
9.0 TO 9.4 PERCENT	0.50	0.44	0.42	0.41
8.5 TO 8.9 PERCENT	2.98	1.88	1.10	0.87
8.0 TO 8.4 PERCENT	18.35	9.38	6.04	4.78
7.5 TO 7.9 PERCENT	52.04	29.59	13.34	9.92
7.0 TO 7.4 PERCENT	21.85	35.30	28.55	20.28
6.0 TO 6.9 PERCENT	3.96	20.31	38.03	42.74
LESS THAN 6.0 PERCENT	0.13	2.68	11.98	20.60

MEAN PROBABILITY ATTACHED TO POSSIBLE
PERCENT CHANGES IN REAL GDP:
(ANNUAL-AVERAGE OVER ANNUAL-AVERAGE)

	2012-2013	2013-2014	2014-2015	2015-2016
6.0 OR MORE	0.02	0.21	0.62	0.45
5.0 TO 5.9	0.14	1.38	2.84	2.15
4.0 TO 4.9	1.74	6.08	9.38	8.19
3.0 TO 3.9	10.12	22.28	25.24	26.78
2.0 TO 2.9	42.98	42.50	34.83	35.38
1.0 TO 1.9	33.35	19.65	18.85	17.59
0.0 TO 0.9	7.84	5.42	5.61	6.99
-1.0 TO -0.1	2.80	2.01	1.90	1.74
-2.0 TO -1.1	0.95	0.38	0.51	0.42
-3.0 TO -2.1	0.06	0.08	0.21	0.28
LESS THAN -3.0	0.00	0.01	0.01	0.05

MEAN PROBABILITY ATTACHED TO POSSIBLE
PERCENT CHANGES IN GDP PRICE INDEX:
(ANNUAL-AVERAGE OVER ANNUAL-AVERAGE)

	2012-2013	2013-2014
8.0 OR MORE	0.00	0.00
7.0 TO 7.9	0.00	0.00
6.0 TO 6.9	0.00	0.02
5.0 TO 5.9	0.11	0.13
4.0 TO 4.9	0.82	2.00
3.0 TO 3.9	5.23	8.98
2.0 TO 2.9	35.89	44.02
1.0 TO 1.9	49.34	36.90
0.0 TO 0.9	7.84	7.07
WILL DECLINE	0.78	0.86

SOURCE: RESEARCH DEPARTMENT, FEDERAL RESERVE BANK OF PHILADELPHIA.
SURVEY OF PROFESSIONAL FORECASTERS, FIRST QUARTER 2013.

TABLE SIX
MEAN PROBABILITY OF CORE CPI AND CORE PCE INFLATION (Q4/Q4)

MEAN PROBABILITY ATTACHED TO CORE CPI INFLATION:

	12Q4 TO 13Q4	13Q4 TO 14Q4
4 PERCENT OR MORE	0.05	0.35
3.5 TO 3.9 PERCENT	0.50	0.73
3.0 TO 3.4 PERCENT	2.86	5.60
2.5 TO 2.9 PERCENT	10.27	15.55
2.0 TO 2.4 PERCENT	30.49	32.55
1.5 TO 1.9 PERCENT	40.36	31.51
1.0 TO 1.4 PERCENT	12.94	10.29
0.5 TO 0.9 PERCENT	1.77	2.62
0.0 TO 0.4 PERCENT	0.34	0.53
WILL DECLINE	0.42	0.28

MEAN PROBABILITY ATTACHED TO CORE PCE INFLATION:

	12Q4 TO 13Q4	13Q4 TO 14Q4
4 PERCENT OR MORE	0.00	0.03
3.5 TO 3.9 PERCENT	0.29	0.37
3.0 TO 3.4 PERCENT	2.14	3.01
2.5 TO 2.9 PERCENT	6.46	11.40
2.0 TO 2.4 PERCENT	26.68	31.74
1.5 TO 1.9 PERCENT	41.32	35.88
1.0 TO 1.4 PERCENT	18.51	13.26
0.5 TO 0.9 PERCENT	3.97	3.25
0.0 TO 0.4 PERCENT	0.52	0.70
WILL DECLINE	0.10	0.36

SOURCE: RESEARCH DEPARTMENT, FEDERAL RESERVE BANK OF PHILADELPHIA.
SURVEY OF PROFESSIONAL FORECASTERS, FIRST QUARTER 2013.

TABLE SEVEN
LONG-TERM (5-YEAR AND 10-YEAR) FORECASTS

ANNUAL AVERAGE OVER THE NEXT 5 YEARS: 2013-2017

CPI INFLATION RATE		PCE INFLATION RATE	
MINIMUM	0.60	MINIMUM	0.61
LOWER QUARTILE	2.00	LOWER QUARTILE	1.80
MEDIAN	2.30	MEDIAN	2.00
UPPER QUARTILE	2.50	UPPER QUARTILE	2.30
MAXIMUM	3.10	MAXIMUM	2.80
MEAN	2.24	MEAN	2.01
STD. DEVIATION	0.45	STD. DEVIATION	0.41
N	40	N	38
MISSING	6	MISSING	8

ANNUAL AVERAGE OVER THE NEXT 10 YEARS: 2013-2022

CPI INFLATION RATE		PCE INFLATION RATE	
MINIMUM	0.97	MINIMUM	0.99
LOWER QUARTILE	2.05	LOWER QUARTILE	1.90
MEDIAN	2.30	MEDIAN	2.00
UPPER QUARTILE	2.60	UPPER QUARTILE	2.40
MAXIMUM	3.50	MAXIMUM	3.00
MEAN	2.33	MEAN	2.12
STD. DEVIATION	0.45	STD. DEVIATION	0.40
N	39	N	37
MISSING	7	MISSING	9

REAL GDP GROWTH RATE		PRODUCTIVITY GROWTH RATE	
MINIMUM	1.75	MINIMUM	0.90
LOWER QUARTILE	2.43	LOWER QUARTILE	1.50
MEDIAN	2.50	MEDIAN	1.80
UPPER QUARTILE	2.80	UPPER QUARTILE	2.20
MAXIMUM	3.50	MAXIMUM	3.00
MEAN	2.57	MEAN	1.86
STD. DEVIATION	0.35	STD. DEVIATION	0.51
N	37	N	30
MISSING	9	MISSING	16

STOCK RETURNS (S&P 500)		BOND RETURNS (10-YEAR)		BILL RETURNS (3-MONTH)	
MINIMUM	4.00	MINIMUM	1.90	MINIMUM	0.50
LOWER QUARTILE	5.05	LOWER QUARTILE	2.75	LOWER QUARTILE	1.80
MEDIAN	6.13	MEDIAN	3.83	MEDIAN	2.40
UPPER QUARTILE	6.95	UPPER QUARTILE	4.30	UPPER QUARTILE	2.85
MAXIMUM	10.00	MAXIMUM	7.00	MAXIMUM	4.25
MEAN	6.15	MEAN	3.70	MEAN	2.46
STD. DEVIATION	1.58	STD. DEVIATION	1.32	STD. DEVIATION	0.98
N	24	N	26	N	25
MISSING	22	MISSING	20	MISSING	21

SOURCE: RESEARCH DEPARTMENT, FEDERAL RESERVE BANK OF PHILADELPHIA.
SURVEY OF PROFESSIONAL FORECASTERS, FIRST QUARTER 2013.

San Diego's Water Sources: Assessing the Options

Sponsored and published by the **Equinox Center**
Researched and produced by the **Fermanian Business & Economic Institute**

July 2010

EQUINOX CENTER

Healthy Environment

Strong Economy

Vibrant Communities

Equinox Center is pleased to partner with the Fermanian Business and Economic Institute (FBEI) to present groundbreaking, independent research on San Diego County's water supply options. Our region's imported water supply is increasingly vulnerable due to structural, environmental and legal issues and is rapidly escalating in cost. This is creating a sense of urgency to develop more local, reliable and sustainable sources of water.

"San Diego's Water Sources: Assessing the Options" is the initial publication of Equinox Center's H2Overview Project, which will provide balanced, easy-to-understand research on San Diego County's water supply to help inform the decision-making process. The Fermanian Business and Economic Institute provides a sharp and thorough economic analysis and offers a new lens with which to view our different water sources.

As the region adds 750,000 more people in the next 20 years, it is important to prepare today for the difficult decisions our region faces to properly steward our water resources well into the future. We thank the many experts that were consulted during this process for their assistance in producing this research.

About Equinox Center

To ensure a healthy environment, vibrant communities and a strong economy for the San Diego Region, Equinox Center researches and advances innovative solutions to balance regional growth with our finite natural resources. We are proponents for our region's responsible growth and we support the conscientious care-taking of the natural and economic assets that we have inherited.

www.equinoxcenter.org
(760) 230-2960

LETTER TO THE READER

The Fermanian Business & Economic Institute of PLNU

The Fermanian Business & Economic Institute is pleased to present its original research report, San Diego's Water Sources: Assessing the Options. Sponsored and published by the Equinox Center, our intention is to provide to the San Diego community a document that is in keeping with the highest levels of economic research, econometrics, modeling and analysis and yet present it in a highly readable format accessible to the widest possible audience. We have carefully considered the key issues related to the pressures associated with water as a scarce resource demanded by a growing regional population and attempted to research and address them so that all stakeholders have the information to make the critical decisions that will enhance our community and region. At the Fermanian Business & Economic Institute this is what we refer to as "actionable economics." We are grateful to the Equinox Center for its vital leadership on water issues, and look forward to additional opportunities to serve our community.

Randy M. Ataide, J.D.
Executive Director

About the Fermanian Business & Economic Institute

The Fermanian Business & Economic Institute (FBEI) is a strategic unit of Point Loma Nazarene University, providing the following services:

> Economic forecasting and events
> Expert business and economic commentary and speeches
> Professional and executive development events
> Business and economic roundtables
> Economic consulting and related services
> Economic studies and research
> Special projects

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EXECUTIVE SUMMARY

> Water is likely to be the most critical resource challenge that the San Diego region will face during the next two decades as it strives to achieve sustainable growth.

> Economic and environmental factors suggest that dependence on imports for the bulk of San Diego County's water is neither optimal nor sustainable. While imported water is likely to remain an important source for the region for some time, diversification into other sources will be necessary.

> Seven primary sources exist to address San Diego County's water demands: imported water, surface water, goundwater, desalinated sea water, recycled non-potable water, recycled potable water, and conservation.

> Imports from the Sacramento-San Joaquin River Delta and the Colorado River currently account for nearly 80% of San Diego County's water supply. Recycled water, only for non-potable purposes, meets about 4% of the region's demand. Desalinated sea water is not presently a source, although a desalination plant is expected to be completed in Carlsbad by 2012.

> Marginal cost estimates vary widely, but current estimates put the cost of desalinated sea water as the

Marginal Costs and Energy Intensity of San Diego County's Water Alternatives, 2010e

		Imported	Surface Water	Groundwater	Desalinated	Recycled Non-potable	Recycled Potable	Conservation
Marginal Cost	low	875	400	375	1,800	1,600	1,200	150
($/acre foot)	high	975	800	1,100	2,800	2,600	1,800	1,000
Energy Intensity	low	2,000	500	400	4,100	600	1,500	negligible
(kWh/acre foot)	high	3,300	1,000	1,200	5,100	1,000	2,000	

e=estimated range

Source: FBEI

highest cost option at about $1,800 to $2,800 per acre foot. The cost of retrofitting the water infrastructure to a dual-pipe system also puts the estimated cost of recycled non-potable water at a relatively high level. While converting recycled water to potable levels entails additional treatment costs, the ability to use the existing water distribution system results in a somewhat more moderate marginal cost. In contrast, conservation carries a low marginal cost of $150 to $1,000 per acre foot. Surface and groundwater also have comparatively low costs, but they do not have the capacity to serve as major sources for San Diego County's water requirements.

> Concerns about the availability and cost of energy, as well as greenhouse gas emissions, make energy intensity a key issue in assessing the different water options. Desalination is the most energy intense solution, with an estimated requirement of 4,100 to 5,100 (kilowatt hours) per acre foot. In contrast, the energy intensity of recycled non-potable water is comparatively low at 600 to 1,000 kWh per acre foot. Direct energy costs for conservation are considered negligible.

> Legal, regulatory, technical, health, social, and environmental factors also are important to assessing the optimal mix of water options for San Diego County. The report presents a matrix ranking the alternatives across these various dimensions.

> Assessing marginal dollar cost, energy intensity, and the array of other major factors yields an overall ranking of the seven water alternatives. On a scale of 1 to 5, where 5 represents the most favorable/lowest-cost option, imported water and sea water desalination carry the lowest scores at 2.6 and 2.7, respectively.

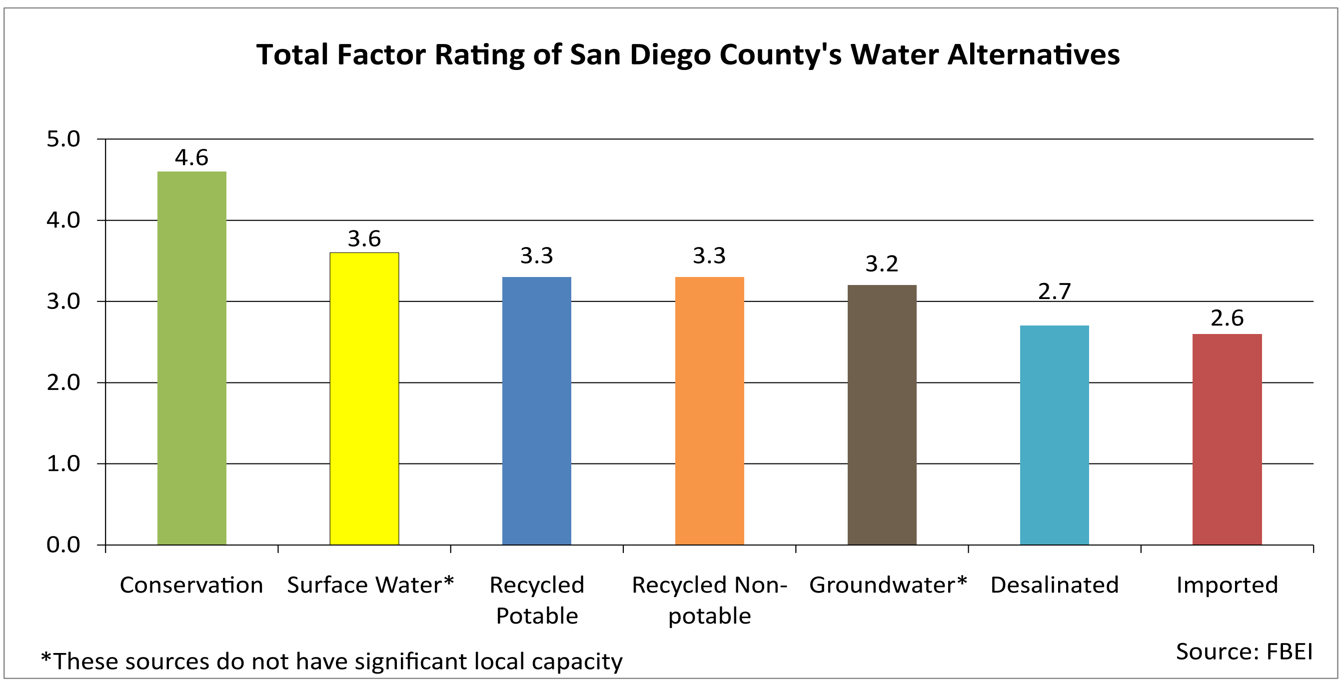
> Surface water and groundwater have relatively favorable scores of 3.6 and 3.2, respectively. However,

neither source has the capacity to supply a substantial proportion of the region's water supply over time.

> Recycled non-potable and potable water carry moderately attractive scores of 3.3 each. At $2 million/mile, the cost of the dual-pipe system poses the largest constraint to non-potable recycled water. Requirements that new residential construction incorporate dual-piping systems could help make the use of recycled non-potable water more feasible over time and locating satellite water recycling plants close to users could also help reduce water transportation costs. Public concerns over the safety of potable water pose the greatest challenge to that source, although public opinion appears to be shifting to more support.

> Conservation currently is and will remain the most favorable and least costly option over the next two decades. It carries a rating of 4.6. However, the extent to which conservation can reduce the region's water consumption as the population continues to grow over the next 20 years remains to be determined.

> These findings suggest that solving San Diego County's water challenge may also rest significantly on the demand side. Pricing water closer to its true marginal cost will be necessary to ration this most valuable and scarce resource.



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INTRODUCTION

Water is the world's most valuable commodity (*The Economist*, May 22nd-28th, 2010). As the pressures of a growing population clash with a limited resource and concerns about energy usage and the environment, it is vital that San Diego County plan strategically for its water future. Considering economic costs, energy intensity, legal, technical, social and other factors, what options should the region pursue to meet its future water demands? This report presents an analytical framework to address those questions and provides its conclusions on the optimal approach.

REPORT STRUCTURE AND METHODOLOGY

The first part of this report examines the current marginal costs of the different present or possible water sources for San Diego County. Projections for 2020 and 2030 are provided to shed light on how the relative costs of the various energy sources may change during the next ten and twenty years.

The second section analyzes the energy intensity of the different sources both to capture the impact on energy supplies and the magnitude of the "carbon footprint." The third section follows a less quantitative approach but analyzes the feasibility of the different water solutions based on legal, technical, safety, social, environmental, and other factors. The report ends with a section summarizing the rankings of the various water supply options according to these various criteria and concludes with recommendations for San Diego's water policy.

Estimates of marginal costs, energy intensity, and other factors were based on inputs from a number of different studies and water authorities from within San Diego County and elsewhere. (See Sources and References at the end of this report.) These estimates vary widely; the authors of this report used their best judgment based on the current state of knowledge in the field and projections of various economic and financial factors. Attention was paid to ensure that definitions of various concepts, such as marginal cost and energy intensity, were treated consistently across the different water source options. In most cases, estimates and forecasts are presented as ranges to portray the considerable uncertainty surrounding these issues and the different conditions that exist in the various local jurisdictions of San Diego County.

SAN DIEGO COUNTY'S WATER SUPPLY OPTIONS

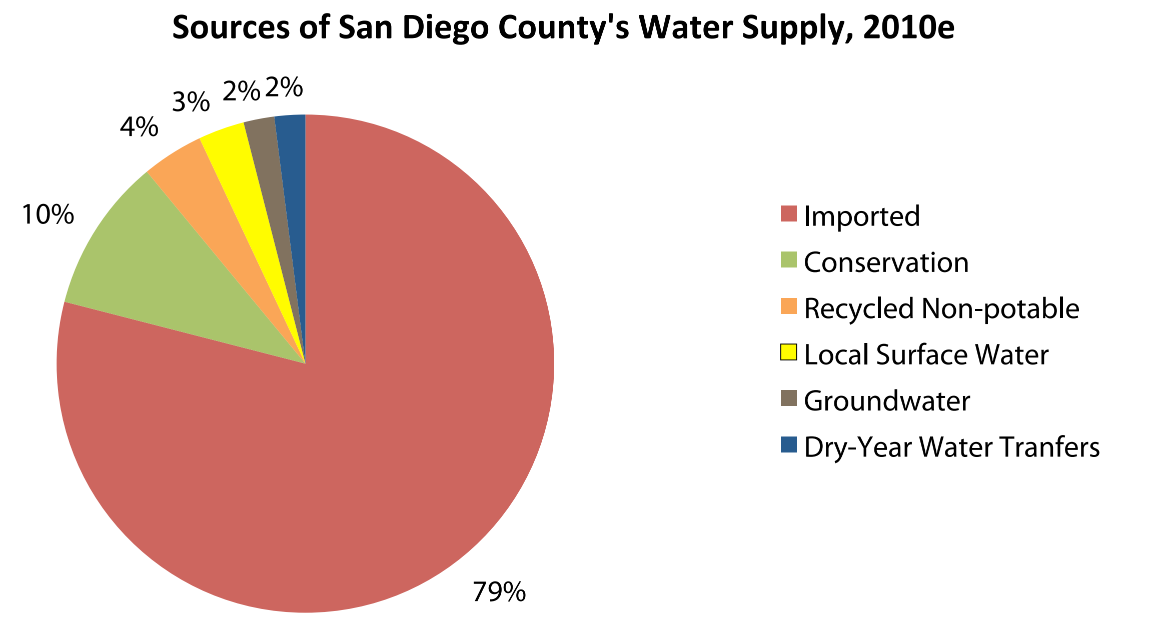
Seven solutions to meet the water demands of San Diego County are examined.

Imported Water: Water from other areas can be imported into the region if available. Currently, San Diego County receives about 80% of its water supply from this source. (See Chart 1.) In 1991, 95% of the region's water was imported. About two-thirds of San Diego County's current imports come from the Sacramento-San Joaquin River Delta; the remainder comes from the Colorado River.

Surface Water: Surface water refers to water accumulated in local streams, rivers, and lakes from precipitation in various watersheds throughout San Diego County. It will represent about 3% of the region's total water supply in 2010. Drought conditions in recent years have reduced the contribution of surface water from a more typical 5% share. Two percent of this year's total water consumption will represent "dry-year transfers," refering to water brought in from substitute sources outside the region.

Groundwater: Groundwater is water located beneath the ground surface in soil pore spaces and in the fractures of rock formations. Some of it only requires that certain minerals be extracted to obtain potable water of desired standards, while other is brackish, requiring desalination. Groundwater currently accounts for about 2% of San Diego County's water supply.

Chart 1



e=estimate

Sources: San Diego County Water Authority; FBEI

Desalinated Sea Water: Potable water can be extracted from sea water as implemented in several facilities in North America. However, this is currently not a water source in this region. In San Diego County, a water desalination plant was approved in 2009 for Carlsbad, with completion set for 2012.

Recycled Water, Non-Potable: Wastewater can be recycled, partially treated, and used for landscaping, industrial, and other uses. Currently, San Diego County relies on this source for about 4% of its total water supply.

Recycled Water, Potable: Recycled water can be treated to potable levels, although this is currently not being done in San Diego County. With advanced treatment, recycled water can be added to existing water supplies in either underground basins ("goundwater recharge") or to open reservoirs. This is referred to as Indirect Potable Reuse, or IPR.

Conservation: Conservation, achieved by using less water or by using water more efficiently, is another option to meet San Diego County's water challenge. Currently, conservation has been able to replace about 10% of the region's potential demand.

WATER MARGINAL COSTS

This section analyzes the marginal costs of the seven alternative water solutions as of 2010. (See Table 1a and Chart 2.) Marginal cost is the cost of producing an additional acre foot of water (the volume of one acre of water that is one foot deep) and includes both operating costs and amortized fixed capital costs. Subsidies are not included. Operating costs encompass various expenses involved in the extraction, treatment, transportation, and distribution of water. The allocation of fixed capital costs represents both the investment in infrastructure and financing costs over time. The ranges indicated below allow for significant variation that may exist in different areas of San Diego County arising from, among other factors, variations in distance from water sources and treatment facilities.

Imported Water: Imported water currently carries a marginal cost with a range of $875 to $975 per acre foot. This reflects a marginal cost of about $535 per acre foot for untreated water from different sources, $215 for treatment, and $175 for other expenses, including transportation, storage, customer service, and the amortized costs of expanding conveyance capacity. The total represents primarily the wholesale cost the Metropolitan Water District charges the San Diego County Water Authority, which in turn is passed on to the 24 water districts in the San Diego region.

Table 1a

Marginal Costs and Energy Intensity of San Diego County's Water Alternatives, 2010e

		Imported	Surface Water	Groundwater	Desalinated	Recycled Non-potable	Recycled Potable	Conservation
Marginal Cost	low	875	400	375	1,800	1,600	1,200	150
($/acre foot)	high	975	800	1,100	2,800	2,600	1,800	1,000
Energy Intensity	low	2,000	500	400	4,100	600	1,500	negligible
(kWh/acre foot)	high	3,300	1,000	1,200	5,100	1,000	2,000	

e=estimated range

Source: FBEI

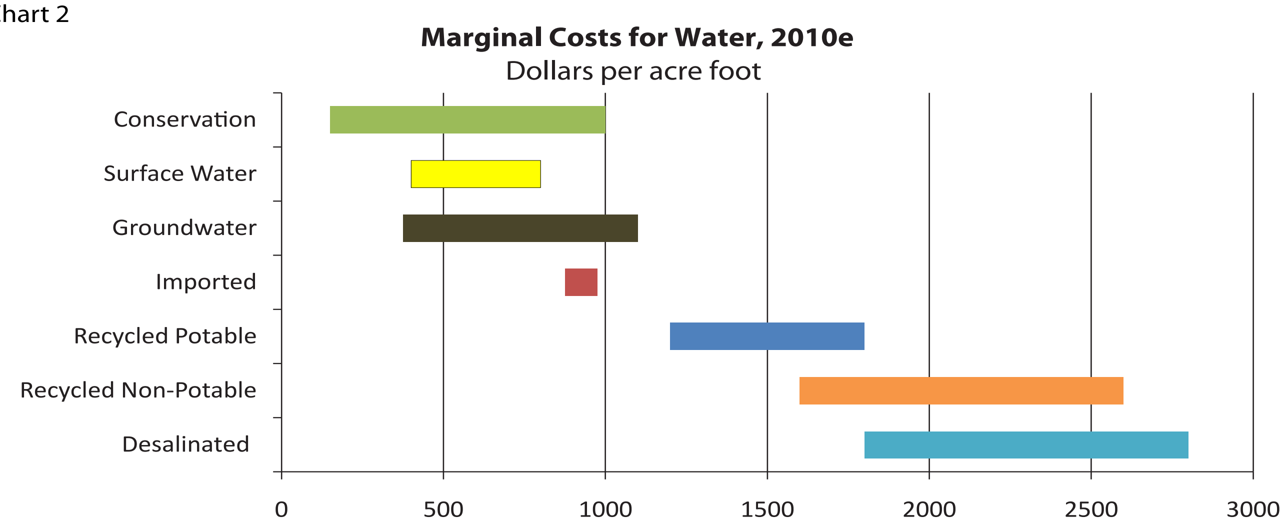
Surface Water: Surface water has a marginal cost estimated to range between $400 and $800 per acre foot. This represents treatment, pumping, distribution, and reservoir costs. Reservoir expenses encompass payments to the state for river usage rights and dam safety, brush clearance, habitat restoration, dikes to prevent contamination from diesel fuel and other elements, and dam improvements over time. The low and high ends of the range represent primarily the differences between reservoir water levels in any given year, with pumping costs per unit considerably higher when reservoir levels are low.

Groundwater: Groundwater has a marginal cost that generally ranges from about $375 to $1,100 per acre foot. Much of the cost and variation reflect differences in required treatment methods to bring the water to potable standards. Fresh water may only need to be disinfected (usually with chloramines) and can have a lower cost than surface water which may require more treatment. This is the case for some of the less expensive water supply available, for example, from the Sweetwater Authority. Demineralization, however, may be required to remove iron and manganese. Where water is brackish, reverse osmosis is necessary along with disposal costs of the brine. Distribution and transportation expense of the water to and from the treatment facility also adds both to the total cost and its variability across the region.

Desalinated Sea Water: Desalinated sea water has a marginal cost ranging from about $1,800 to $2,800 per acre foot. Although advances in technology have helped reduce the cost of desalination over the past 15 years, the high energy requirements of this source make it the most expensive of the seven energy alternatives investigated in this report. A significant part of the cost and variability in costs of this option reflects the distances that sea water and potable water must be moved. For example, if a desalination plant is connected with a power plant, it can use the outflow from the once-through cooling system of the power plant to dilute the salty brine from the desalination plant before it is discharged back to the ocean. Where dilutants for the brine need to be brought to the plant, costs are substantially higher. It should be noted that California's State Water Resources Control Board voted in May 2010 to phase out once-through cooling systems, where ocean water is cycled through the plant and then returned to the sea, because of envirnomental concerns.

The choice of intake systems is also significant in terms of both the potential environmental impact and marginal cost. Large sea water desalination plants have typically used open sea, surface water intake systems, which can trap marine organisms in the intake screens. Subsurface intake systems, involving horizontal or vertical beach wells, infiltration galleries, or seabed filtration, can eliminate much of the impact on marine life, although costs will generally be higher than those associated with open sea, surface water arrangements. Such a design to mitigate ecological damage is being incorporated in a new plant in Adelaide, Australia, and is being considered for the proposed Camp Pendleton Desalination Project.

Chart 2



e=estimated range

Source: FBEI

Recycled Water, Non-Potable: Recycled, non-potable water carries a marginal cost estimated at $1,600 to $2,600 per acre foot for the San Diego region. The size and variation of the cost of recycled non-potable water depend on the quality of the wastewater received, the standards required by the end users (such as with varying degrees of health concerns), the cost of treatment, and the distance between the recycling facility and potential users. Although there is a large supply of wastewater available for recycling, the capital costs required to install new distribution systems in San Diego County make the marginal cost of this source relatively high. Recycled water that is not treated to potable levels must be conveyed in a separate pipe system ("purple pipes") labeled and readily distinguished from traditional water lines.

In Orange County, the ability to install the necessary pipes as new communities were initially built in the Irvine Ranch Water District has helped to contain the cost of recycled water. About 25% of this district's water supply represents recycled water. The capital costs of retrofitting much of San Diego County's water system with new piping systems would be substantial, with it costing about $2 million per mile to install these pipes. Dual-piping systems (accommodating potable and non-potable water) could be installed at much lower costs at the beginning of new property developments. Currently, the Olivenhain Water District supplies about two million gallons per day of non-potable recycled water for irrigation to several cities in North San Diego County.

Last November, California's Building Standards Commission adopted a dual-plumbing code for the state. This should help clarify the requirements for installing potable and non-potable systems in commercial, retail, office, hotel, apartment, educational, and other facilities.

Recycled Water, Potable: Recycled potable water has a marginal cost estimated at about $1,200 to $1,800 per acre foot. Although the cost of treatment to potable levels adds about 10% to 15% to the cost of non-potable recycled water, the expense of conveying recycled potable water for reservoir augmentation is less than that required to construct an entirely separate system for distribution to customers as required for non-potable systems. Conveyance costs are still a factor for this source. In the specific case of reservoir augmentation at San Vicente Dam, a large pipeline would need to be constructed to transport the water to the reservoir and pumping costs would also be considerable. For other projects that have a closer source of recycled water or that are injecting recycled water into groundwater aquifers, such as is the case with the Helix Water District's proposed project, the conveyance costs would be significantly less.

Conservation: Conservation programs carry a current marginal cost of about $150 to $1,000 per acre foot. This measure reflects the estimated expenditures on educational initiative or subsidies to promote conservation divided by the cumulative water savings of the programs. For example, the marginal cost of a program to achieve greater water efficiency of dishwashers would be calculated as the total expenditures on rebates divided by the total water savings of the dishwashers over their lifetimes. Information on or distribution of water-efficient plants for landscaping represents a lower cost option. Mandatory restrictions have also been used, with their marginal cost reflecting the expense of publicizing and enforcing the restrictions.

Marginal Costs: 2020 and 2030

Table 1b

Marginal Cost Forecasts, 2020 and 2030

Constant 2010 dollars

		Imported	Surface Water	Groundwater	Desalinated	Recycled Non-potable	Recycled Potable	Conservation
Marginal Cost	low	1,479	600	530	3,391	2,861	1,929	336
($/acre foot), 2020	high	2,079	1,200	1,600	4,391	3,661	2,729	1,136
Marginal Cost	low	2,839	875	900	4,988	4,327	3,048	608
($/acre foot), 2030	high	3,839	1,750	2,500	5,988	5,327	3,848	1,508

e=estimated range

Source: FBEI

Based on the estimated path of energy costs, labor, interest rates, water demands from competing users, and other factors, marginal costs for the seven different water alternatives were projected for the next ten and twenty years for the San Diego region. These numbers are presented in terms of 2010 dollars. (See Table 1b, Chart 3, and Chart 4.)

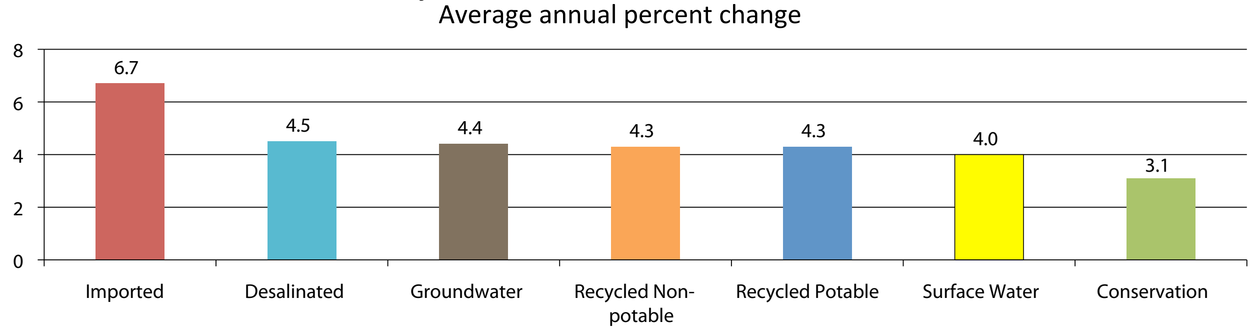
Although the relative cost rankings of the different sources do not change (with desalinated sea water still the most costly option and conservation the least expensive), there is some change in the relative dispersion of costs across the alternatives. In particular, by 2030, the marginal cost of recycled potable water could be competitive with that of imported water.

The cost of imported water is projected to rise at a real (in addition to inflation) rate averaging 6.7% over the next twenty years. The ongoing growth of California's population will continue to press supplies available from the Sacramento-San Joaquin River Delta, while continued rights to supplies from the Colorado River are challenged.

Chart 3

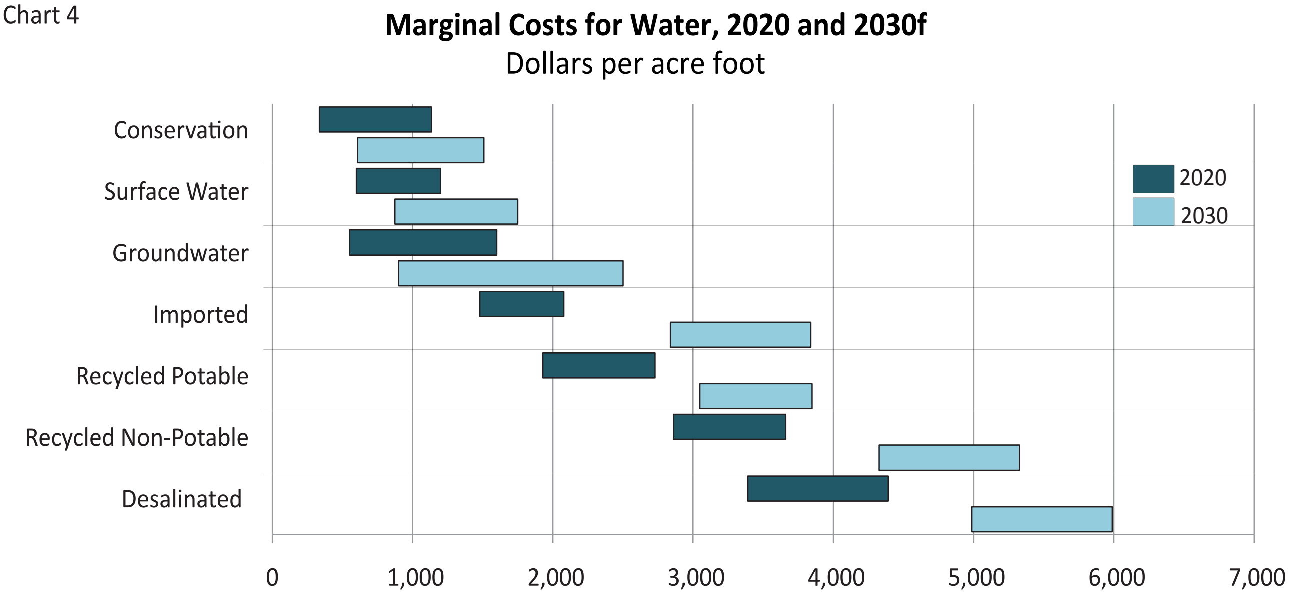
Projected Real Cost Increases, 2010-2030

Average annual percent change



Source: FBEI

Chart 4



f=forecasted range

Source: FBEI

The costs of labor, amortized expense of dam building and repair, and energy costs for pumping and treatment are forecast to push the cost of surface water up at an average rate of 4.0% over the next twenty years. Depletion of fresh goundwater could drive the cost of that source up at an average annual rate of 4.4% in the period through 2020, with greater pumping and treatment requirements.

The cost of desalinated water is forecast to rise at a relatively rapid real rate averaging 4.5% over the time period to 2030. Although technological advances could lower capital and operating costs, interest and energy expenses are expected to drive costs up at a significant pace.

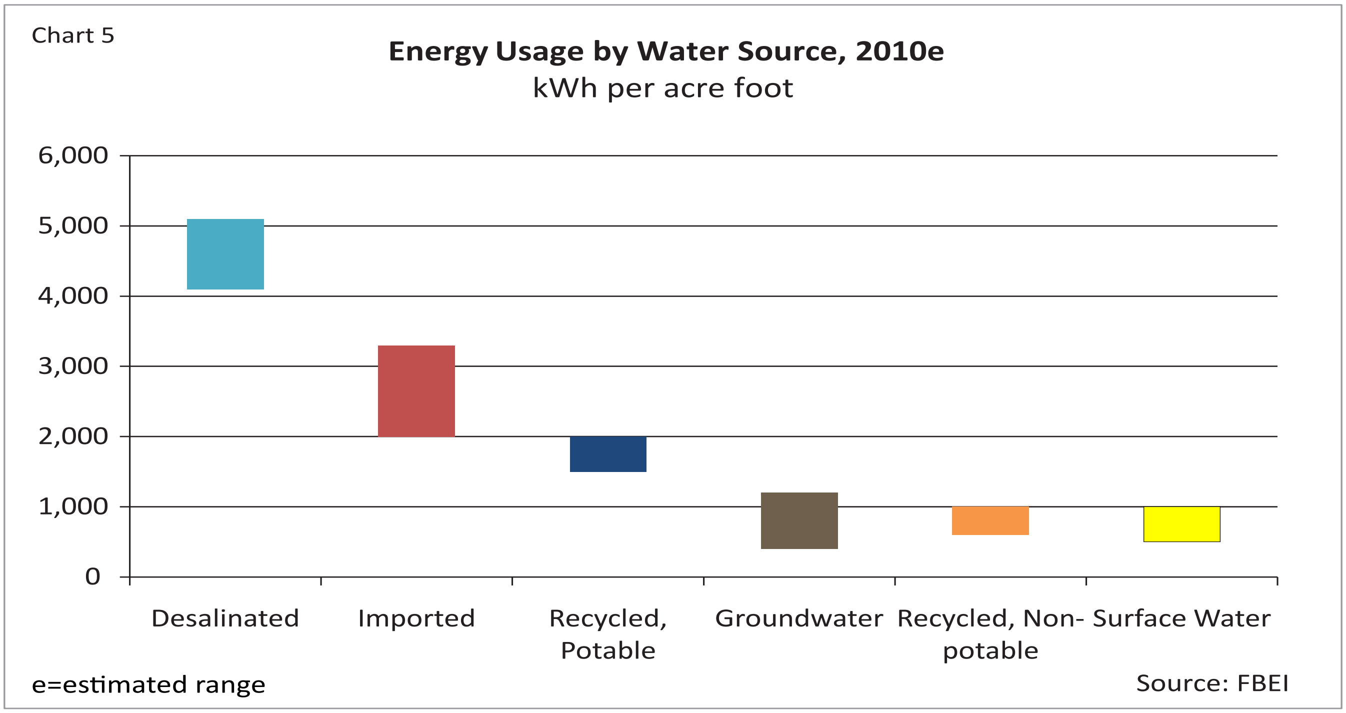
The cost of recycled, potable and non-potable water is expected to increase at a 4.3% pace in real terms on average over the next twenty years. Although energy costs can be expected to continue to rise at a considerable pace, the cost increases could moderate in the second half of the twenty-year period if most of the infrastructure building and retrofitting was done earlier in the period.

The marginal cost of conservation programs is projected to rise at a 3.1% real pace over the twenty-year period. Although new technologies could enhance water saving efforts, conservation programs could start to run into diminishing returns over the next two decades as the easiest and least costly options for water users are implemented.

ENERGY INTENSITY

According to a California Energy Commission 2005 report, water-related energy consumption accounts for nearly one-fifth of the state's total electricity usage. Energy usage for water is important to understand not only because of the implications for the state's total energy demands but also because of the implications for greenhouse gas emissions and the climate goals of the region. Estimates of the energy intensity of the different water alternatives are analyzed in this section in terms of kilowatt hours (kWh) per acre foot for 2010. (See Chart 5 and Table 1a.)

Imported Water: Imported water is quite energy intensive, requiring approximately 2,000 to 3,300 kWh per acre foot. Considerable transporatation costs keep this as a high-energy alternative.



Surface Water: In contrast, the energy requirements of surface water are considerably lower, with a range of 500 kWh to 1,000 kWh per acre foot because of lower transportation and distribution requirements. Pumping accounts for most of the energy requirements from this water source, with treatment, transportation, and distribution responsible for the remainder.

Groundwater: The contrast of pumping fresh water to the requirements of possible demineralization and reverse osmosis take the energy range of goundwater from about 400 to 1,200 kWh per acre foot. The higher end of the range represents the energy demands from treating brackish water.

Desalinated Sea Water: Desalinated sea water carries the highest energy cost at 4,100 to 5,100 kWh per acre foot. Transportation costs and the plant energy costs involved in converting saltwater to potable water drive up the total. As noted above, "co-locating" a desalination plant with a power plant can eliminate the conveyance costs of water needed to dilute the brine, although the banning of "once-through" cooling systems could limit that advantage. Other transportation costs plus the energy intensity of the desalination process result in this water source being a high user of energy with a large "carbon footprint."

Recycled Water, Non-Potable: Recycled, non-potable, water is a relatively low energy user at 600 to 1,000 kWh per acre foot. Locating primary or satellite recycling plants relatively close to end users can help keep energy costs at the lower end of this range.

Recycled Water, Potable: Recycled potable water requires considerably more energy than its non-potable sibling because of the transportation costs necessary to convey the treated water to a storage reservoir, if this is the chosen treatment strategy. Energy costs for this source are estimated at 1,500 to 2,000 kWh per acre foot. Where significant pumping is required, such as is the case with the San Vicente Reservoir, energy expenditures could be substantial. The extent of treatment costs necessary to achieve desired quality standards for potability also adds to energy requirements.

Conservation: Conservation has no direct energy costs, although the manufacturing process of producing various energy-saving devices entails some energy usage. For the purposes of this study, the energy consumed by conservation is considered to be negligible.

OTHER FACTORS

In addition to marginal cost and energy considerations, a number of other factors are important in assessing the feasibility and desirability of different water solutions. This section discusses those factors, assessing them both as they exist currently and are expected to develop over the next twenty years. Table 2 presents a matrix which scores the seven water options on a scale of 1 (least favorable or highest cost) to 5 (most favorable or lowest cost). A wide range of sources and experts were consulted (see Sources and References) in developing these estimates.

Table 2

Factor Matrix for San Diego County Water Options*

	Conservation	Surface Water	Recyled Potable	Recycled Non-potable	Groundwater	Desalinated	Imported
Marginal Cost	5	4	3	2	4	1	4
Energy Intensity	5	4	3	4	4	1	2
Legal/Regulatory	5	3	2	3	3	2	2
Technical	4	5	3	2	4	2	3
Health/Safety	5	4	4	3	3	4	3
Social Acceptance	4	5	2	3	4	3	4
Environment	5	3	4	4	3	2	1
Availability	4	2	5	5	2	5	3
Reliability	4	2	4	4	2	4	1
Average	**4.6**	**3.6**	**3.3**	**3.3**	**3.2**	**2.7**	**2.6**

*Scale of 1 to 5, with 5 representing the most favorable/lowest cost

Source: FBEI

Legal and Regulatory: Water projects and solutions fall under the jurisdiction of local, state, and/or federal laws. Permit processes can often be lengthy with a number of legal challenges following. Desalinated sea water facilities face relatively high legal and regulatory constraints. For example, the Carlsbad desalination plant required 11 years of litigation and negotiation before the permit was received in 2009. Lawsuits have continued into 2010. Imported water also faces many legal hurdles in the period ahead as various parties dispute the rights to water from the Sacramento-San Joaquin River Delta and the Colorado River. Recycled potable water will be regulated by rigid health standards. Recycled non-potable, goundwater, and surface water are expected to face moderate legal and regulatory constraints. Conservation probably faces limited legal issues unless personal rights are disputed in the case of mandatory restrictions.

Technical: Technical factors refer to design or operational elements related to each water source alternative. Technical issues pose both upside and downside risk to some of the water options analyzed in this report. Technological advances could, for example, substantially lower costs over time for desalination and recycling. At the same time, problems can plague various water facilities, particularly as new technologies are applied or projects are moved from small-scale test facilities to large-scale operations. Desalination sea water plants are categorized with relatively high technical costs. For example, the plant in Tampa, Florida, the largest desalination sea water facility in North America, has encountered a number of design and construction problems. Non-potable recycling systems could encounter considerable technical issues. A risk for such systems is the possibility of "cross-connections" or an accidental connecting of potable and non-potable water systems, leading to contamination of potable water. Although the probability of such an event is low, the consequences could be serious.

Potable water recycling technologies also face considerable technical issues, particularly where users require that stringent standards are met, as well as possible contamination events. Imported water could face significant technical challenges in the future as the Sacramento-San Joaquin River Delta could require sophisticated redesign and construction (involving either a canal built above or tunnel below very soft substrata). Other sources face more limited technical challenges. Conservation, for example, may require the development of new technologies to achieve even greater water efficiencies than offered by the current array of available appliances. Technical issues with groundwater will primarily involve future treatment options. The technology involved in the storage and use of surface water is expected to change little in the period ahead.

Health and Safety: While all water alternatives, except conservation, carry some health risk, the extent of water treatment processes put the quality of both desalinated and recycled potable water at comparatively high levels. Recycled non-potable water is not treated to the same level of standards because of its designated applications. Possible contaminants in groundwater, surface water, and from imported sources put them at a moderate level of health and safety risks, although treatment processes generally ensure that they are safe to consume.

Social: Social factors reflect the general public attitude towards different water options based either on confidence in the quality of water or impact on local residents (the "nimby"—"not in my backyard" mentality). Incorporating potable recycled water into the general water supply could face public resistance, although attitudes appear to be changing. A 2009 public opinion poll conducted by the San Diego County Water Authority found that 63% of respondants favor augmenting our potable water supply with recycled water, compared with only 28% who endorsed that approach in 2005. Desalinated water and recycled non-potable water plants could face opposition from local residents over possible concerns related to traffic, safety, or general views of the landscape. The other options face moderate social acceptance. Some consumers may be starting to be concerned over the pollutant discharges that occur in water from the Colorado River and Northern California. In the case of conservation, while many Californians see the need to conserve water, others will need to see a compelling case before they make significant changes in their lifestyles. Groundwater probably faces relatively little public resistance although there could be some concerns over contamination of underground aquifers. Surface water probably ranks highest in terms of social acceptance because of its long history as a community's water source.

Environment: The different water alternatives can affect various aspects of the environment in addition to energy and greenhouse gas emissions. The choice of water solutions can impact wildlife, vegetation, and the general ecosystem. Particularly because of their current and potential impact on various plant and animal species, both sea water desalination and imported water have relatively high environmental costs. The tapping of groundwater supplies could also have some significant effects on the environment. Capturing of surface water has possible environmental implications because of effects on water levels and wildlife habitats. Conservation clearly has the most positive impact on the environment. Recycling (both potable and non-potable) also carries benefits by considerably reducing the amount of untreated or only partially treated effluents that otherwise might be discharged into streams, rivers, and the ocean.

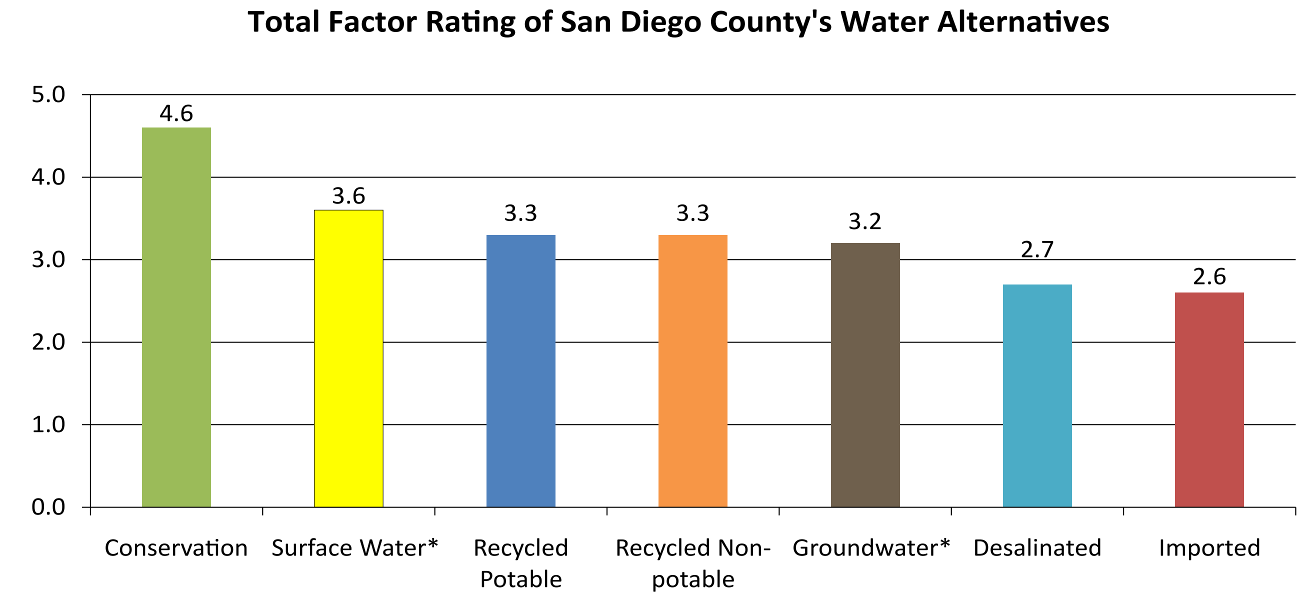
Availability: Availability refers to the amount of water that can be potentially supplied from each source. This factor measures the amount of the raw material resource assuming that the infrastructure to treat and convey it is in place. Availability is included in the scoring matrix because of the potential, or lack thereof, of the various options to play a significant role in meeting San Diego County's water demands. For example, limited supplies of both groundwater and surface water suggest that these sources will each account for only a small percentage of San Diego County's total usage on an ongoing basis. While San Diego County can be expected to continue to import large amounts of water, this source could be significantly constrained over time by global warming, climate change, and less precipitation. Reduced snow accumulations could substantially restrict the supply of water from the Sacramento-San Joaquin River Delta, while the Colorado River also faces reduced flows. In contrast, sea water and recycled water (both potable and non-potable) have abundant sources of supply. Conservation also has significant latitude to achieve changes in water consumption and practices.

Reliability: Reliability refers to the amount of possible volatility in water supply from the various options. Many businesses are concerned about the access to a reliable source of water to run their operations, while individual consumers assume a ready access to water at all times. None of the water sources can be totally guaranteed. Imported water appears to face the greatest risk because of the possibility of drought conditions and natural disasters that would result in sea water intrusion in the Sacramento-San Joaquin River Delta or destroy pipelines and canals either in Northern or Southern California, thus impeding flows to the San Diego area. Groundwater and surface water face significant swings in availability because of changes in weather, climate, and precipitation. Desalination and recycling facilities could face temporary disruptions due to power failures, earthquakes, or technical problems. Even conservation cannot be relied on totally because of the failure of consumers to adhere to water restrictions or to change their behavior substantially. The inability of one single water source or option to be completely reliable argues for the importance of a diversified approach to meeting the region's water demands.

CONSOLIDATING THE RESULTS

Different water districts may have different priorities and resources. The matrix decision tool discussed in the previous section and shown as Table 2 allows policymakers and other interested parties to place different weights on the various factors, such as marginal cost or the environment, as they see appropriate. Using an equal-weighting scheme, where a simple average is taken of the nine different factors analyzed, the following results are produced. (See Chart 6.)

Chart 6



*These sources do not have significant local capacity

Source: FBEI

Conservation appears as the most favorable/lowest cost option, based on this analysis, with a score of 4.6, a number substantially above that of any of the other alternatives.

Surface water has a moderately high score of 3.6. However, as noted above, it can only be counted on for a limited amount of the region's total water supply. Both potable and non-potable recycled water also have moderately favorable scores of 3.3 each. Groundwater's 3.2 score is relatively good, but like surface water, it is likely going to be able to contribute only about 5% to San Diego County's water consumption in a typical year.

Desalinated and imported water are the least favorable/highest cost options, with ratings of 2.7 and 2.6, respectively.

CONCLUSIONS

An analysis of current and projected marginal costs, energy intensity, social, health, legal, environmental, and other factors yields clear differences among the water policy options and directions San Diegan water districts may wish to pursue.

Economic and environmental factors suggest that dependence on imports for about 80% of San Diego County's water is neither optimal nor sustainable. While imported water is likely to remain an important source for the region for some time, diversification into other sources would appear to be necessary. A combination of different sources would be desirable, rather than relying on one approach. The results of this study, however, suggest that some approaches may merit more focus than others.

Although sea water desalination still might play a role in meeting our region's water demands, its high marginal cost and energy intensity, combined with a number of other considerations, render it the least favorable option along with imported water. While groundwater and surface water are moderately attractive alternatives, their limited availability will prohibit them from playing major roles in meeting San Diego County's water demands.

Recycled water, both potable and non-potable, has a moderately favorable ranking after considering the broad array of factors and would appear to have considerable potential in being part of the region's water "portfolio." The biggest constraint facing recycled water treated to potable levels is one of social acceptance. Clearly, to achieve a significantly higher use of potable recycled water a major educational drive would be necessary.

For non-potable purposes, the cost of retrofitting the region with a dual-pipe system to accommodate widespread use of recycled water poses the largest constraint to that source. Locating satellite recycling plants closer to large water users (such as agricultural entities) or to large numbers of households and commercial users could help mitigate some of the considerable transportation and distribution costs of recycled water.

Conservation appears as the most attractive of the seven water solutions analyzed for San Diego County by a wide margin. These findings suggest that solving San Diego County's water challenge may rest significantly on the demand side. For example, previous Equinox Center research revealed that appropriate water pricing (see www.equinoxcenter.org) is one tool that can spur significant water conservation. More research and modeling is needed before we can confidently project the extent to which conservation could reduce the region's demand for water as the population continues to grow over the next twenty years.

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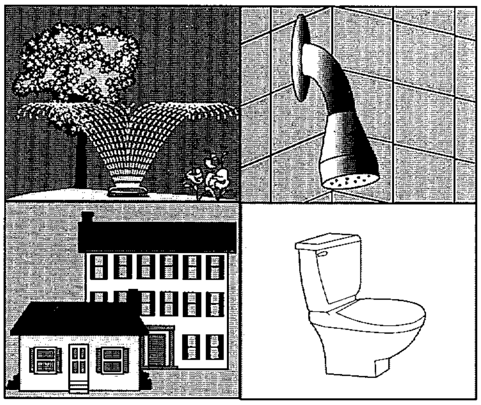
Summary

The Value of Water Supply Reliability:

Results of a Contingent Valuation Survey of Residential Customers



California Urban Water Agencies

Prepared by:
Barakat & Chamberlin, Inc.

August 1994

Summary

THE VALUE OF WATER SUPPLY RELIABILITY:
Results of a Contingent Valuation Survey of Residential Customers

CALIFORNIA URBAN WATER AGENCIES

Participating Agencies:

Alameda County Water District
Contra Costa Water District
Los Angeles Department of Water and Power
Metropolitan Water District of Southern California
Municipal Water District of Orange County
Orange County Water District
San Diego County Water Authority
San Diego Water Utilities Department
San Francisco Public Utilities Commission
Santa Clara Valley Water District

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August 1994

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FOREWORD

California Urban Water Agencies (CUWA) is an organization of the largest urban water providers in California. Its member agencies serve water to metropolitan areas comprising about two-thirds of the state's 32 million population. CUWA was formed to work on water supply issues of common concern to its members. Paramount among these concerns is the reliability of our urban water supplies. Statewide surveys show that California citizens rank water shortages close to crime, taxes, and traffic in listing their concerns about current problems in our society.

CUWA has an ongoing program to improve understanding of all aspects of urban water supply reliability. One important component of planning for supply reliability is being able to estimate the economic impact of water shortages so that an appropriate balance between costs and benefits of water management improvements can be found. CUWA and its member agencies sponsored earlier work on the cost of water shortages in California's manufacturing industries and the urban horticulture industry. However, the largest shortage cost component in some communities is in the residential sector, and this factor has proven difficult to quantify. CUWA and its consultant, Barakat & Chamberlin, Inc., determined that contingent valuation (CV) is the best available method for studying residential water shortage losses, and so undertook this survey—the most comprehensive and informative survey of its type conducted in the urban water supply industry.

This report detailed results of the CV surveys which shows that, on average, California residents are willing to pay $12 to $17 more per month per household on their water bills to avoid the kinds of water shortages which they or their regional neighbors have incurred in recent memory. The statewide magnitude of such additional consumer payments would be well over $1 billion per year. This customer value can be considered in planning for various demand- and supply-related options to meet reliability goals. While environmental and social impacts were not assessed in the CV survey, this report points out that they must be considered in water resource planning. CUWA is planning an additional phase of its Water Supply Reliability Program which will help water managers integrate all aspects of reliability planning.

California Urban Water Agencies

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THE VALUE OF WATER SUPPLY RELIABILITY:
Results of a Contingent Valuation Survey of Residential Customers

Summary

INTRODUCTION

California Urban Water Agencies (CUWA) is conducting ongoing research on issues of water supply reliability. The goal of the CUWA reliability project is to provide the framework and tools with which each water agency can better incorporate reliability issues into its overall resource planning. One of the key pieces of information needed to do this is the *value* that customers place on reliability.

To address this question, CUWA engaged the consulting firm of Barakat & Chamberlin, Inc., to design, conduct, and analyze the results of a *contingent valuation* survey to estimate the value to residential customers of water supply reliability. The survey was conducted within the service areas of ten CUWA member agencies. This summary discusses combined results for the ten participating agencies. The individual results for each agency are included as appendices to the full report.

As will be discussed below, estimates and patterns of willingness to pay (WTP) for increased water supply reliability are remarkably consistent across participating agencies. This consistency supports the integrity of the results and general findings of the study. However, contingent valuation is not an exact science, and dollar figures should be used with caution.

THE CUWA CONTINGENT VALUATION SURVEY

The primary purpose of the CUWA contingent valuation (CV) survey is to estimate the value residential customers place on water supply reliability, specifically how much they are willing to pay to avoid water shortages of varying magnitude and frequency.

The CUWA CV survey asked participants whether they would vote "yes" or "no" in a hypothetical referendum. Participants were told that if a majority votes "yes," water bills would be increased by a designated amount, and there would be no future water shortages; if a majority votes "no," respondents were told that water bills would remain the same as they otherwise would have been, but water shortages of a specified magnitude and frequency would occur. Of course, individual customers differ in their willingness to pay to avoid different shortages.

The survey purposely did not tell customers where additional supply would come from, but rather indicated that it could come from any of a number of different sources. The intent was to avoid responses that were unduly influenced by preferences for or against particular resource types.

The CV questions are preceded by a series of questions that address a number of experiential and attitudinal issues, which help to place the CV questions in context and are also used in the analysis. The actual CV questions include a carefully worded description of the hypothetical "scenario" that will form the basis of a "yes" or "no" vote. The CV questions are followed by several "debriefing" questions that provide information on the reasons why respondents voted as they did. The survey concludes with a series of demographic questions.

Respondents are distributed randomly across a range of shortage scenarios. Shortage magnitudes range from 10% to 50%. Frequencies range from once every 3 years to once every 30 years. Bid amounts range from $1 to $50 increments to monthly water bills.[1]

Magnitudes and frequencies were combined to accomplish three objectives:

- To cover a wide range of shortage severity;
- To present shortage scenarios that would be perceived by respondents as realistic possibilities; and
- To avoid shortage scenarios that are too mild to elicit reliable WTP responses.

There are some critical concerns that are intentionally not addressed by the survey. The amount that some customers are willing to pay to avoid shortages will likely depend on one or more "external" impacts associated with the resource(s) added. These might include environmental or various social impacts. The CUWA Project

[1]Initial bid amounts ranged from $5 to $20. However, the follow-up portion of the double-bounded question accommodated values as low as $1 or as high as $50, if necessary.

Advisory Committee (PAC) and the consultants determined that, in the context of an agency's resource planning process, these issues would be best treated as costs associated with particular resource additions. Pretests and focus groups conducted during the survey design process indicated that, through proper wording of the survey questions, respondents could, in fact, give answers that were not influenced by such matters.

Because of the complexity of a survey of this type, it was decided to use a combination mail/telephone survey. A package of information was mailed to potential respondents. The mail package contained material that explained the purpose of the survey and helped customers understand the impacts of various shortage magnitudes. Interviewers called several days after the mail material was received.

The survey was conducted from August 1993 through February 1994. The total number of completions across all participating agencies was 3,769.

ANALYTICAL APPROACH

As described earlier, the contingent valuation (CV) survey uses the referendum approach. The referendum approach "bounds" the maximum willingness to pay (WTP) by asking the respondent whether he or she would be willing to pay a specified amount. A "yes" response indicates that the respondent would be willing to pay that amount or more, i.e, it gives a lower bound to the maximum WTP; a "no" response gives an upper bound. The mean WTP to avoid particular shortage scenario can be estimated statistically from responses of different residential customers to different shortage descriptions.

An extension of this approach, and one which is more statistically reliable, is the "double-bounded" technique. The CUWA contingent valuation survey asked respondents whether they would pay an additional monthly amount (or bid) to avoid a particular percentage shortage occurring with a specified frequency. A second choice question, whose bid depended on the answer to the first question, was then asked. If the response to the first question was "yes," then the second bid was an amount greater than the first bid, and if it was "no," the second bid was an amount smaller.

The superior statistical efficiency of the "double-bounded" approach makes intuitive sense given that the "double-bounded" approach yields more information than the "single-bounded" approach about each respondent's preferences. The solution to the double-bounded model used maximum likelihood techniques, applying a program that was written in GAUSS, a statistical software package widely used by economists and statisticians.

Specification of the Statistical Model

As described above, many questions pertaining to sociodemographic, attitudinal, and perceptual variables were included in the survey. Responses to many of these questions were included as explanatory variables in the statistical model. By doing this, we can see how these factors affect WTP. Figure S-1 describes the key explanatory variables included in the model.

Two statistical models were estimated. The so-called "detailed" model included all of the key explanatory variables discussed above. A "simplified" model included only those variables that can be obtained from census or agency billing records. These include:

- Age
- Household income
- Education level
- Dwelling type
- Household size

To the extent that this simplified model is statistically valid, it will enable agencies to reestimate willingness to pay in the future without resurveying residential customers.

The approach results in the following expression for the mean WTP for each shortage frequency (FREQ) and magnitude (REDUCE) combination:

$$WTP(REDUCE,FREQ) =$$

$$\frac{\log(1+\exp(\alpha+\beta_1(REDUCE)+\beta_2(FREQ)+\sum\gamma_n X_{mean_n}+\sum\delta_t Z_{prop_t}))}{-\beta_3}$$

Figure S-1
KEY EXPLANATORY VARIABLES

- **Number of years living in area**
- **Household size†**
- **Age†**
- **Income†**
- **Education†**
- **Housing type†**
- **Concern for other public issues**
- **Perception of drought severity**
- **Perception of water shortages as a long-term problem**
- **Awareness of agency mandates to cut back on water use**
- **Home ownership/rental status and water bill responsibility**
- **Amount and type (private or shared) of external landscaping**
- **Population growth preferences**
- **Average residential water rate for respondent's water agency**
- **Northern California or Southern California agency**

†Included in simplified model.

where:

X_{mean} = the mean of those explanatory variables that are not binary (i.e., either zero or one)

Z_{prop} = the proportion of customers for which each of the binary explanatory variables takes on a value of one.

This expression enables us to derive *customer loss functions* that express average customer willingness to pay as a function of shortage magnitude and frequency. Such functions can be a key tool for agency resource planners.

ANALYTICAL RESULTS

Willingness to pay (WTP) can be interpreted as the losses that residential customers incur as a result of particular shortage scenarios. The amount that a customer is willing to pay to avoid an event is a measure of the losses that customer would incur if that event were to occur. Therefore, we refer to these willingness to pay results as a "loss function."

Tables S-1A and S-1B present the mean WTP for the detailed model and the simplified model for each magnitude and frequency of shortage. WTP figures represent increments to monthly water bills.

WTP for the detailed model varies from a low of approximately $11.60/month to avoid either a 10% shortage every 10 years or a 20% shortage once every 30 years, to a high of about $16.90/month to avoid a 50% shortage every 20 years. The results of the simplified model are almost identical to the results of the detailed model. While results for individual agencies do exhibit some differences, the range of WTP estimates is remarkably consistent across all participating agencies.

Table S-1A
MEAN MONTHLY WILLINGNESS TO PAY, DETAILED MODEL
(Additional $/Month)

Shortage (Percent Reduction From Full Service)	Frequency (Occurrences/Years)				
	1/30	1/20	1/10	1/5	1/3
10%			$11.63	$11.98	$12.12
20%	$11.62	$12.33	$13.06		
30%	$13.05	$13.80	$14.57		
40%	$14.56	$15.34	$16.13		
50%	$16.12	$16.92			
Blank cells in the table reflect scenarios that were not part of the survey.					

Table S-1B
MEAN MONTHLY WILLINGNESS TO PAY, SIMPLIFIED MODEL
(Additional $/Month)

Shortage (Percent Reduction From Full Service)	Frequency (Occurrences/Years)				
	1/30	1/20	1/10	1/5	1/3
10%			$11.67	$12.00	$12.14
20%	$11.71	$12.39	$13.08		
30%	$13.13	$13.84	$14.56		
40%	$14.61	$15.35	$16.10		
50%	$16.15	$16.92			
Blank cells in the table reflect scenarios that were not part of the survey.					

The "loss function" is shown graphically in Figure S-2. In examining the tabular and graphical results, two major conclusions can be drawn:

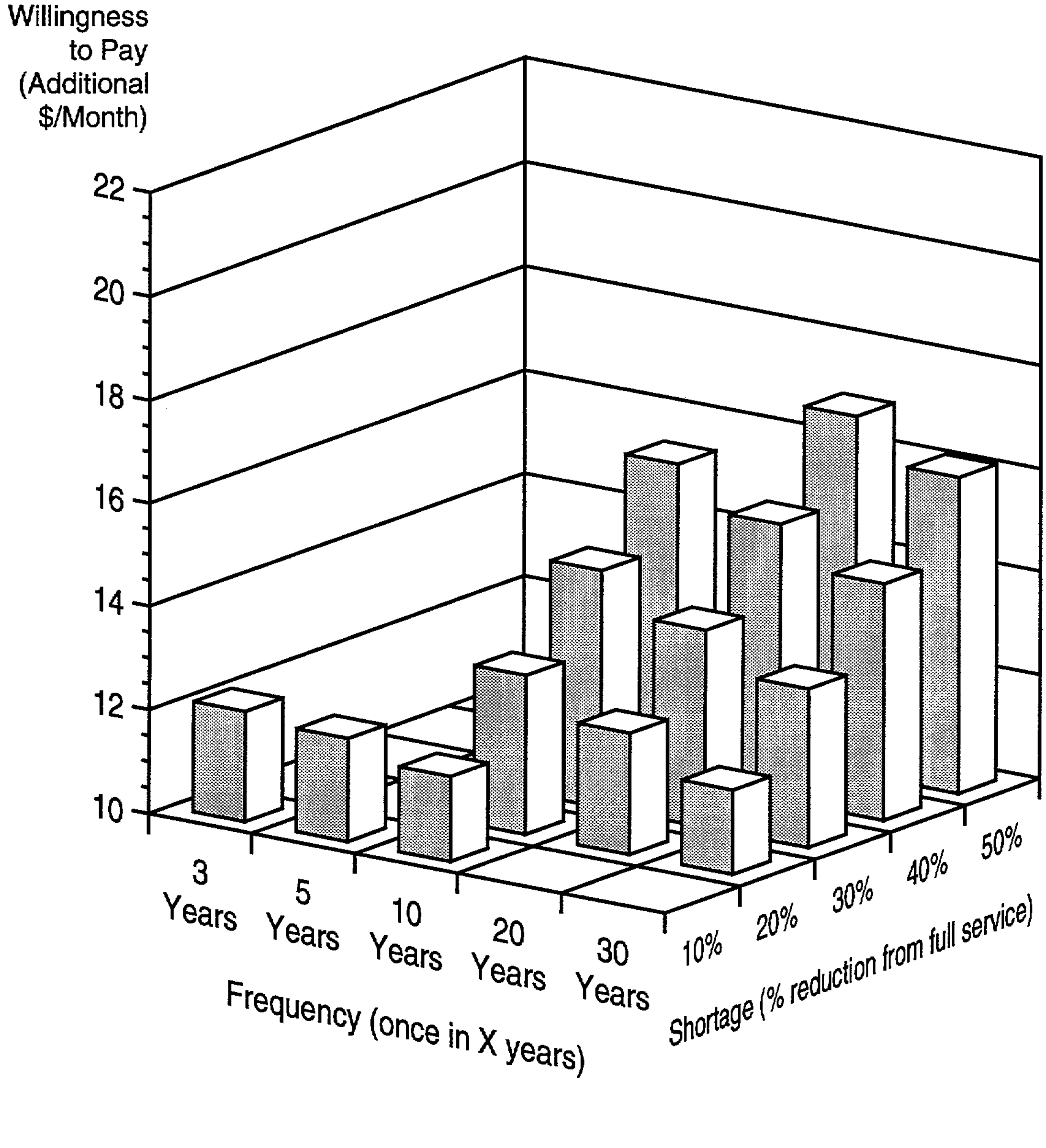
- As expected, respondents are willing to pay more to avoid larger shortages and for shortages that occur with higher frequency. However, the impact of frequency variations is considerably smaller than the impact of shortage magnitude on consumers' responses.

  Put another way, it appears that residential customers believe that infrequent large shortages impose higher losses than more frequent small shortages. This result is also consistent across all of the individual agencies. This type of conclusion may be important to agencies as they plan supply-side or demand-side resource additions and make system operations decisions.

- To avoid even apparently minor shortage scenarios (e.g., 10% once every 10 years), respondents are willing to pay substantial amounts. This type of "threshold" response is not uncommon in surveys of this type and may indicate that respondents regard even a mild shortage scenario as an inconvenience that they want to avoid. They may make a greater distinction between "shortage" and "no shortage" than between different magnitude or frequencies of shortages. Again, this pattern of responses holds for all participating agencies.

Figure S-2

Mean Monthly Willingness to Pay to Avoid Particular Shortage Frequencies and Magnitudes



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Impact of Key Explanatory Variables on Willingness to Pay

As described previously, the statistical model includes many variables that could potentially explain the variation in willingness to pay. For example, the variable "RATE" was included to determine if the average residential rate charged by the respondent's water agency affected WTP. The impact of this variable was not statistically distinguishable from zero. The following discussion selects three explanatory variables that are statistically significant and illustrates their impact on WTP.

Figures S-3 to S-5 show the variation of WTP at various shortage magnitudes when all other variables, other than the one in question, are held constant.

Landscape Area

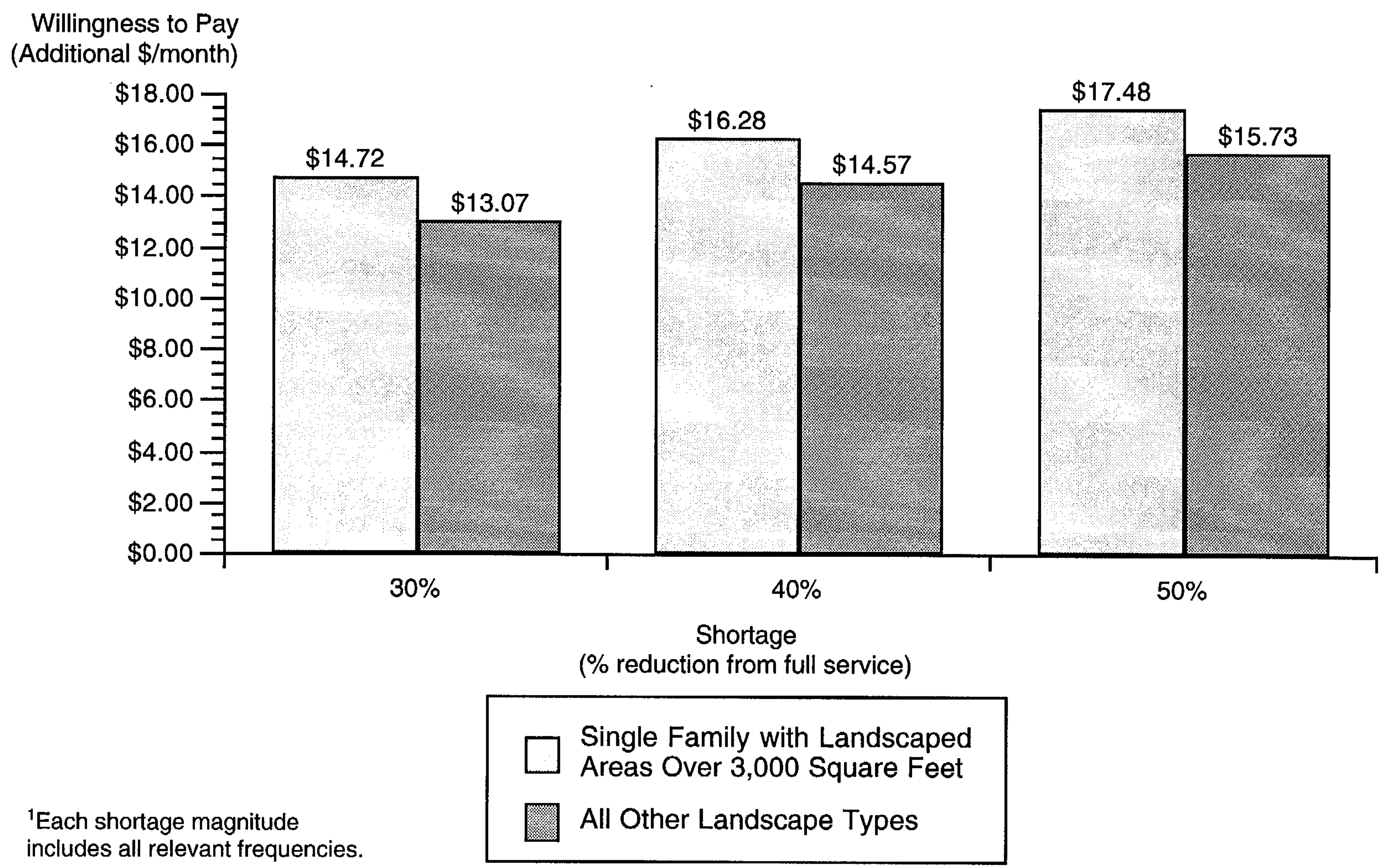
Not unexpectedly, the quantity and type of outdoor landscaping has a statistically significant influence on respondents' willingness to pay to avoid future shortages. Figure S-3 illustrates this by using the variables in the model that capture variations in landscaped area. The results show that respondents who have private lots with landscapes larger than 3,000 square feet have higher WTP than families with other types of landscaping.

Growth Preferences

Another interesting relationship is demonstrated in Figure S-4, which shows the relationship between participant feelings about community growth and their willingness to pay to avoid water shortages. Individuals who indicate a desire for their communities to grow in size have a higher WTP than do people who want their communities to stay the same size or to get smaller. Many in the latter group may perceive a relationship between water resource development and growth and are therefore more likely to prefer enduring more severe and/or frequent water shortages rather than adding to the resource base.

Figure S–3

Effect of Landscape Characteristics on Willingness to Pay[1]



[1]Each shortage magnitude includes all relevant frequencies.

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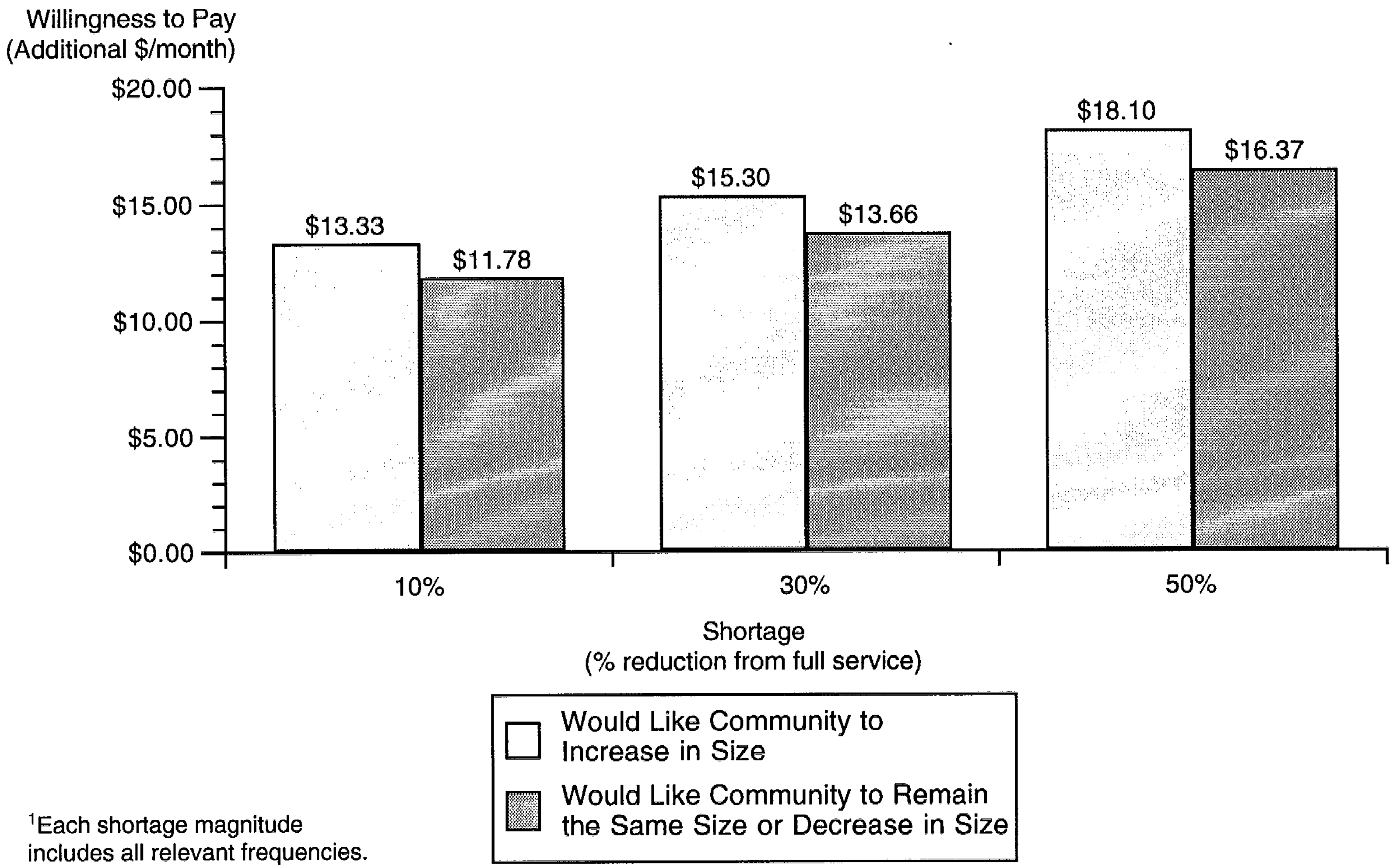
Figure S–4

Effect of Population Growth Preferences on Willingness to Pay[1]



[1]Each shortage magnitude includes all relevant frequencies.

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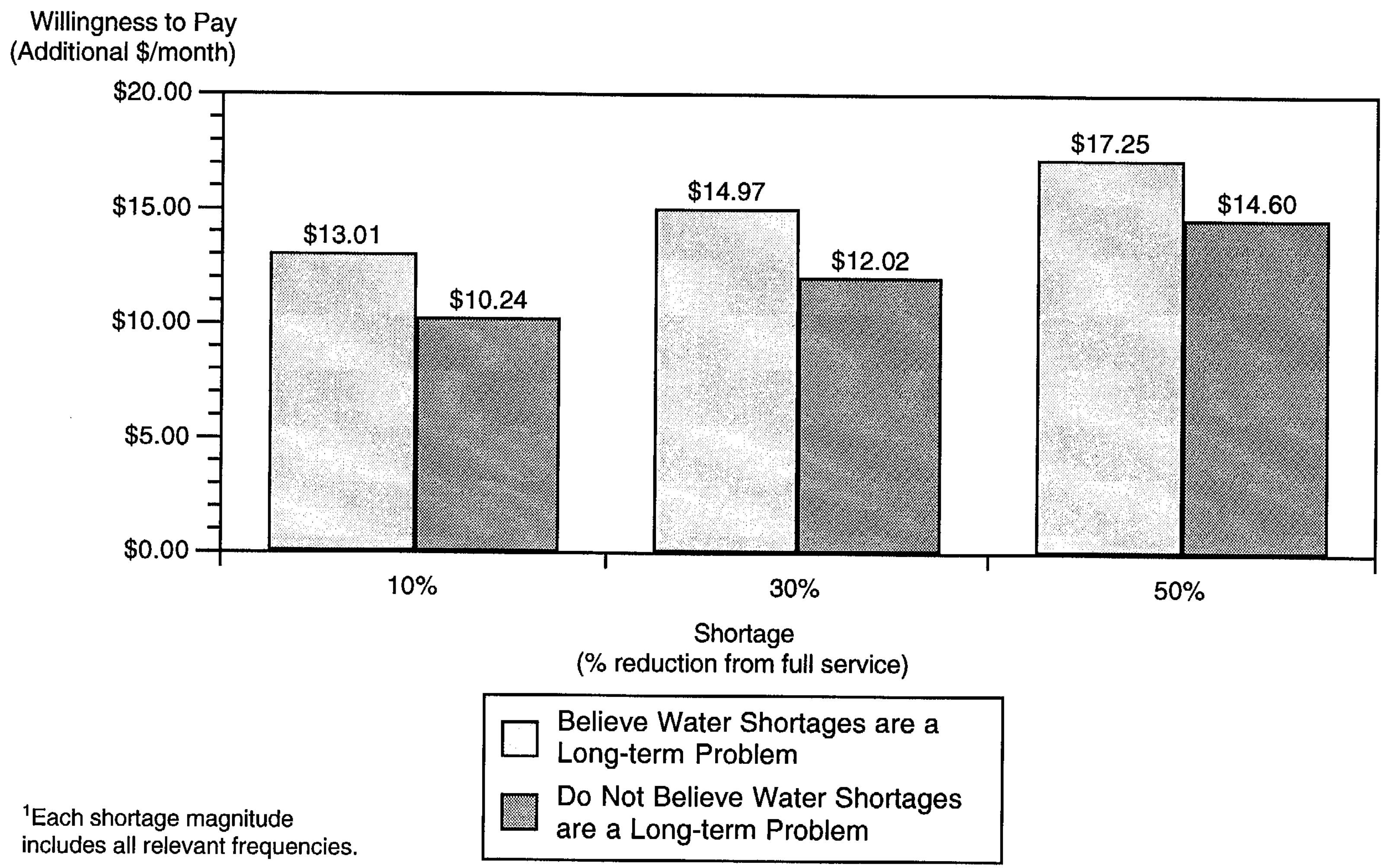
Figure S–5

Effect of Perception of Water Shortages as a Long-term Problem on Willingness to Pay



[1]Each shortage magnitude includes all relevant frequencies.

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Perception of Water Shortages as a Long-Term Problem

Survey respondents were asked to what extent they considered water shortages to be a long-term problem in their area. Those who considered the water shortages to be a long-term problem have higher WTP than those who do not. WTP for these two groups is illustrated in Figure S-5.

Regional Comparisons

An analysis was done to determine whether Northern California respondents had different WTP than Southern California respondents. To isolate the variation that is due to regional differences, a variable NORTH was included in the model.
The variable was set equal to 1 if the respondent was in the service area of:

- Alameda County Water District
- Contra Costa Water District
- San Francisco Public Utilities Commission
- Santa Clara Valley Water District

The variable was set to 0 if the respondent was in the service area of:

- Los Angeles Department of Water and Power
- Metropolitan Water District of Southern California
- Municipal Water District of Orange County
- Orange County Water District
- San Diego County Water Authority
- City of San Diego

Although all Southern California mean values are slightly lower than the corresponding Northern California mean values, the variable "North" was not statistically different from zero.

Separate models were then run for the Northern California and Southern California agencies to determine whether, apart from a difference that could be attributed to living in Northern or Southern California, there were demographic and attitudinal differences that were captured in other model variables and that resulted in different estimates of WTP for the two populations. The results, illustrated in Table S-2, indicate no significant differences in WTP.

Table S-2
MEAN MONTHLY WILLINGNESS TO PAY, BY REGION
(Additional $/Month)

Shortage (% Reduction from Full Service)	Frequency (One Occurrence in X Years)	Northern California	Southern California
10%	10	$12.32	$11.13
10%	5	$12.70	$11.50
10%	3	$12.85	$11.64
20%	30	$12.10	$11.19
20%	20	$12.85	$11.93
20%	10	$13.63	$12.68
30%	30	$13.40	$12.75
30%	20	$14.19	$13.52
30%	10	$14.99	$14.32
40%	30	$14.75	$14.38
40%	20	$15.57	$15.20
40%	10	$16.40	$16.02
50%	30	$16.15	$16.09
50%	20	$16.99	$16.93

The confidence interval for the Southern California model is +/- $0.51; the confidence interval for the Northern California model is +/-$0.63. Except at the 10% shortage magnitude, the differences all fall within the overlapping confidence intervals. Given that the confidence interval is underestimated at that level because there are fewer observations, it is likely that the actual confidence intervals overlap at the 10% shortage as well and that there is therefore no statistically significant difference in WTP between Northern and Southern California respondents.

Water Shortages as a Public Concern

In the survey, respondents were asked to rate the importance of various public problems, including water shortages, as "not at all important," "somewhat important," or "very important." There were three reasons for asking this question:

- To analyze the extent to which concern with any given set of issues (e.g., financial issues) affected willingness to pay.

- To test the perceived importance of water shortages relative to other public issues.

- To see how respondents categorized water shortages. With what other issues are water shortages associated?

Overall, the mean response for each issue is illustrated in Table S-3.

Water shortages fall in the middle of the list of concerns.[2]

The factor analysis showed that respondents grouped issues as illustrated in Table S-4. Water shortages fall into the category that includes issues that can best be described as having public service components. The factors are ranked within each category according to the strength of their rating in the factor analysis.

Each of the four factors was included in the model as a binary variable to test its explanatory impact on WTP.[3] Each of these variables was assigned the value of 1 if the mean value of all of a respondent's ratings for the issues included in that factor exceeded the value assigned to the water shortage issue, and zero otherwise. For the combined CUWA results, the social concerns, quality of life, and financial factors are statistically significant in explaining WTP. Respondents who placed any of those concerns above their concern for water shortages had lower WTP.

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[2]It is possible that had this survey been conducted a year earlier, when the state was still in the grip of a serious drought, water shortages would have been viewed as much more of a concern.

[3]The "public services/environmental" factor included in the model excluded the water shortages variable.

Table S-3
ISSUE RANKING AND MEAN RESPONSE

Issue	Mean Rating	Standard Error
Economy	2.66	.0095
Drug abuse	2.38	.0126
Education	2.35	.0136
Housing costs	2.32	.0122
Taxes	2.31	.0123
Traffic	2.29	.0122
Crime	2.26	.0122
Drinking water quality	2.18	.0138
Water shortages	**2.17**	**.0129**
Air pollution	2.08	.0124
Homelessness	1.98	.0130
Overcrowding	1.92	.0129
Trash disposal	1.88	.0138
Racial issues	1.73	.0126

Table S-4
FACTOR ANALYSIS OF PUBLIC ISSUES

Public Services Concerns	Social Concerns	Quality of Life Concerns	Financial Concerns
Trash disposal	Crime	Overcrowding	Taxes
Education	Racial issues	Traffic	Economy
Water shortages	Drug abuse	Air pollution	
Homelessness			
Drinking water quality			

SUMMARY OF KEY CONCLUSIONS

The important conclusions that can be drawn from the analysis are as follows:

- Monthly willingness to pay higher residential water bills to avoid shortages ranged from \$11.60 to \$16.90. Individual agency results, while exhibiting some variation, are generally consistent with this range.

- As expected, respondents' willingness to pay increases with increasing magnitude and frequency of shortages.

- To avoid even apparently minor shortage scenarios (e.g. 10% once every 10 years), respondents are willing to pay substantial amounts. This type of "threshold" may indicate that respondents regard even a mild shortage scenario as an inconvenience that they want to avoid. They may make a greater distinction between "shortage" and "no shortage" than between different sizes or frequencies of shortages.

- Shortage frequency is not as important a determinant of willingness to pay as shortage magnitude. Residential customers appear to be more willing to tolerate frequent small shortages than infrequent large ones.

- There are no significant differences in willingness to pay between Northern California and Southern California respondents.

- The simplified model has virtually the same predictive power as the detailed model. Participating agencies who wish to replicate this type of analysis in the future can therefore use the simplified model rather than resurveying their customers to gather data on the remaining variables required for the detailed model.

Analysis of the Energy Intensity of Water Supplies for West Basin Municipal Water District

March, 2007

Robert C. Wilkinson, Ph.D.

Note to Readers

This report for West Basin Municipal Water District is an update and revision of an analysis and report by Robert Wilkinson, Fawzi Karajeh, and Julie Mottin (Hannah) conducted in April 2005. The earlier report, *Water Sources "Powering" Southern California: Imported Water, Recycled Water, Ground Water, and Desalinated Water*, was undertaken with support from the California Department of Water Resources, and it examined the energy intensity of water supply sources for both West Basin and Central Basin Municipal Water Districts. This analysis focuses exclusively on West Basin, and it includes new data for ocean desalination based on new engineering developments that have occurred over the past year and a half.

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Overview

Southern California relies on imported and local water supplies for both potable and non-potable uses. Imported water travels great distances and over significant elevation gains through both the California State Water Project (SWP) and Colorado River Aqueduct (CRA) before arriving in Southern California, consuming a large amount of energy in the process. Local sources of water often require less energy to provide a sustainable supply of water. Three water source alternatives which are found or produced locally and could reduce the amount of imported water are desalinated ocean water, groundwater, and recycled water. Groundwater and recycled water are significantly less energy intensive than imports, while ocean desalination is getting close to the energy intensity of imports.

Energy requirements vary considerably between these four water sources. All water sources require pumping, treatment, and distribution. Differences in energy requirements arise from the varying processes needed to produce water to meet appropriate standards. This study examines the energy needed to complete each process for the waters supplied by West Basin Municipal Water District (West Basin).

Specific elements of energy inputs examined in this study for each water source are as follows:

- Energy required to **import water** includes three processes: pumping California SWP and CRA supplies to water providers; treating water to applicable standards; and distributing it to customers.
- **Desalination of ocean water** includes three basic processes: 1) pumping water from the ocean or intermediate source (e.g. a powerplant) to the desalination plant; 2) pre-treating and then desalting water including discharge of concentrate; and 3) distributing water from the desalination plant to customers.
- **Groundwater** usage requires energy for three processes: pumping groundwater from local aquifers to treatment facilities; treating water to applicable standards; and distributing water from the treatment plant to customers. Additional injection energy is sometimes needed for groundwater replenishment.
- Energy required to **recycle water** includes three processes: pumping water from secondary treatment plants to tertiary treatment plants; tertiary treatment of the water, and distributing water from the treatment plant to customers.

The energy intensity results of this study are summarized in the table on the following page. They indicate that recycled water is among the least energy-intensive supply options available, followed by groundwater that is naturally recharged and recharged with recycled water. Imported water and ocean desalination are the most energy intensive water supply options in California. East Branch State Water Project water is close in energy intensity to desalination figures based on current technology, and at some points along the system, SWP supplies exceed estimated ocean desalination energy intensity. The following table identifies energy inputs to each of the water supplies including estimated energy requirements for desalination. Details describing the West Basin system operations are included in the water source sections. Note that the Title 22 recycled water energy figure reflects only the *marginal* energy required to treat secondary effluent wastewater which has been processed to meet legal discharge requirements, along with the energy to convey it to user

Energy Intensity of Water Supplies for West Basin Municipal Water District

	af/yr	Percentage of Total Source Type	kWh/af Conveyance Pumping	kWh/af MWD Treatment	kWh/af Recycled Treatment	kWh/af Groundwater Pumping	kWh/af Groundwater Treatment	kWh/af Desalination	kWh/af WBMWD Distribution	Total kWh/af	Total kWh/year
Imported Deliveries											
State Water Project (SWP) [1]	57,559	43%	3,000	44	NA	NA	NA	NA	0	3,044	175,209,596
Colorado River Aqueduct (CRA) [1] (other that replenishment water)	76,300	57%	2,000	44	NA	NA	NA	NA	0	2,044	155,957,200
Groundwater[2]											
natural recharge	19,720	40%	NA	NA	NA	350	0	NA	0	350	6,902,030
replenished with (injected) SWP water [1]	9,367	19%	3,000	44	NA	350	0	NA	0	3,394	31,791,598
replenished with (injected) CRA water [1]	11,831	24%	2,000	44	NA	350	0	NA	0	2,394	28,323,432
replenished with (injected) recycled water	8,381	17%	205	0	790	350	0	NA	220	1,565	13,116,278
Recycled Water											
West Basin Treatment, Title 22	21,506	60%	205	NA	0	NA	NA	NA	285	490	10,537,940
West Basin Treatment, RO	14,337	40%	205	NA	790	NA	NA	NA	285	1,280	18,351,360
	35,843										
Ocean Desalination	20,000	100%	200	NA	NA	NA	NA	3,027	460	3,687	82,588,800

Notes:

NA Not applicable

1 Imported water based on percentage of CRA and SWP water MWD received, averaged over an 11-year period. Note that the figures for imports do not include an accounting for system losses due to evaporation and other factors. These losses clearly exist, and an estimate of 5% or more may be reasonable. The figures for imports above should therefore be understood to be conservative (that is, the actual energy intensity is in fact higher for imported supplies than indicated by the figures).

2 Groundwater values include entire basin, West Basin service area covers approximately 86% of the basin. Groundwater values are specific to aquifer characteristics, including depth, within the basin.

Energy Intensity of Water

Water treatment and delivery systems in California, including extraction of "raw water" supplies from natural sources, conveyance, treatment and distribution, end-use, and wastewater collection and treatment, account for one of the largest energy uses in the state.[1] The California Energy Commission estimated in its 2005 Integrated Energy Policy Report that approximately 19% of California's electricity is used for water related purposes including delivery, end-uses, and wastewater treatment.[2] The total energy embodied in a unit of water (that is, the amount of energy required to transport, treat, and process a given amount of water) varies with location, source, and use within the state. In many areas, the energy intensity may increase in the future due to limits on water resource extraction, and regulatory requirements for water quality, and other factors.[3] Technology improvements may offset this trend to some extent.

> ***Energy intensity*** is the total amount of energy, calculated on a whole-system basis, required for the use of a given amount of water in a specific location.

The Water-Energy Nexus

Water and energy systems are interconnected in several important ways in California. Water systems both provide energy – through hydropower – and consume large amounts of energy, mainly through pumping. Critical elements of California's water infrastructure are highly energy-intensive. Moving large quantities of water long distances and over significant elevation gains, treating and distributing it within the state's communities and rural areas, using it for various purposes, and treating the resulting wastewater, accounts for one of the largest uses of electrical energy in the state.[4]

Improving the efficiency with which water is used provides an important opportunity to increase related energy efficiency. (*"Efficiency"* as used here describes the useful work or service provided by a given amount of water.) Significant potential economic as well as environmental benefits can be cost-effectively achieved in the energy sector through efficiency improvements in the state's water systems and through shifting to less energy intensive local sources. The California Public Utilities Commission is currently planning to include water efficiency improvements as a means of achieving energy efficiency benefits for the state.[5]

Overview of Energy Inputs to Water Systems

There are four principle energy elements in water systems:

1. primary water extraction and supply delivery (imported and local)
2. treatment and distribution within service areas
3. on-site water pumping, treatment, and thermal inputs (heating and cooling)

4. wastewater collection, treatment, and discharge

Pumping water in each of these four stages is energy-intensive. Other important components of embedded energy in water include groundwater pumping, treatment and pressurization of water supply systems, treatment and thermal energy (heating and cooling) applications at the point of end-use, and wastewater pumping and treatment.[6]

1. ***Primary water extraction and supply delivery***
   Moving water from near sea-level in the Sacramento-San Joaquin Delta to the San Joaquin-Tulare Lake Basin, the Central Coast, and Southern California, and from the Colorado River to metropolitan Southern California, is highly energy intensive. Approximately 3,236 kWh is required to pump one acre-foot of SWP water to the end of the East Branch in Southern California, and 2,580 kWh for the West Branch. About 2,000 kWh is required to pump one acre foot of water through the CRA to southern California.[7] Groundwater pumping also requires significant amounts of energy depending on the depth of the source. (Data on groundwater is incomplete and difficult to obtain because California does not systematically manage groundwater resources.)

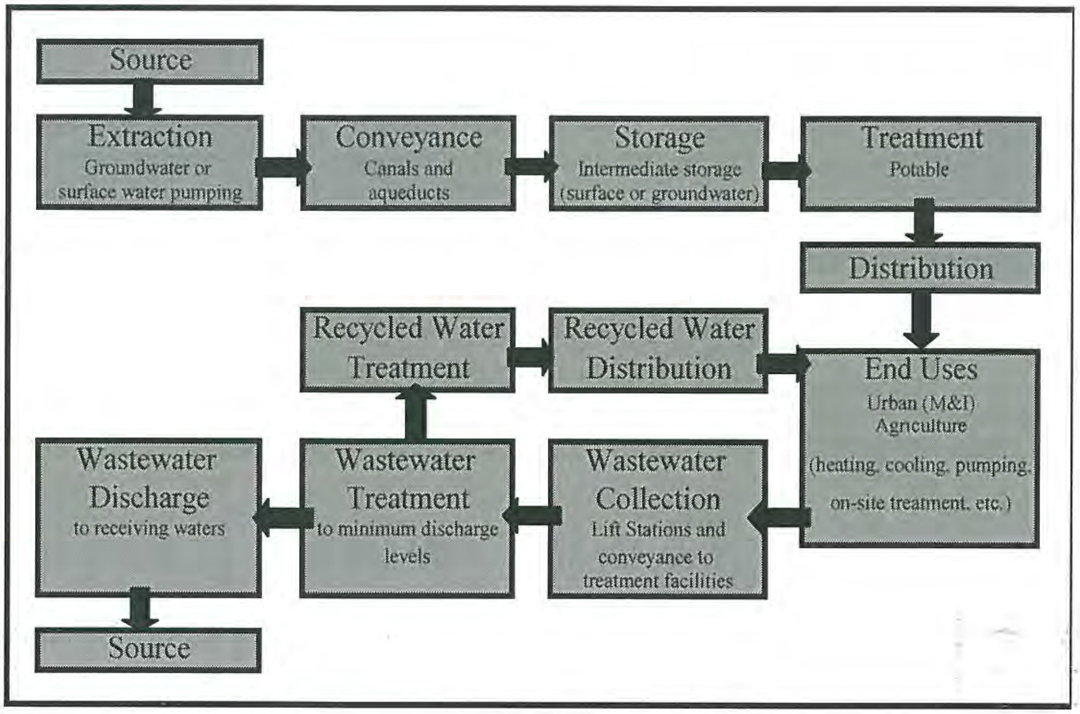
2. ***Treatment and distribution within service areas***
   Within local service areas, water is treated, pumped, and pressurized for distribution. Local conditions and sources determine both the treatment requirements and the energy required for pumping and pressurization.

3. ***On-site water pumping, treatment, and thermal inputs***
   Individual water users use energy to further treat water supplies (e.g. softeners, filters, etc.), circulate and pressurize water supplies (e.g. building circulation pumps), and heat and cool water for various purposes.

4. ***Wastewater collection, treatment, and discharge***
   Finally, wastewater is collected and treated by a wastewater authority (unless a septic system or other alternative is being used). Wastewater is often pumped to treatment facilities where gravity flow is not possible, and standard treatment processes require energy for pumping, aeration, and other processes. (In cases where water is reclaimed and re-used, the calculation of total energy intensity is adjusted to account for wastewater as a *source* of water supply. The energy intensity generally includes the additional energy for treatment processes beyond the level required for wastewater discharge, plus distribution.)

The simplified flow chart below illustrates the steps in the water system process. A spreadsheet computer model is available to allow cumulative calculations of the energy inputs embedded at each stage of the process. This methodology is consistent with that applied by the California Energy Commission in its analysis of the energy intensity of water.

Simplified Flow Diagram of Energy Inputs to Water Systems



Source: Robert Wilkinson, UCSB[8]

Calculating Energy Intensity

Total energy intensity, or the amount of energy required to facilitate the use of a given amount of water in a specific location, may be calculated by accounting for the summing the energy requirements for the following factors:

- imported supplies
- local supplies
- regional distribution
- treatment
- local distribution
- on-site thermal (heating or cooling)
- on-site pumping
- wastewater collection
- wastewater treatment

Water pumping, and specifically the long-distance transport of water in conveyance systems, is a major element of California's total demand for electricity as noted above. Water use (based on embedded energy) is the next largest consumer of electricity in a typical Southern California home after refrigerators and air conditioners. Electricity required to support water service in the typical home in Southern California is estimated at between 14% to 19% of total residential energy demand.[9] If air conditioning is not a factor the figure is even higher. Nearly three quarters of this energy demand is for pumping imported water.

Interbasin Transfers

Some of California's water systems are uniquely energy-intensive, relative to national averages, due to the pumping requirements of major conveyance systems which move large volumes of water long distances and over thousands of feet in elevation lift. Some of the interbasin transfer systems (systems that move water from one watershed to another) are net energy producers, such as the San Francisco and Los Angeles aqueducts. Others, such as the SWP and the CRA require large amounts of electrical energy to convey water. On *average*, approximately 3,000 kWh is necessary to pump one AF of SWP water to southern California,[10] and 2,000 kWh is required to pump one AF of water through the CRA to southern California.[11]

Total energy savings for reducing the full embedded energy of *marginal* (e.g. imported) supplies of water used indoors in Southern California is estimated at about 3,500 kWh/af.[12] Conveyance over long distances and over mountain ranges accounts for this high marginal energy intensity. In addition to avoiding the energy and other costs of pumping additional water supplies, there are environmental benefits through reduced extractions from stressed ecosystems such as the delta.

Imported Water: The State Water Project and the Colorado River Aqueduct

Water diversion, conveyance, and storage systems developed in California in the 20^{th} century are remarkable engineering accomplishments. These water works move millions of AF of water around the state annually. The state's 1,200-plus reservoirs have a total storage capacity of more than 42.7 million acre feet (maf).[13] West Basin receives imported water from Northern California through the State Water Project and Colorado River water via the Colorado River Aqueduct. The Metropolitan Water District of Southern California delivers both of these imported water supplies to the West Basin.

California's Major Interbasin Water Projects

The State Water Project

The State Water Project (SWP) is a state-owned system. It was built and is managed by the California Department of Water Resources (DWR). The SWP provides supplemental water for agricultural and urban uses.[14] SWP facilities include 28 dams and reservoirs, 22 pumping and generating plants, and nearly 660 miles of aqueducts.[15] Lake Oroville on the Feather River, the project's largest storage facility, has a total capacity of about 3.5 maf.[16] Oroville Dam is the tallest and one of the largest earth-fill dams in the United States.[17]

Water is pumped out of the delta for the SWP at two locations. In the northern Delta, Barker Slough Pumping Plant diverts water for delivery to Napa and Solano counties through the North Bay

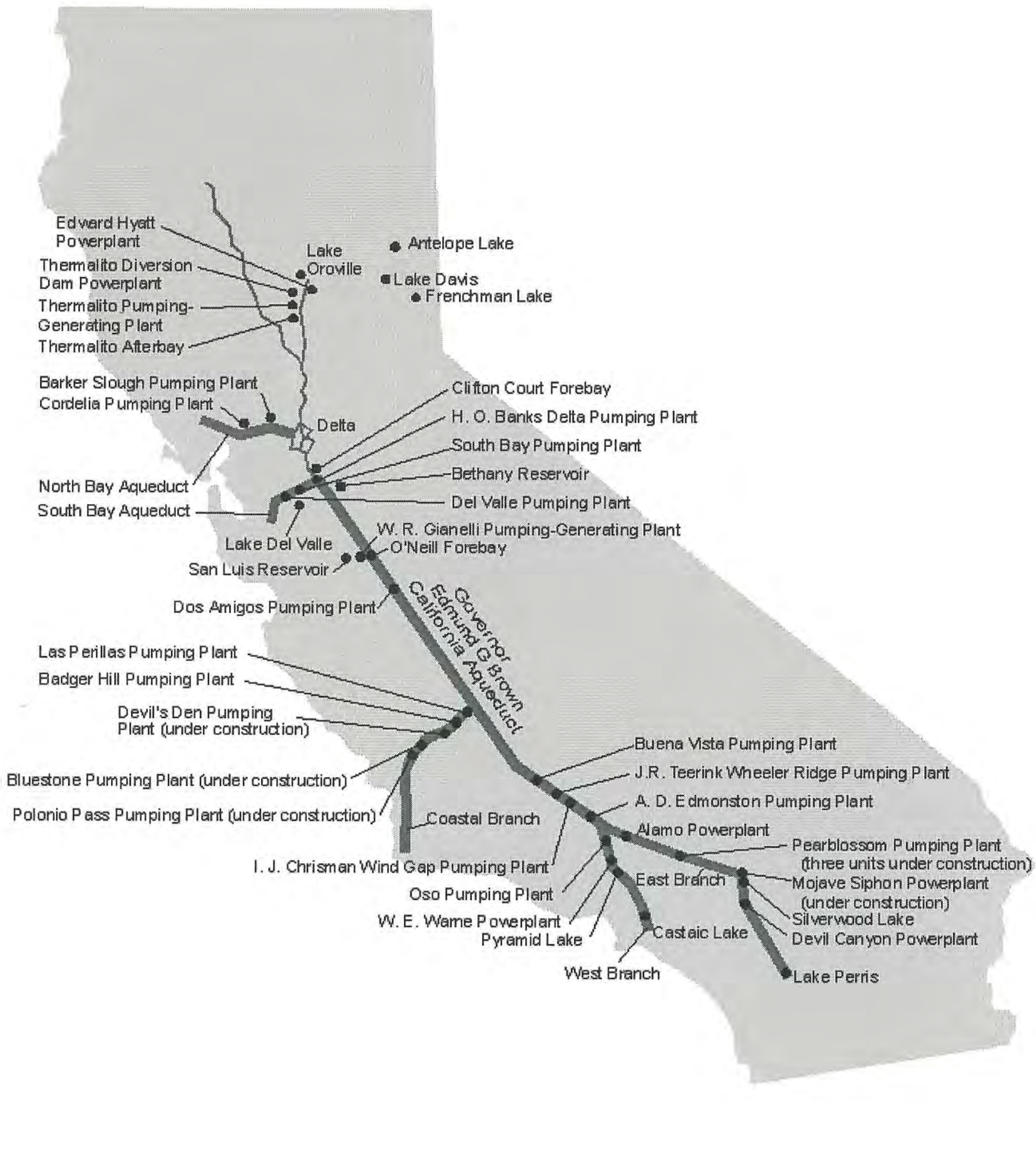
Aqueduct.[18] Further south at the Clifton Court Forebay, water is pumped into Bethany Reservoir by the Banks Pumping Plant. From Bethany Reservoir, the majority of the water is conveyed south in the 444-mile-long Governor Edmund G. Brown California Aqueduct to agricultural users in the San Joaquin Valley and to urban users in Southern California. The South Bay Pumping Plant also lifts water from the Bethany Reservoir into the South Bay Aqueduct. [19]

The State Water Project is the largest consumer of electrical energy in the state, requiring an average of 5,000 GWh per year.[20] The energy required to operate the SWP is provided by a combination of DWR's own hydroelectric and other generation plants and power purchased from other utilities. The project's eight hydroelectric power plants, including three pumping-generating plants, and a coal-fired plant produce enough electricity in a normal year to supply about two-thirds of the project's necessary power.

Energy requirements would be considerably higher if the SWP was delivering full contract volumes of water. The project delivered an average of approximately 2.0 mafy, or half its contracted volumes, throughout the 1980s and 1990s.[21] Since 2000 the volumes of imported water have generally increased.

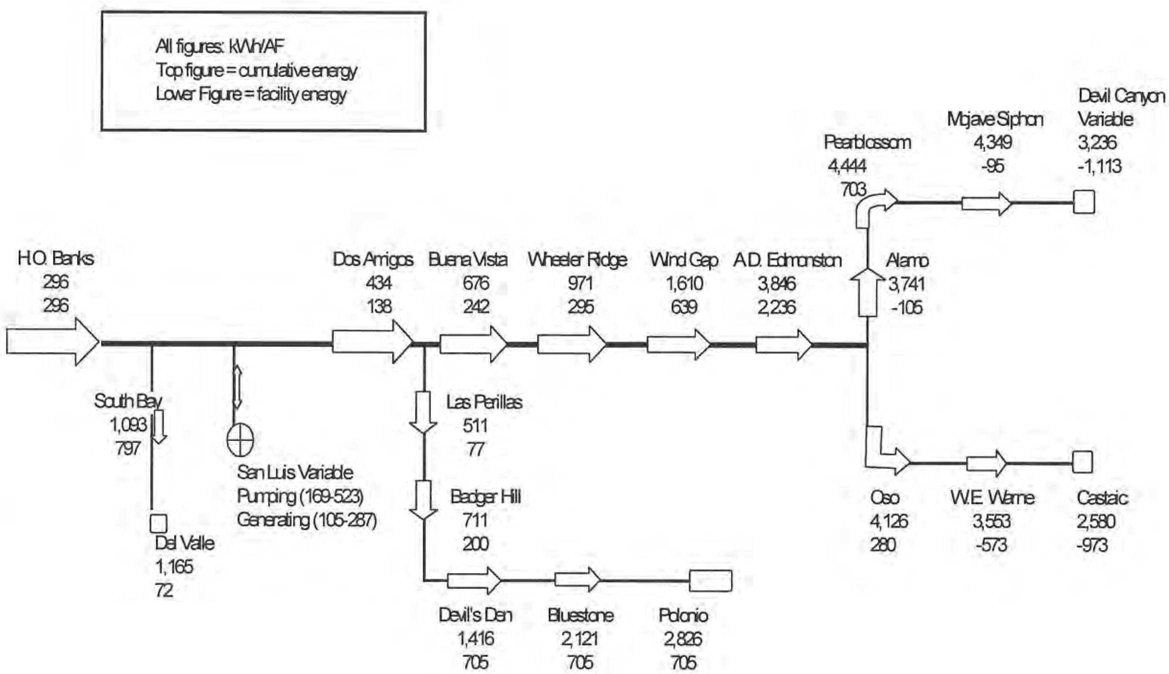
The following map indicates the location of the pumping and power generation facilities on the SWP.

Names and Locations of Primary State Water Delivery Facilities



The following schematic shows each individual pumping unit on the State Water Project, along with data for both the individual and cumulative energy required to deliver an AF of water to that point in the system. Note that the figures include energy recovery in the system, but they do not account for losses due to evaporation and other factors. These losses may be in the range of 5% or more. While more study of this issue is in order, it is important to observe that the energy intensity numbers are conservative (e.g. low) in that they assume that all of the water originally pumped from the delta reaches the ends of the system without loss.

State Water Project
Kilowatt-Hours per Acre Foot Pumped
(Includes Transmission Losses)



Source: Wilkinson, based on data from: California Department of Water Resources, State Water Project Analysis Office, Division of Operations and Maintenance. *Bulletin 132-97*, 4/25/97.

The Colorado River Aqueduct

Significant volumes of water are imported to the Los Angeles Basin and San Diego in Southern California from the Colorado River via the Colorado River Aqueduct (CRA). The aqueduct was built by the Metropolitan Water District of Southern California (MWD). Though MWD's allotment of the Colorado River water is 550,000 afy, it has historically extracted as much as 1.3 mafy through a combination of waste reduction arrangements with Imperial Irrigation District (IID) (adding about 106,000 afy) and by using "surplus" water.[22] The Colorado River water supplies require about 2,000 kWh/af for conveyance to the Los Angeles basin.

The Colorado River Aqueduct extends 242 miles from Lake Havasu on the Colorado River to its terminal reservoir, Lake Mathews, near Riverside. The CRA was completed in 1941 and expanded in 1961 to a capacity of more than 1 MAF per year. Five pumping plants lift the water 1,616 feet, over several mountain ranges, to southern California. To pump an average of 1.2 maf of water per year into the Los Angeles basin requires approximately 2,400 GWh of energy for the CRA's five pumping plants.[23] On average, the energy required to import Colorado River water is about 2,000 kWh/AF. The aqueduct was designed to carry a flow of 1,605 cfs (with the capacity for an additional 15%).

The sequence for CRA pumping is as follows: The Whitsett Pumping Plant elevates water from Lake Havasu 291 feet out of the Colorado River basin. At "mile 2," Gene pumping plant elevates water 303 feet to Iron Mountain pumping plant at mile 69, which then boosts the water another 144 feet. The last two pumping plants provide the highest lifts - Eagle Mountain, at mile 110, lifts the water 438 feet, and Hinds Pumping Plant, located at mile 126, lifts the water 441 feet.[24]

MWD has recently improved the system's energy efficiency. The average energy requirement for the CRA was reduced from approximately 2,100 kWh /af to about 2,000 kWh /af "through the increase in unit efficiencies provided through an energy efficiency program." The energy required to pump each acre foot of water through the CRA is essentially constant, regardless of the total annual volume of water pumped. This is due to the 8-pump design at each pumping plant. The average pumping energy efficiency does not vary with the number of pumps operated, and MWD states that the same 2,000 kWh/af estimate is appropriate for both the "Maximum Delivery Case" and the "Minimum Delivery Case."[25]

It appears that there are limited opportunities to shift pumping off of peak times on the CRA. Due to the relatively steep grade of the CRA, limited active water storage, and transit times between plants, the system does not generally lend itself to shifting pumping loads from on-peak to off-peak. Under the Minimum Delivery Case, the reduced annual water deliveries would not necessarily bring a reduction in annual peak load, since an 8-pump flow may still need to be maintained in certain months.

Electricity to run the CRA pumps is provided by power from hydroelectric projects on the Colorado River as well as off-peak power purchased from a number of utilities. The Metropolitan Water District has contractual hydroelectric rights on the Colorado River to "more than 20 percent of the firm energy and contingent capacity of the Hoover power plant and 50 percent of the energy and capacity of the Parker power plant."[26] Energy purchased from utilities makes up approximately 25 percent of the remaining energy needed to power the Colorado River Aqueduct.[27]

Minimizing the Need for Inter-Basin Transfers

For over 100 years, California has sought to transfer water from one watershed for use in another. The practice has caused a number of problems. As of 2001, California law requires that the state examine ways to "*minimize the need to import water from other hydrologic regions*" and report on these approaches in the official State Water Plan.[28] A new focus and priority has been placed on developing *local* water supply sources, including efficiency, reuse, recharge, and desalination. The law directs the Department of Water Resources as follows:[29]

> The department, as a part of the preparation of the department's Bulletin 160-03, shall include in the California Water Plan a report on the development of regional and local water projects within each hydrologic region of the state, as described in the department's Bulletin 160-98, to improve water supplies to meet municipal, agricultural, and environmental water needs and *minimize the need to import water from other hydrologic regions*.

(Note that Bulletin 160-03 became Bulletin 160-05 due to a slip in the completion schedule.)

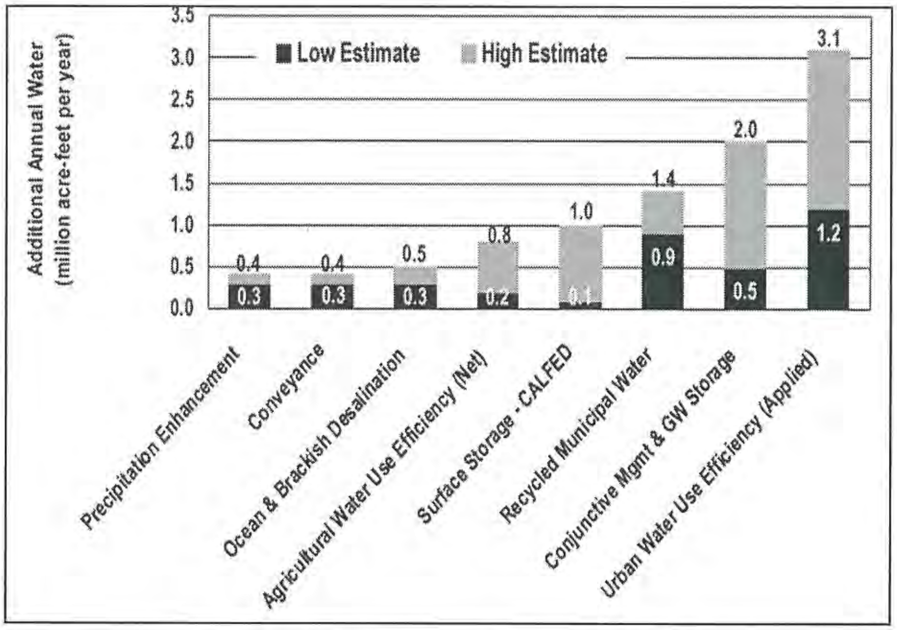
The legislation set forth the range of local supply options to be considered:

> The report shall include, but is not limited to, regional and local water projects that use technologies for desalting brackish groundwater and ocean water, reclaiming water for use within the community generating the water to be reclaimed, the construction of improved potable water treatment facilities so that water from sources determined to be unsuitable can be used, and the construction of dual water systems and brine lines, particularly in connection with new developments and when replacing water piping in developed or redeveloped areas.

This law calls for a thorough consideration in the state's official water planning process of work that is already going on in various areas of the state. The significance of the legislation is that for the first time, local supply development is designated as a priority in order to minimize inter-basin transfers.

The Department of Water Resources State Water Plan (Bulletin 160-05) reflects this new direction for the state in its projection of water supply options for the next quarter century. The following graph clearly indicates the importance of local water supplies from various sources in the future.

California State Water Plan 2005
Water Management and Supply Options for the Next 25 Years



Source: *California Water Plan Update 2005*.[30]

Energy Requirements for Treatment of State Water Project and the Colorado River Aqueduct Supplies

Imported SWP and CRA supplies require an estimated 44 kWh/af for treatment before it enters the local distribution systems. Water pressure from MWD's system is sufficient to move supplies through the West Basin distribution system without requiring additional pressure.

Groundwater and Recycled Water at West Basin MWD

Nearly half of the water used in the service area of the Metropolitan Water District of Southern California (from Ventura to Mexico) is secured from *local* sources, and the percentage of total supplies provided by local sources is growing steadily.[31] This figure is up from approximately one-third of the supply provided by local resources in the mid-1990s.[32] MWD has encouraged local supply development through support for recycling, groundwater recovery, conservation, groundwater storage, and most recently, ocean desalination.

Groundwater and recycled water are important and growing supply sources for West Basin. Water flows through natural hydrologic cycles continuously. The water we use today has made the journey many times. In water recycling programs, water is treated and re-used for various purposes including recharging groundwater aquifers. The treatment processes essentially short-circuit the longer-term process of natural evaporation and precipitation. In cities around the world water is used and then returned to natural water systems where it flows along to more users down stream. It is often used again and again before it flows to the ocean or to a terminal salt sink.

Groundwater at West Basin MWD

Groundwater reservoirs in West Basin are replenished with four water sources; natural recharge, SWP supplies, CRA supplies, and recycled water supplies. The largest portion (approximately 40%) of groundwater supplies is derived from natural recharge. The energy associated with recovering this naturally recharged supply is estimated at 350 kWh/af for groundwater pumping.

Imported water, from both the SWP and CRA, is injected into the groundwater supply in West Basin. The imported water remains at sufficient pressure for injection, so no additional energy is required. The energy requirements for importing water are significant, however, primarily due to the energy associated with importing the water from northern California and the Colorado River. The imported water also passes through MWD's treatment plant, incurring additional energy requirements. The total energy intensity for West Basin's imported water used for recharge of groundwater storage from the SWP is 3,394 kWh/af and from the CRA is 2,394 kWh/af.

Recycled water is also used to recharge groundwater in the basin. West Basin replenishes groundwater by injecting RO treated recycled water from the West Basin Water Recycling Facility (WBWRF). The total energy use is 1,565 kWh/af. Details for the recycled water energy are described in the next section.

Recycled Water at West Basin MWD

Many cities in California are using advanced processes and filtering technology to treat wastewater so it can be re-used for irrigation, industry, and other purposes. In response to increasing demands for water, limitations on imported water supplies, and the threat of drought, West Basin has developed state-of-the-art regional water recycling programs. Water is increasingly being used more than once within systems at both the end-use level and at the municipal level. This is because scarce water resources (and wastewater discharges) are increasing in cost and because cost-effective technologies and techniques for re-using water have been developed that meet health and safety requirements. At the end-use, water is recycled within processes such as cooling towers and industrial processes prior to entering the wastewater system. Once-through systems are increasingly being replaced by re-use technologies. At the municipal level, water re-use has become a significant source of supplies for both landscape irrigation and for commercial and industrial processes. MWD of Southern California is supporting 33 recycling programs in which treated wastewater is used for non-potable purposes.[33]

West Basin provides customers with recycled water used for municipal, commercial and industrial applications. Approximately 27,000 AF of recycled water is annually distributed to more than 210 sites in the South Bay. These sites use recycled water for a wide range of non-potable applications. Based in El Segundo, California, the WBWRF is among the largest projects of its kind in the nation, producing five qualities of recycled water with the capacity at full build-out to recycle 100,000 AF per year of wastewater from the Los Angeles Hyperion Treatment Plant.

In 1998, West Basin began to construct the nation's only regional high-purity water treatment facility, the Carson Regional Water Recycling Facility (CRWRF). A pipeline stretching through five South Bay communities connects the CRWRP to West Basin's El Segundo facility. At the CRWRF, West Basin ultra-purifies the recycled water it gets from the El Segundo facility. From the CRWRF, West Basin uses service lines to transport two types of purified water to the BP Refinery in Carson. The West Basin expansion also includes a new disposal pipeline to carry brine reject water from the CRWRF to a Los Angeles County Sanitation District's outfall.

In order to provide perspective on the energy requirements for the WBWRF, two water qualities and associated energy intensity are presented. "Title 22" water, produced by a gravity filter treatment system, requires conveyance pumping energy from Hyperion to WBWRF at 205 kWh/af. The water flows through the filters via gravity, thus no additional energy is required for treatment. The final energy requirement is 285 kWh/af for distribution with a total energy requirement of 490 kWh/af. This is the lowest grade of recycled water that WBWRF produces. Contrasting the Title 22 water, WBWRF produces RO water with a total energy requirement of 1,280 kWh/af. This includes 205 kWh/af for conveyance from Hyperion, 790 kWh/af for treatment with RO, and 285 kWh/af for distribution.

More than 210 South Bay sites use 9 billion gallons of West Basin's recycled water for applications including irrigation, industrial processes, indirect potable uses, and seawater barrier injection. West Basin has been successful in changing the perception of recycled water from merely a conservation tool with minimal applications to a cost-effective business tool that can reduce costs and improve reliability.

Local oil refineries are major customers for West Basin's recycled water. The Chevron Refinery in El Segundo, the Exxon-Mobile refinery in Torrance, and the BP refinery in Carson use recycled water for cooling towers and in the boiler feed systems.

Ocean Water Desalination Development

Desalination technologies are in use around the world. A number of approaches work well and produce high quality water. Many workable and proven technology options are available to remove salt from water. During World War Two, desalination technology was developed as a water source for military operations.[34] Grand plans for nuclear-driven desalination systems in California were drawn up after the war, but they were never implemented due to cost and feasibility problems.

Desalination techniques range from distillation to "reverse osmosis" (RO) technologies. Current applications around the world are dominated by the "multistage flash distillation" process (at about 44% of the world's applications), and RO, (at about 42%).[35] Other desalting technologies include electrodialysis (6%), vapor compression (4%), multi-effect distillation (4%), and membrane softening (2%) to remove salts.[36] All of the ocean desalination projects currently in place or proposed for municipal water supply in California employ RO technology.

Reverse Osmosis Membranes

A recent inventory of desalination facilities world-wide indicated that as of the beginning of 1998, a total of 12,451 desalting units with a total capacity of 6.72 afy[37] had been installed or contracted worldwide. [38] (Note that *capacity* does not indicate actual operation.) Non-seawater desalination plants have a capacity 7,620 af/d[39], whereas the seawater desalination plant capacity reached 10,781af/d.[40]

Desalination systems are being used in over 100 countries, but 10 countries are responsible for 75 percent of the capacity.[41] Almost half of the desalting capacity is used to desalt seawater in the Middle East and North Africa. Saudi Arabia ranks first in total capacity (about 24 percent of the world's capacity) followed by the United Arab Emirates and Kuwait, with most of the capacity being made up of seawater desalting units that use the distillation process.[42]

The salinity of ocean water varies, with the average generally exceeding 30 grams per liter (g/l).[43] The Pacific Ocean is 34-38 g/l, the Atlantic Ocean averages about 35 g/l, and the Persian Gulf is 45 g/l. Brackish water drops to 0.5 to 3.0 g/l.[44] Potable water salt levels should be below 0.5 g/l.

Reducing salt levels from over 30 g/l to 0.5 g/l and lower (drinking water standards) using existing technologies requires considerable amounts of energy, either for thermal processes or for the pressure to drive water through extremely fine filters such as RO, or for some combination of thermal and pressure processes. Recent improvements in energy efficiency have reduced the amount of thermal and pumping energy required for the various processes, but high energy intensity is still an issue. The energy required is in part a function of the degree of salinity and the temperature of the water.

West Basin is in the process of developing plans to construct an ocean desalinating plant. Estimated energy requirements have been calculated by Gerry Filteau of Separation Processes, Inc for each step in the process.[45] The values presented for desalination are based on his work. Since the proposed plant will tap the source water at the power plant, there is no ocean intake pumping required. The source water is estimated to require 200 kWh/af this energy will bring ocean water from the power plant to the desalination system, approximately one quarter of a mile in distance. Pre-treatment of the source water is estimated at 341 kWh/af. This figure includes microfiltration and transfer to the RO units via a 5-10 micron cartridge filter. The RO process requires 2,686 kWh/af if operated at the most energy-efficient level. A slightly less efficient but more cost-effective level of operation would require 2,900 kWh/af, or 214 kWh/af additional energy input according to Filteau. Finally, an estimated 460 kWh/af is required to deliver the product water to the distribution system, including elevation gain, conveyance over distance, and pressurization to 90 psi. No additional energy is required to discharge the brine, as it flows back to the ocean outfall line by gravity.

The energy intensity figures presented here for desalination are lower than previous estimates. This is mainly due to improved membrane technologies, efficiency improvements for high pressure pumps, and pressure recovery systems. It should be noted that the figures provided here are based on engineering estimates, not on actual plant operations.

The total energy required to desalinate the ocean water, including each of the steps above, is estimated to be 3,687 kWh/af. If the energy intensity is increased slightly to improve cost-effectiveness, the total figure increases to 3,901 kWh/af.

Summary

This study examined the energy intensity of imported and local water supplies (ocean water, groundwater, and recycled water) for both potable and non-potable uses for West Basin. All water sources require pumping, treatment, and distribution. Differences in energy requirements arise from varying pumping, treatment, and distribution processes needed to produce water to meet appropriate standards for different uses.

The key findings of this study are: 1) the marginal energy required to treat and deliver recycled water is among the *least* energy intensive supply options available, 2) naturally recharged groundwater is low in energy intensity, though replenishment with imported water is not, and 3) current ocean desalination technology is getting close to the level of energy intensity of imported supplies.

Further refinement of the data in this study, such as applying an agency's own energy values, may provide a more accurate basis for decision-making tailored to a unique water system. The information presented, however, provides a reasonable basis for water managers to explore energy (and cost) benefits of increased use of local water sources, and it indicates that desalination of ocean water is getting close to the energy intensity of existing supplies.

Sources

[1] Water systems account for roughly 7% of California's electricity use: See Wilkinson, Robert C., 2000. Methodology For Analysis of The Energy Intensity of California's Water Systems, and an Assessment of Multiple Potential Benefits Through Integrated Water-Energy Efficiency Measures, Exploratory Research Project, Ernest Orlando Lawrence Berkeley Laboratory, California Institute for Energy Efficiency.

[2] California Energy Commission, 2005. *Integrated Energy Policy Report*, November 2005, CEC-100-2005-007-CMF.

[3] Franklin Burton, in a recent study for the Electric Power Research Institute (EPRI), includes the following elements in water systems: "Water systems involve the transportation of water from its source(s) of treatment plants, storage facilities, and the customer. Currently, most of the electricity used is for pumping; comparatively little is used in treatment. For most surface sources, treatment is required consisting usually of chemical addition, coagulation and settling, followed by filtration and disinfection. In the case of groundwater (well) systems, the treatment may consist only of disinfection with chlorine. In the future, however, implementation of new drinking water regulations will increase the use of higher energy consuming processes, such as ozone and membrane filtration." Burton, Franklin L., 1996, *Water and Wastewater Industries: Characteristics and Energy Management Opportunities.* (Burton Engineering) Los Altos, CA, Report CR-106941, Electric Power Research Institute Report, p.3-1.

[4] Wilkinson, Robert C., 2000. *Methodology For Analysis of The Energy Intensity of California's Water Systems, and an Assessment of Multiple Potential Benefits Through Integrated Water-Energy Efficiency Measures*, Exploratory Research Project, Ernest Orlando Lawrence Berkeley Laboratory, California Institute for Energy Efficiency.

[5] California Public Utilities Commission, Order Instituting Rulemaking Regarding to Examine the Commission's post-2005 Energy Efficiency Policies, Programs, Evaluation, Measurement and Verification, and Related Issues, Rulemaking 06-04-010 (Filed April 13, 2006)

[6] An AF of water is the volume of water that would cover one acre to a depth of one foot. An AF equals 325,851 gallons, or 43,560 cubic feet, or 1233.65 cubic meters.

[7] Metropolitan Water District of Southern California, *Integrated Resource Plan for Metropolitan's Colorado River Aqueduct Power Operations*, 1996, p.5.

[8] This schematic, based on the original analysis by Wilkinson (2000) has been refined and improved with input from Gary Wolff, Gary Klein, William Kost, and others. It is the basic approach reflected in the CEC IEPR and other analyses.

[9] QEI, Inc., 1992, *Electricity Efficiency Through Water Efficiency*, Report for the Southern California Edison Company, p. 24.

[10] Figures cited are *net* energy requirements (gross energy for pumping minus energy recovered through generation).

[11] Metropolitan Water District of Southern California, *Integrated Resource Plan for Metropolitan's Colorado River Aqueduct Power Operations*, 1996, p.5.

[12] Wilkinson, Robert C., 2000. *Methodology For Analysis of The Energy Intensity of California's Water Systems, and an Assessment of Multiple Potential Benefits Through Integrated Water-Energy Efficiency Measures*, Exploratory Research Project, Ernest Orlando Lawrence Berkeley Laboratory, California Institute for Energy Efficiency.

[13] California Department of Finance. California Statistical Abstract. Tables G-2, "Gross Capacities of Reservoirs by Hydrographic Region," and G-3 "Major Dams and Reservoirs of California." January 2001. (http://www.dof.ca.gov/html/fs_data/stat-abs/toc.htm)

[14] "The SWP, managed by the Department of Water Resources, is the largest state-built, multi-purpose water project in the country. Approximately 19 million of California's 32 million residents receive at least part of their water from the SWP. SWP water irrigates approximately 600,000 acres of farmland. The SWP was designed and built to deliver water, control floods, generate power, provide recreational opportunities, and enhance habitats for fish and wildlife." California Department of Water Resources, *Management of the California State Water Project.* Bulletin 132-96. p.xix.

[15] California Department of Water Resources, 1996, *Management of the California State Water Project.* Bulletin 132-96.p.xix.

[16] Three small reservoirs upstream of Lake Oroville — Lake Davis, Frenchman Lake, and Antelope Lake — are also SWP facilities. California Department of Water Resources, 1996, *Management of the California State Water Project.* Bulletin 132-96.

[17] California Department of Water Resources, 1996, *Management of the California State Water Project.* Bulletin 132-96. Power is generated at the Oroville Dam as water is released down the Feather River, which flows into the Sacramento River, through the Sacramento-San Joaquin Delta, and to the ocean through the San Francisco Bay.

[18] The North Bay Aqueduct was completed in 1988. (California Department of Water Resources, 1996, *Management of the California State Water Project.* Bulletin 132-96.)

[19] The South Bay Aqueduct provided initial deliveries for Alameda and Santa Clara counties in 1962 and has been fully operational since 1965. (California Department of Water Resources, 1996, *Management of the California State Water Project.* Bulletin 132-96.)

[20] Carrie Anderson, 1999, "Energy Use in the Supply, Use and Disposal of Water in California", Process Energy Group, Energy Efficiency Division, California Energy Commission, p.1.

[21] Average deliveries for 1980-89 were just under 2.0 mafy, deliveries for 1990-99 were just over 2.0 mafy. There is disagreement regarding the ability of the SWP to deliver the roughly 4.2 mafy that has been contracted for.

[22] According to MWD, "Metropolitan's annual dependable supply from the Colorado River is approximately 656,000 AF -- about 550,000 AF of entitlement and at least 106,000 AF obtained through a conservation program Metropolitan funds in the Imperial Irrigation District in the southeast corner of the state. However, Metropolitan has been allowed to take up to 1.3 maf of river water a year by diverting either surplus water or the unused portions of other agencies' apportionments." Metropolitan Water District of Southern California, 1999, "Fact Sheet" at: http://www.mwd.dst.ca.us/docs/fctsheet.htm.

[23] Metropolitan Water District of Southern California, 1999, http://www.mwd.dst.ca.us/pr/powres/summ.htm.

[24] The five pumping plants each have nine pumps. The plants are designed for a maximum flow of 225 cubic feet per second (cfs). The CRA is designed to operate at full capacity with eight pumps in operation at each plant (1800 cfs). The ninth pump operates as a spare to facilitating maintenance, emergency operations, and repairs. Metropolitan Water District of Southern California, 1999, Colorado River Aqueduct: http://aqueduct.mwd.dst.ca.us/areas/desert.htm, 08/01/99.

[25] Metropolitan Water District of Southern California, 1996, "Integrated Resource Plan for Metropolitan's Colorado River Aqueduct Power Operations", 1996, p.5.

[26] Metropolitan Water District of Southern California, 1999, "Summary of Metropolitan's Power Operation". February, 1999, p.1, http://aqueduct.mwd.dst.ca.us/areas/desert.htm.

[27] Metropolitan Water District of Southern California, 1999, http://www.mwd.dst.ca.us/pr/powres/summ.htm. MWD provides further important system information as follows: Metropolitan owns and operates 305 miles of 230 kV transmission lines from the Mead Substation in southern Nevada. The transmission system is used to deliver power from Hoover and Parker to the CRA pumps. Additionally, Mead is the primary interconnection point for Metropolitan's economy energy purchases. Metropolitan's transmission system is interconnected with several utilities at multiple

interconnection points. Metropolitan's CRA lies within Edison's control area. Resources for the load are contractually integrated with Edison's system pursuant to a Service and Interchange Agreement (Agreement), which terminates in 2017. Hoover and Parker resources provide spinning reserves and ramping capability, as well as peaking capacity and energy to Edison, thereby displacing higher cost alternative resources. Edison, in turn, provides Metropolitan with exchange energy, replacement capacity, supplemental power, dynamic control and use of Edison's transmission system.

[28] SB 672, Machado, 2001. California Water Plan: Urban Water Management Plans. (The law amended Section 10620 of, and adds Section 10013 to, the Water Code) September 2001.

[29] SEC. 2. Section 10013 to the Water Code, 10013. (a) SB 672, Machado. California Water Plan: Urban Water Management Plans. September 2001, (Emphasis added.)

[30] California Department of Water Resources, 2005. California Water Plan Update 2005. Bulletin 160-05, California Department of Water Resources, Sacramento, CA.

[31] Metropolitan Water District of Southern California, 2000. *The Regional Urban Water Management Plan for the Metropolitan Water District of Southern California*, p.A.2-3.

[32] "About 1.36 maf per year (34 percent) of the region's average supply is developed locally using groundwater basins and surface reservoirs and diversions to capture natural runoff." Metropolitan Water District of Southern California, 1996, "Integrated Resource Plan for Metropolitan's Colorado River Aqueduct Power Operations", 1996, Vol.1, p.1-2.

[33] MWD estimates that reclaimed water will ultimately produce 190,000 AF of water annually. Metropolitan Water District of Southern California, 1999, "Fact Sheet" at: http://www.mwd.dst.ca.us/docs/fctsheet.htm.

[34] Buros notes that "American government, through creation and funding of the Office of Saline Water (OSW) in the early 1960s and its successor organizations like the Office of Water Research and echnology (OWRT), made one of the most concentrated efforts to develop the desalting industry. The American government actively funded research and development for over 30 years, spending about $300 million in the process. This money helped to provide much of the basic investigation of the different technologies for desalting sea and brackish waters." Buros, O.K., 2000. *The ABCs of Desalting, International Desalination Association*, Topfield, Massachusetts, p.5. This very useful summary is available at http://www.ida.bm/PDFS/Publications/ABCs.pdf

[35] Buros, O.K., 2000. *The ABCs of Desalting, International Desalination Association*, Topfield, Massachusetts, p.5. This very useful summary is available at http://www.ida.bm/PDFS/Publications/ABCs.pdf See also; Buros et al.1980. *The USAID Desalination Manual.* Produced by CH2M HILL International for the U.S. Agency for International Development.

[36] Wangnick,Klaus.1998 *IDA Worldwide Desalting Plants Inventory Report No.15.*Produced by Wangnick Consulting for International Desalination Association; and Buros, O.K., 2000. *The ABCs of Desalting, International Desalination Association*, Topfield, Massachusetts, p.5.

[37] Desalination systems with a unit size of 100 m3/d or more. Figures in original cited as 6,000 mgd.

[38] Wangnick Consulting GMBH (http://www.wangnick.com) maintains a permanent desalting plants inventory and publishes the results biennially in co-operation with the International Desalination Association, as the IDA Worldwide Desalting Plants Inventory Report. Thus far, fifteen reports have been published, with the latest report having data through the end of 1997; and see Wangnick,Klaus.*1998 IDA Worldwide Desalting Plants Inventory Report No.15.*Produced by Wangnick Consulting for International Desalination Association. The data cited are as of December 31, 1997.

[39] Cited in original as 9,400,000 m3/d.

[40] Wangnick,Klaus.*1998 IDA Worldwide Desalting Plants Inventory Report No.15.*Produced by Wangnick Consulting for International Desalination Association. (Cited in original in m3d (13,300,000 m3/d).

[41] Wangnick,Klaus.1998 *IDA Worldwide Desalting Plants Inventory Report No.15.*Produced by Wangnick Consulting for International Desalination Association; and Buros, O.K., 2000. *The ABCs of Desalting, International Desalination Association*, Topfield, Massachusetts. The United States ranks second in over-all capacity (16 %) with most of the capacity in the RO process used to treat brackish water. The largest plant, at Yuma, Arizona, is not in use.

[42] Wangnick,Klaus.1998. *IDA Worldwide Desalting Plants Inventory Report No.15.* Produced by Wangnick Consulting for International Desalination Association; and Buros, O.K., 2000. *The ABCs of Desalting, International Desalination Association*, Topfield, Massachusetts.

[43] Salinity levels referenced in metric units.

[44] OTV. 1999. "Desalinating seawater." Memotechnique, Planete Technical Section, No. 31 (February), p.1; and Gleick, Peter H. 2000. *The World's Water: 2000-2001*, Island Press, Covelo, p.94.

[45] Gerry Filteau, Separation Processes, Inc., 2386 Faraday Ave., Suite 100, Calsbad, CA 92008, www.spi-engineering.com