Appendix y-J: South Gardena Recycled Water Pipeline Project Supporting Documents

(Please see Appendix CD for documents)

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Using Effluent Water **On Your** Golf Course

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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

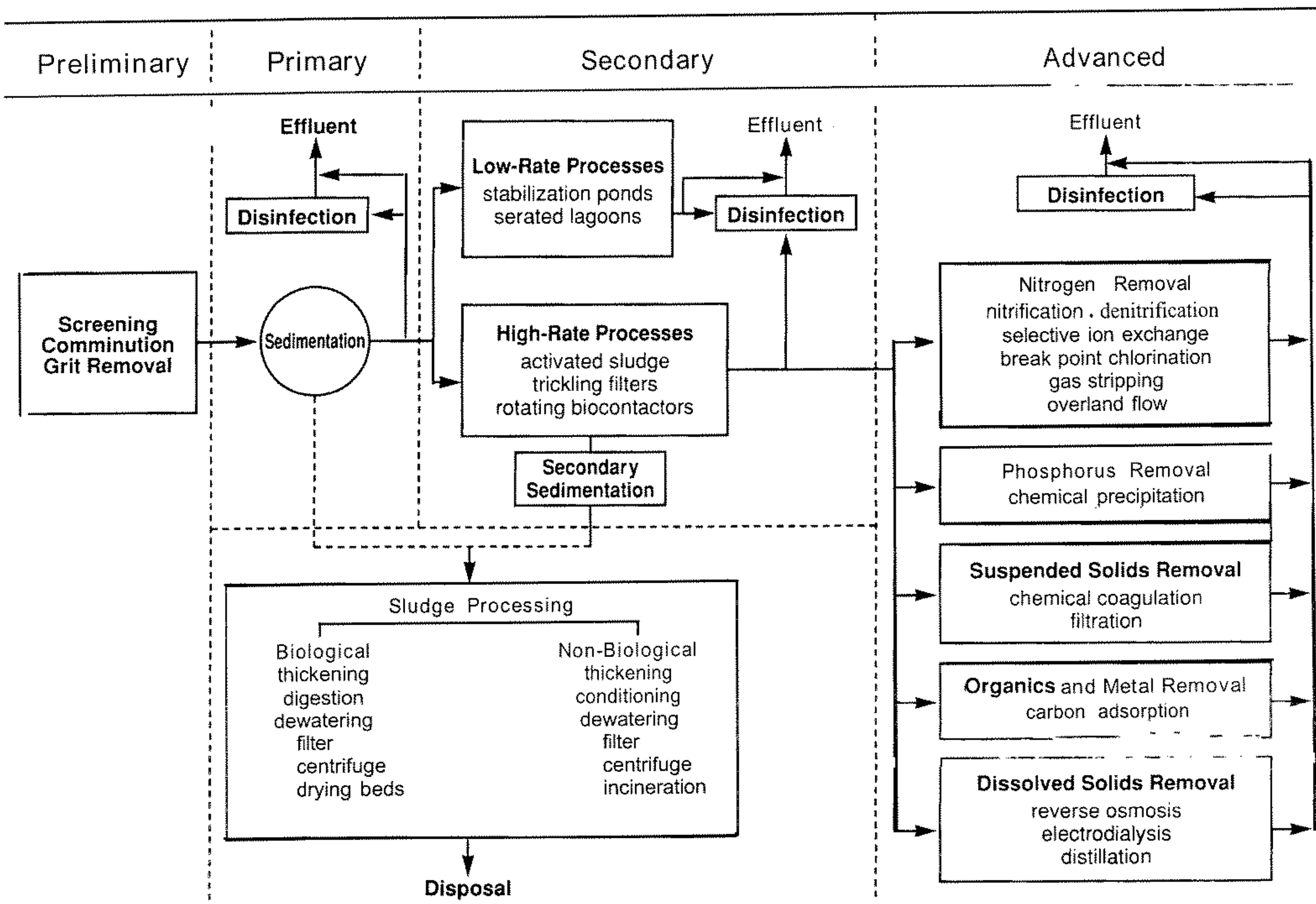

Figure **1** — Generalized Flow Sheet for Wastewater Treatment
Source: Asano, T., R. G. Smith, and G. Tschobanoglous, 1984

(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 arc not as fortunate, however, and can experience disfiguring leaf bums. 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 used 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]

REFERENCES

Asano, T. (Proj. Dir.). 1981. Evaluation of agricultural irrigation projects using reclaimed water. Agreement 8-179-215-2. Office of Water Recycling. California State Water Resources Control Board. Sacramento, CA.

Boyle Engineering

Asano, T., R. G. Smith and G. Tschobanoglous. 1984. in Pettygrove, G. S., and T. Asano (eds.). 1984. Irrigation with Reclaimed Municipal Wastewater — A Guidance Manual. Report No. 84-1 California State Water Resources Control Board. Sacramento, CA.

California Department of Health Services. 1978. Wastewater reclamation criteria. California Administrative Code.

Appendix y-K: Upper Malibu Creek Watershed Restoration Supporting Documents

(Please see Appendix CD for documents)

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State of California
The Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Biogeographic Data Branch
California Natural Diversity Database

STATE & FEDERALLY LISTED ENDANGERED & THREATENED ANIMALS OF CALIFORNIA

January 2013

This is a list of animals found within California or off the coast of the State that have been classified as Endangered or Threatened by the California Fish & Game Commission (state list) or by the U.S. Secretary of the Interior or the U.S. Secretary of Commerce (federal list). The federal agencies responsible for listing are the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS).

The official California listing of Endangered and Threatened animals is contained in the California Code of Regulations, Title 14, Section 670.5. The official federal listing of Endangered and Threatened animals is published in the Federal Register, 50 CFR 17.11. The California Endangered Species Act of 1970 created the categories of “Endangered” and “Rare.” The California Endangered Species Act of 1984 created the categories of “Endangered” and “Threatened.” On January 1, 1985, all animal species designated as “Rare” were reclassified as “Threatened.”

Also included on this list are animal “Candidates” for state listing and animals “Proposed” for federal listing; federal “Candidates” are currently not included. A state Candidate species is one that the Fish and Game Commission has formally declared a candidate species. A federal Proposed species is one that has had a published proposed rule to list in the Federal Register.

Designation		Totals as of January 2013
State listed as Endangered	SE	46
State listed as Threatened	ST	34
Federally listed as Endangered	FE	91
Federally listed as Threatened	FT	39
State Candidate (Endangered)	SCE	3
State Candidate (Threatened)	SCT	2
State Candidate (Delisting)	SCD	1
Federally proposed (Endangered)	FPE	0
Federally proposed (Threatened)	FPT	0
Federally proposed (Delisting)	FPD	2
Total number of animals listed (includes subspecies & population segments)		155
Total number of candidate/proposed animals for listing		5
Number of animals State listed only		32
Number of animals Federally listed only		75
Number of animals listed under both State & Federal Acts		50

Common and scientific names are shown as they appear on the state or federal lists. If the nomenclature differs for a species that is included on both lists, the state nomenclature is given and the federal nomenclature is shown in a footnote. Synonyms, name changes, and other clarifying points are also footnoted.

The “List Date” for **final** federal listing is the date the listing became effective. This is usually not the date of publication of the rule in the Federal Register; it is usually about 30 days after publication, but may be longer.

If an animal was previously listed or proposed for listing and no longer has any listing status, the entry has been grayed out.

For taxa that have more than one status entry, the **current status is in bold and underlined**.

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	State Listing		Federal Listing	
GASTROPODS				
Trinity bristle snail *Monadenia setosa*[1]	ST	10-02-80		
Morro shoulderband (=banded dune) snail *Helminthoglypta walkeriana*			FE	1-17-95
White abalone *Haliotis sorenseni*			FE[2] FE	11-16-05 6-28-01
Black abalone *Haliotis cracherodii*			FE[3] FE	4-13-11 2-13-09
CRUSTACEANS				
Riverside fairy shrimp *Streptocephalus woottoni*			FE	8-03-93
Conservancy fairy shrimp *Branchinecta conservatio*			FE	9-19-94
Longhorn fairy shrimp *Branchinecta longiantenna*			FE	9-19-94
Vernal pool fairy shrimp *Branchinecta lynchi*			FT	9-19-94
San Diego fairy shrimp *Branchinecta sandiegonensis*			FE	2-03-97
Vernal pool tadpole shrimp *Lepidurus packardi*			FE	9-19-94
Shasta crayfish *Pacifastacus fortis*	**SE** ST	2-26-88 10-02-80	FE	9-30-88
California freshwater shrimp *Syncaris pacifica*	SE	10-02-80	FE	10-31-88
INSECTS				
Zayante band-winged grasshopper *Trimerotropis infantilis*			FE	2-24-97
Mount Hermon June beetle *Polyphylla barbata*			FE	2-24-97
Casey's June beetle *Dinacoma caseyi*			**FE** FPE	10-24-11 7-09-09
Delta green ground beetle *Elaphrus viridis*			FT	8-08-80
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*			FPD **FT**	10-2-12 8-08-80

[1] Current taxonomy is *Monadenia infumata setosa.*
[2] Listed by NMFS in 2001 and by USFWS in 2005.
[3] Listed by NMFS in 2009 and by USFWS in 2011.

	State Listing		Federal Listing	
Ohlone tiger beetle *Cicindela ohlone*			FE	10-03-01
Kern primrose sphinx moth *Euproserpinus euterpe*			FT	4-08-80
Mission blue butterfly *Icaricia icarioides missionensis*[4]			FE	6-01-76
Lotis blue butterfly *Lycaeides argyrognomon lotis*[5]			FE	6-01-76
Palos Verdes blue butterfly *Glaucopsyche lygdamus palosverdesensis*			FE	7-02-80
El Segundo blue butterfly *Euphilotes battoides allyni*			FE	6-01-76
Smith's blue butterfly *Euphilotes enoptes smithi*			FE	6-01-76
San Bruno elfin butterfly *Callophrys mossii bayensis*			FE	6-01-76
Lange's metalmark butterfly *Apodemia mormo langei*			FE	6-01-76
Bay checkerspot butterfly *Euphydryas editha bayensis*			FT	10-18-87
Quino checkerspot butterfly *Euphydryas editha quino (=E. e. wrighti)*			FE	1-16-97
Carson wandering skipper *Pseudocopaeodes eunus obscurus*			FE	8-07-02
Laguna Mountains skipper *Pyrgus ruralis lagunae*			FE	1-16-97
Callippe silverspot butterfly *Speyeria callippe callippe*			FE	12-05-97
Behren's silverspot butterfly *Speyeria zerene behrensii*			FE	12-05-97
Oregon silverspot butterfly[6] *Speyeria zerene hippolyta*			FT	7-02-80
Myrtle's silverspot butterfly *Speyeria zerene myrtleae*			FE	6-22-92
Delhi Sands flower-loving fly *Rhaphiomidas terminatus abdominalis*			FE	9-23-93

[4] Current taxonomy is *Plebejus icarioides missionensis.*
[5] Current taxonomy is *Plebejus idas lotis.*
[6] Also known by the common name is Hippolyta fritillary.

	State Listing		Federal Listing	
FISHES				
Green sturgeon - southern DPS *Acipenser medirostris*			FT[7]	6-06-06
Mohave tui chub *Gila bicolor mohavensis*[8]	SE	6-27-71	FE	10-13-70
Owens tui chub *Gila bicolor snyderi*[9]	SE	1-10-74	FE	8-05-85
Thicktail chub (**Extinct**) *Gila crassicauda*	**Delisted** SE	10-02-80 1-10-74		
Bonytail[10] *Gila elegans*	**SE** SR	1-10-74 6-27-71	FE	4-23-80
Sacramento splittail *Pogonichthys macrolepidotus*			**Removed**[11] FT	9-22-03 3-10-99
Colorado squawfish[12] *Ptychocheilus lucius*	SE	6-27-71	FE	3-11-67
Modoc sucker *Catostomus microps*	**SE** SR	10-02-80 1-10-74	FE	6-11-85
Santa Ana sucker *Catostomus santaanae*			FT[13]	5-12-00
Shortnose sucker *Chasmistes brevirostris*	**SE** SR	1-10-74 6-27-71	FE	7-18-88
Lost River sucker *Deltistes luxatus*	**SE** SR	1-10-74 6-27-67	FE	7-18-88
Razorback sucker *Xyrauchen texanus*	**SE** SR	1-10-74 6-27-71	FE	10-23-91
Delta smelt *Hypomesus transpacificus*	**SE** ST	1-20-10 12-09-93	FT	3-05-93
Longfin smelt *Spirinchus thaleichthys*	**ST** SCE	4-09-10 2-02-08		
Pacific eulachon - southern DPS *Thaleichthys pacificus*			FT FT	4-13-11[14] 5-17-10
Lahontan cutthroat trout *Oncorhynchus clarkii henshawi*[15]			**FT** FE	7-16-75 10-13-70

[7] Includes all spawning populations south of the Eel River.
[8] Current taxonomy: *Siphateles bicolor mohavensis.*
[9] Current taxonomy: *Siphateles bicolor snyderi*.
[10] Federal common name: bonytail chub.
[11] On 23 June 2000, the Federal Eastern District Court of Calif. found the final rule to be unlawful and on 22 Sept 2000 remanded the determination back to the USFWS for a reevaluation of the final decision. After a thorough review the USFWS removed the Sacramento splittail from the list of Threatened species.
[12] Current nomenclature and federal listing: Colorado pikeminnow.
[13] Populations in the Los Angeles, San Gabriel, and Santa Ana River basins.
[14] Eulachon was listed as Threatened by the NMFS in 2010 and by the USFWS in 2011.
[15] According to the American Fisheries Society Special Publication 29 (2004), "clarkii" has two i's.

	State Listing		Federal Listing	
Paiute cutthroat trout *Oncorhynchus clarkii seleniris*			**<u>FT</u>** FE	7-16-75 3-11-67[16]
Coho salmon - south of Punta Gorda[17] *Oncorhynchus kisutch*	SE[18]	3-30-05	**<u>FE</u>**[19] FT	8-29-05 12-02-96
Coho salmon - Punta Gorda to the N. border of California[20] *Oncorhynchus kisutch*	ST[21]	3-30-05	FT[22] FT	8-29-05 6-05-97
Steelhead - Southern California DPS[23] *Oncorhynchus mykiss*			FE[24] FE	2-06-06 10-17-97
Steelhead - South-Central California Coast DPS[25] *Oncorhynchus mykiss*			FT[26] FT	2-06-06 10-17-97
Steelhead - Central California Coast DPS[27] *Oncorhynchus mykiss*			FT[28] FT	2-06-06 10-17-97
Steelhead - California Central Valley DPS[29] *Oncorhynchus mykiss*			FT[30] FT	2-06-06 5-18-98
Steelhead - Northern California DPS[31] *Oncorhynchus mykiss*			FT[32] FT	2-06-06 8-07-00
Little Kern golden trout *Oncorhynchus mykiss whitei*[33]			FT	4-13-78
Chinook salmon - Winter-run[34] *Oncorhynchus tshawytscha*	SE	9-22-89	FE[35] FE	8-29-05 2-03-94
Chinook salmon - California coastal ESU[36] *Oncorhynchus tshawytscha*			FT[37] FT	8-29-05 11-15-99

[16] All species with a list date of 03-11-67 were listed under the Endangered Species Preservation Act of October 15, 1966.
[17] The Federal listing is for Central California Coast Coho ESU and includes populations from Punta Gorda south to, and including, the San Lorenzo River as well as populations in tributaries to San Francisco Bay, excluding the Sacramento-San Joaquin River system.
[18] The Coho south of San Francisco Bay were state listed in 1995. In February 2004 the Fish and Game Commission determined that the Coho from San Francisco to Punta Gorda should also be listed as Endangered. This change was finalized by the Office of Administrative Law on March 30, 2005.
[19] The NMFS completed a comprehensive status review in 2005 reaffirming the status.
[20] The Federal listing is for Southern Oregon/Northern California Coast Coho ESU and includes populations in coastal streams between Cape Blanco, Oregon and Punta Gorda, California.
[21] The Fish and Game Commission determined that the Coho from Punta Gorda to the Oregon border should be listed as Threatened on February 25, 2004. This determination was finalized by the Office of Administrative Law on March 30, 2005.
[22] The NMFS completed a comprehensive status review in 2005 reaffirming the status.
[23] Coastal basins from the Santa Maria River (inclusive), south to the U.S.-Mexico Border.
[24] The NMFS completed a comprehensive status review in 2006 reaffirming the status.
[25] Coastal basins from the Pajaro River (inclusive) south to, but not including, the Santa Maria River.
[26] The NMFS completed a comprehensive status review in 2006 reaffirming the status.
[27] Coastal streams from the Russian River (inclusive) to Aptos Creek (inclusive), and the drainages of San Francisco, San Pablo, and Suisun Bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin Rivers; and tributary streams to Suisun Marsh including Suisun Creek, Green Valley Creek, and an unnamed tributary to Cordelia Slough (commonly referred to as Red Top Creek), exclusive of the Sacramento-San Joaquin River Basin of the California Central Valley.
[28] The NMFS completed a comprehensive status review in 2006 reaffirming the status.
[29] The Sacramento and San Joaquin Rivers and their tributaries.
[30] The NMFS completed a comprehensive status review in 2006 reaffirming the status.
[31] Naturally spawned populations residing below impassable barriers in coastal basins from Redwood Creek in Humboldt County to, and including, the Gualala River in Mendocino County.
[32] The NMFS completed a comprehensive status review in 2006 reaffirming the status.
[33] Originally listed as *Salmo aguabonita whitei*. The genus *Salmo* was reclassified as *Oncorhynchus* changing the name to *Oncorhynchus aguabonita whitei*. However, recent studies indicate this is a subspecies of rainbow trout, therefore *Oncorhynchus mykiss whitei*.
[34] The federal designation is for Chinook salmon - Sacramento River winter-run ESU and described as winter-run populations in the Sacramento River and its tributaries in California.
[35] The NMFS completed a comprehensive status review in 2005 reaffirming the status.

	State Listing		Federal Listing	
Chinook salmon - Spring-run[38] *Oncorhynchus tshawytscha*	ST	2-05-99	FT[39] FT	8-29-05 11-15-99
Bull trout *Salvelinus confluentus*	SE	10-02-80	FT	12-01-99
Desert pupfish *Cyprinodon macularius*	SE	10-02-80	FE	3-31-86
Tecopa pupfish (**Extinct)** *Cyprinodon nevadensis calidae*	**Delisted** SE	1987 6-27-71	**Delisted** FE	1-15-82 10-13-70
Owens pupfish *Cyprinodon radiosus*	SE	6-27-71	FE	3-11-67
Cottonball Marsh pupfish *Cyprinodon salinus milleri*	ST	1-10-74		
Unarmored threespine stickleback *Gasterosteus aculeatus williamsoni*	SE	6-27-71	FE	10-13-70
Rough sculpin *Cottus asperrimus*	ST	1-10-74		
Tidewater goby *Eucyclogobius newberryi*			Withdrawn FPD[40] **FE**	12-09-02 6-24-99 2-04-94
AMPHIBIANS				
California tiger salamander[41] *Ambystoma californiense*	ST[42]	8-19-10	(FE) (FT)	
California tiger salamander - central California DPS *Ambystoma californiense*	(ST)		FT[43]	9-03-04
California tiger salamander - Santa Barbara County DPS *Ambystoma californiense*	(ST)		FE[43]	9-15-00
California tiger salamander - Sonoma County DPS *Ambystoma californiense*	(ST)		FE[43]	3-19-03
Santa Cruz long-toed salamander *Ambystoma macrodactylum croceum*	SE	6-27-71	FE	3-11-67
Siskiyou Mountains salamander *Plethodon stormi*	SCD **ST**	9-30-05 6-27-71		

36 Rivers and streams south of the Klamath River to the Russian River.
37 The NMFS completed a comprehensive status review in 2005 reaffirming the status.
38 The State listing is for "Spring-run chinook salmon (*Oncorhynchus tshawytscha*) of the Sacramento River drainage." The Federal listing is for Central Valley spring-run Chinook ESU and includes populations of spring-run Chinook salmon in the Sacramento River and its tributaries including the Feather River.
39 The NMFS completed a comprehensive status review in 2005 reaffirming the status.
40 Proposal to delist referred to populations north of Orange County only.
41 The State listing refers to the entire range of the species.
42 Adopted May 20, 2010. The Office of Administrative Law approved the listing on Aug 2, 2010 and the effective date of regulations is Aug 19, 2010.
43 In 2004 the California tiger salamander was listed as Threatened statewide. The Santa Barbara County and Sonoma County Distinct Vertebrate Population Segments (DPS), formerly listed as Endangered, were reclassified to Threatened. On Aug 19 2005 U.S. District court vacated the downlisting of the Sonoma and Santa Barbara populations from Endangered to Threatened. Therefore, the Sonoma & Santa Barbara populations are once again listed as Endangered.

	State Listing			Federal Listing	
Scott Bar salamander *Plethodon asupak*	ST[44]	6-27-71			
Tehachapi slender salamander *Batrachoseps stebbinsi*	ST	6-27-71			
Kern Canyon slender salamander *Batrachoseps simatus*	ST	6-27-71			
Desert slender salamander *Batrachoseps aridus*[45]	SE	6-27-71		FE	6-04-73
Shasta salamander *Hydromantes shastae*	ST	6-27-71			
Limestone salamander *Hydromantes brunus*	ST	6-27-71			
Black toad *Bufo exsul*[46]	ST	6-27-71			
Arroyo toad *Anaxyrus californicus*[47]				FE	1-17-95
California red-legged frog *Rana aurora draytonii*[48]				FT	5-20-96
Southern mountain yellow-legged frog[49] *Rana muscosa*	SCE[50]	9-21-10		FE[51]	8-01-02
Sierra Nevada mountain yellow-legged frog *Rana sierrae*	SCT[52]	9-21-10			
<u>REPTILES</u>					
Desert tortoise *Gopherus agassizii*	ST	8-03-89		FT	4-02-90
Green sea turtle[53] *Chelonia mydas*				**<u>FT</u>** FE	7-28-78 10-13-70
Loggerhead sea turtle - North Pacific DPS[54] *Caretta caretta*				**<u>FE</u>** FPE FT	10-24-11 3-16-10 7-28-78

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[44] Since this newly described species was formerly considered to be a subpopulation of *Plethodon stormi*, and since *Plethodon stormi* is listed as Threatened under the CESA, *Plethodon asupak* retains the Threatened designation.
[45] Current taxonomy: *Batrachoseps major aridus.*
[46] Current taxonomy: *Anaxyrus exsul*.
[47] At the time of listing, arroyo toad was known as *Bufo microscaphus californicus*, a subspecies of southwestern toad. In 2001 it was determined to be its own species, *Bufo californicus*. Since then, many species in the genus *Bufo* were changed to the genus *Anaxyrus*, and now arroyo toad is known as *Anaxyrus californicus*.
[48] Current taxonomy: *Rana draytonii.*
[49] Though the scientific name *Rana muscosa* is not disputed, the State used this common name in the 16 Oct 2012 Notice of Proposed Changes in Regulation, whereas the USFWS listing refers to the distinct population segment listed as mountain yellow-legged frog – Southern California DPS. This species is also known by the common name Sierra Madre yellow-legged frog (Vredenburg et al. 2007).
[50] Filed with the Office of Administrative Law on 16 January 2013; Effective Date of Regulation is pending.
[51] Federal listing refers to the distinct population segment (DPS) in the San Gabriel, San Jacinto, and San Bernardino Mountains only, with a recognized common name of Mountain yellow-legged frog - Southern California DPS. MYLF north of the Tehachapi Mountains are a Federal candidate.
[52] Filed with the Office of Administrative Law on 16 January 2013; Effective Date of Regulation is pending.
[53] Current nomenclature: green turtle.

	State Listing			Federal Listing	
Olive (=Pacific) ridley sea turtle *Lepidochelys olivacea*				FT	7-28-78
Leatherback sea turtle *Dermochelys coriacea*				FE	6-02-70
Barefoot banded gecko[55] *Coleonyx switaki*	ST	10-02-80			
Coachella Valley fringe-toed lizard *Uma inornata*	SE	10-02-80		FT	9-25-80
Blunt-nosed leopard lizard *Gambelia silus*[56]	SE	6-27-71		FE	3-11-67
Flat-tailed horned lizard *Phrynosoma mcallii*				**Withdrawn**[57] FPT[58]	3-15-11 11-29-93
Island night lizard *Xantusia riversiana*				FT	8-11-77
Southern rubber boa *Charina bottae umbratica*[59]	ST	6-27-71			
Alameda whipsnake *Masticophis lateralis euryxanthus*	ST	6-27-71		FT	12-05-97
San Francisco garter snake *Thamnophis sirtalis tetrataenia*	SE	6-27-71		FE	3-11-67
Giant garter snake *Thamnophis couchi gigas*[60]	ST	6-27-71		FT	10-20-93
BIRDS					
Short-tailed albatross *Phoebastria albatrus*				FE FE	8-30-00[61] 6-2-1970
California brown pelican[62] (**Recovered**) *Pelecanus occidentalis californicus*	**Delisted** SE	6-03-09 6-27-71		**Delisted** FE	12-17-09 2-20-08 10-13-70
Aleutian Canada goose **(Recovered)** *Branta canadensis leucopareia*[63]				**Delisted** FT FE	3-20-01 12-12-90 3-11-67

[54] 1978 listing was for the worldwide range of the species. The Mar 16, 2010 proposed rule and Oct 24, 2011 final rule are for the North Pacific DPS (north of the equator & south of 60 degrees north latitude).
[55] Current nomenclature: Barefoot gecko.
[56] Current taxonomy: *Gambelia sila*. Both the State and Federal recognize the common name blunt-nosed leopard lizard (SSAR), but also known as bluntnose leopard lizard (CNAH). Originally listed under the ESA as *Crotaphytus wislizenii silus*.
[57] On June 28, 2006 the USFWS determined that the proposed listing was not warranted and the proposed rule that had been reinstated on Nov 17, 2005 was withdrawn. USFWS specifically reiterated that the 29 Nov 1993 proposal to list as Threatened was withdrawn as of 15 Mar 2011.
[58] On November 17, 2005, the U. S. District Court for the District of Arizona vacated the January 3, 2003 withdrawal of the proposed rule to list the flat-tailed horned lizard and reinstated the 1993 proposed rule.
[59] Current taxonomy: *Charina umbratica*.
[60] Current taxonomy and Federal listing: *Thamnophis gigas.*
[61] Listed as Endangered in one of the original species list, but "due to an inadvertent oversight" when the 1973 ESA repealed the 1969 Act, short-tailed albatross was effectively delisted. Proposed listing to fix this error in 1980, with final rule in 2000.
[62] Federal nomenclature: Brown pelican (*Pelecanus occidentalis*).
[63] Current taxonomy: Cackling goose (*Branta hutchinsii leucopareia*).

	State Listing			Federal Listing	
California condor *Gymnogyps californianus*	SE	6-27-71		FE	3-11-67
Bald eagle *Haliaeetus leucocephalus*	**SE** (rev) SE	10-02-80 6-27-71		**Delisted**[64] FT FE (rev) FE	8-08-07 7-06-99 8-11-95 2-14-78 3-11-67
Swainson's hawk *Buteo swainsoni*	ST	4-17-83			
American peregrine falcon **(Recovered)** *Falco peregrinus anatum*	**Delisted** SE	11-04-09 6-27-71		**Delisted** FE	8-25-99 6-02-70
Arctic peregrine falcon **(Recovered)** *Falco peregrinus tundrius*				**Delisted** FT FE	10-05-94 3-20-84 6-02-70
California black rail *Laterallus jamaicensis coturniculus*	ST	6-27-71			
California clapper rail *Rallus longirostris obsoletus*	SE	6-27-71		FE	10-13-70
Light-footed clapper rail *Rallus longirostris levipes*	SE	6-27-71		FE	10-13-70
Yuma clapper rail *Rallus longirostris yumanensis*	**ST** SE	2-22-78 6-27-71		FE	3-11-67
Greater sandhill crane *Grus canadensis tabida*	ST	4-17-83			
Western snowy plover *Charadrius alexandrinus nivosus*[65]				FT[66]	4-05-93
Mountain plover *Charadrius montanus*				**Withdrawn** FPT	5-12-11 12-5-02
California least tern *Sterna antillarum browni*[67]	SE	6-27-71		FE	10-13-70
Marbled murrelet *Brachyramphus marmoratus*	SE	3-12-92		FT	9-30-92
Xantus's murrelet *Synthliboramphus hypoleucus*	ST[68]	12-22-04			
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	**SE** ST	3-26-88 6-27-71			

[64] The Post-delisting Monitoring Plan will monitor the status of the bald eagle over a 20 year period with sampling events held once every 5 years.
[65] Current taxonomy: *Charadrius nivosus nivosus* (AOU 2011).
[66] Federal status applies only to the Pacific coastal population.
[67] Current taxonomy: *Sternula antillarum browni.*
[68] The Fish and Game Commission determined that Xantus's murrelet should be listed as a Threatened species February 24, 2004. As part of the normal listing process, this decision was reviewed by the Office of Administrative Law. The listing became effective on Dec 22, 2004.

	State Listing			Federal Listing	
Elf owl *Micrathene whitneyi*	SE	10-02-80			
Northern spotted owl *Strix occidentalis caurina*				FT	6-22-90
Great gray owl *Strix nebulosa*	SE	10-02-80			
Gila woodpecker *Melanerpes uropygialis*	SE	3-17-88			
Black-backed woodpecker *Picoides arcticus*	SCE or SCT	12-27-11			
Gilded northern flicker[69] *Colaptes auratus chrysoides*	SE	3-17-88			
Willow flycatcher *Empidonax traillii*	SE[70]	1-02-91			
Southwestern willow flycatcher *Empidonax traillii extimus*	(SE)			FE	3-29-95
Bank swallow *Riparia riparia*	ST	6-11-89			
Coastal California gnatcatcher *Polioptila californica californica*				FT	3-30-93
San Clemente loggerhead shrike *Lanius ludovicianus mearnsi*				FE	8-11-77
Arizona Bell's vireo *Vireo bellii arizonae*	SE	3-17-88			
Least Bell's vireo *Vireo bellii pusillus*	SE	10-02-80		FE	5-02-86
Inyo California towhee *Pipilo crissalis eremophilus*[71]	SE	10-02-80		FT	8-03-87
San Clemente sage sparrow *Amphispiza belli clementeae*				FT	8-11-77
Belding's savannah sparrow *Passerculus sandwichensis beldingi*	SE	1-10-74			
Santa Barbara song sparrow **(Extinct)** *Melospiza melodia graminea*				**Delisted** FE	10-12-83 6-04-73
MAMMALS					
Point Arena mountain beaver *Aplodontia rufa nigra*				FE	12-12-91

69 Current taxonomy: Gilded flicker (*Colaptes chrysoides*).
70 State listing includes all subspecies.
71 Current taxonomy: *Melozone crissalis eremophilus*.

	State Listing		Federal Listing	
San Joaquin antelope squirrel[72] *Ammospermophilus nelsoni*	ST	10-02-80		
Mohave ground squirrel[73] *Spermophilus mohavensis*	ST	6-27-71		
Morro Bay kangaroo rat *Dipodomys heermanni morroensis*	SE	6-27-71	FE	10-13-70
Giant kangaroo rat *Dipodomys ingens*	SE	10-02-80	FE	1-05-87
San Bernardino kangaroo rat[74] *Dipodomys merriami parvus*			FE	9-24-98
Tipton kangaroo rat *Dipodomys nitratoides nitratoides*	SE	6-11-89	FE	7-08-88
Fresno kangaroo rat *Dipodomys nitratoides exilis*	**SE** SR	10-02-80 6-27-71	FE	3-01-85
Stephens' kangaroo rat *Dipodomys stephensi*[75]	ST	6-27-71	FE	9-30-88
Pacific pocket mouse *Perognathus longimembris pacificus*			FE	9-26-94
Amargosa vole *Microtus californicus scirpensis*	SE	10-02-80	FE	11-15-84
Riparian woodrat[76] *Neotoma fuscipes riparia*			FE	3-24-00
Salt-marsh harvest mouse *Reithrodontomys raviventris*	SE	6-27-71	FE	10-13-70
American pika *Ochotona princeps*	SCT	10-26-11		
Riparian brush rabbit *Sylvilagus bachmani riparius*	SE	5-29-94	FE	3-24-00
Buena Vista Lake shrew[77] *Sorex ornatus relictus*			FE	4-05-02
Lesser long-nosed bat *Leptonycteris yerbabuenae*			FE	10-31-88
Gray wolf *Canis lupus*	SCE	10-18-12	FE[78]	4-10-78

[72] Current taxonomy: Nelson's antelope squirrel.
[73] Current taxonomy: *Xerospermophilus mohavensis.*
[74] Federal nomenclature: San Bernardino Merriam's kangaroo rat.
[75] Federal taxonomy: included *Dipodomys cascus*, an invalid junior synonym for *Dipodomys stephensi.*
[76] Federal nomenclature: Riparian (=San Joaquin Valley) woodrat.
[77] Federal nomenclature: Buena Vista Lake ornate shrew.
[78] The full species, *Canis lupus*, was listed as Endangered in 1978. Though the status of the gray wolf is being challenged in other states, any gray wolves present or dispersing into California are considered federally Endangered.

	State Listing			Federal Listing	
Island fox *Urocyon littoralis*	ST[79]	6-27-71			
San Miguel Island Fox *Urocyon littoralis littoralis*	(ST)			FE	4-05-04
Santa Catalina Island Fox *Urocyon littoralis catalinae*	(ST)			FE	4-05-04
Santa Cruz Island Fox *Urocyon littoralis santacruzae*	(ST)			FE	4-05-04
Santa Rosa Island Fox *Urocyon littoralis santarosae*	(ST)			FE	4-05-04
San Joaquin kit fox *Vulpes macrotis mutica*	ST	6-27-71		FE	3-11-67
Sierra Nevada red fox *Vulpes vulpes necator*	ST	10-02-80			
Guadalupe fur seal *Arctocephalus townsendi*	ST	6-27-71		**FT** FE	1-15-86 3-11-67
Steller sea lion - Eastern DPS *Eumetopias jubatus*				FPD **FT** FT	4-18-12 6-4-97[80] 4-05-90
Southern sea otter *Enhydra lutris nereis*				FT	1-14-77
Wolverine *Gulo gulo*	ST	6-27-71			
Fisher - West Coast DPS[81] *Martes pennant*	**Not warranted** SCT or SCE[82]	6-23-10 4-14-09			
California (=Sierra Nevada) bighorn sheep *Ovis canadensis californiana*[83]	**SE** ST	8-27-99 6-27-71		FE	1-03-00
Peninsular bighorn sheep DPS[84] *Ovis canadensis cremnobates*	ST	6-27-71		FE	3-18-98
North Pacific right whale *Eubalaena japonica*[85]				FE[86] FE	4-7-08 6-02-70

[79] State listing includes all 6 subspecies on all 6 islands. Federal listing is for only 4 subspecies on 4 islands.
[80] The NMFS reclassified Steller sea lion as two distinct population segments: western DPS west of 144 degrees longitude (Endangered), and eastern DPS east of 144 degrees longitude (Threatened).
[81] The Fish and Game Commission during their review of the fisher petitioning recognized the common name Pacific fisher. Adopted here is the common name used in the USFWS candidacy (2 Apr 2004), fisher, for the West Coast distinct population segment for California, Oregon, and Washington.
[82] The Fish and Game Commission notice of finding stated that the Pacific fisher was a candidate for listing as either an Endangered or a Threatened species. At the June 23, 2010 meeting the Commission determined that the listing was not warranted.
[83] Current & Federal taxonomy: Sierra Nevada bighorn sheep (*Ovis canadensis sierrae)*
[84] Current taxonomy: the subspecies *O.c. cremnobates* has been synonymized with *O.c. nelsoni*. Peninsular bighorn sheep are now considered to be a Distinct Vertebrate Population Segment (DPS).
[85] The scientific name was clarified in the Federal Register Vol. 68, No. 69 April 10, 2003.

	State Listing			Federal Listing	
Sei whale *Balaenoptera borealis*				FE	6-02-70
Blue whale *Balaenoptera musculus*				FE	6-02-70
Fin whale *Balaenoptera physalus*				FE	6-02-70
Humpback whale[87] *Megaptera novaeangliae*				FE	6-02-70
Gray whale **(Recovered)** *Eschrichtius robustus*				**Delisted** FE	6-15-94 6-02-70
Killer whale (Southern resident DPS) *Orcinus orca*				FE[88] FE	4-04-07 2-16-06 12-22-04
Sperm whale *Physeter macrocephalus*[89]				FE	6-02-70

[86] The NMFS completed a status review of right whales in the N. Pacific and N. Atlantic Oceans and determined the previously Endangered northern right whale (*Eubalaena* spp.) as two separate Endangered species: North Pacific right whale (*E. japonica*) and North Atlantic right whale (*E. glacialis*).
[87] Also known as Hump-backed whale.
[88] The killer whale was listed as Endangered by the NMFS on Feb 16, 2006 and by the USFWS on Apr 4, 2007.
[89] Current taxonomy: *Physeter catodon* with *P. macrocephalus* as a synonym.

ABBREVIATIONS

CESA: California Endangered Species Act

DPS: Distinct population segment

ESA: Endangered Species Act (Federal)

ESU: Evolutionarily significant unit

NMFS: National Marine Fisheries Service

NOAA: National Oceanic and Atmospheric Administration

USFWS: United States Fish and Wildlife Service

ADDITIONAL RESOURCES

The California Fish and Game Commission publishes notices relating to changes to Title 14 of the California Code of Regulations: http://www.fgc.ca.gov/

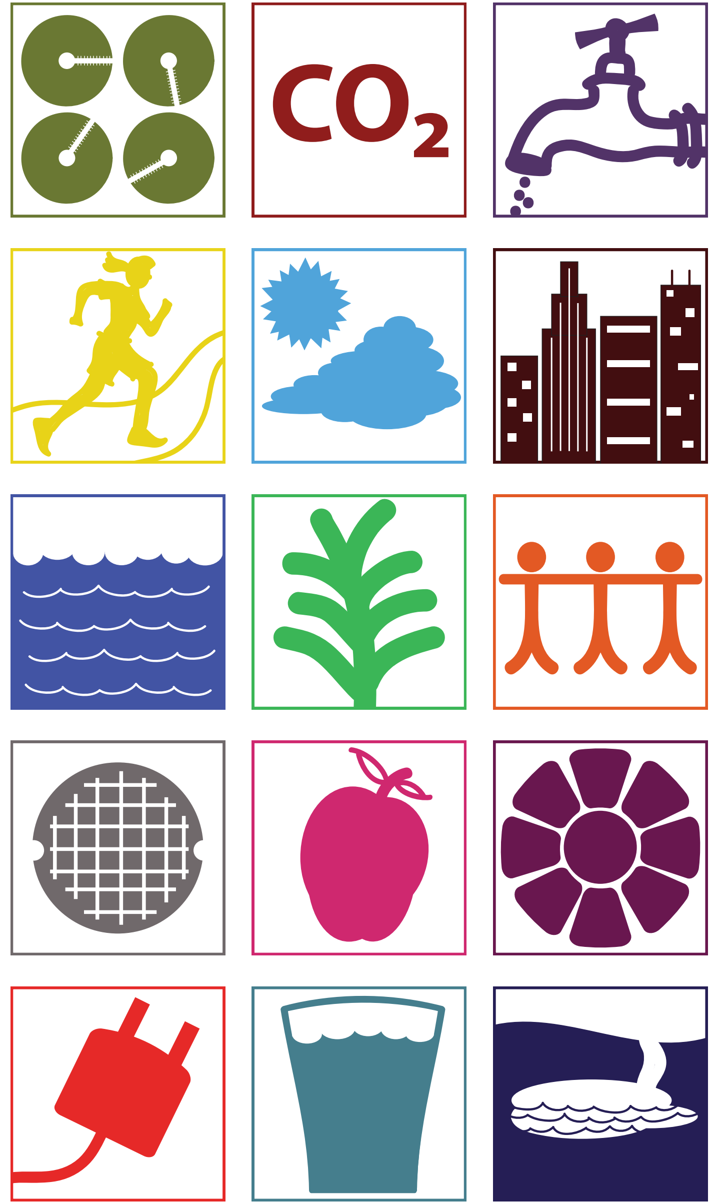
Title 14 of the California Code of Regulations can be accessed through The Office of Administrative Law: http://www.oal.ca.gov/

The U.S. Fish and Wildlife Service is responsible for protecting Endangered and Threatened species, and conserving candidate species and at-risk species so that ESA listing is not necessary: http://www.fws.gov/Endangered/

NOAA's National Marine Fisheries Service, Office of Protected Resources is responsible for protecting marine mammals and Endangered and Threatened marine life: http://www.nmfs.noaa.gov/pr/

The Value of Green Infrastructure

A Guide to Recognizing Its Economic, Environmental and Social Benefits



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Acknowledgements

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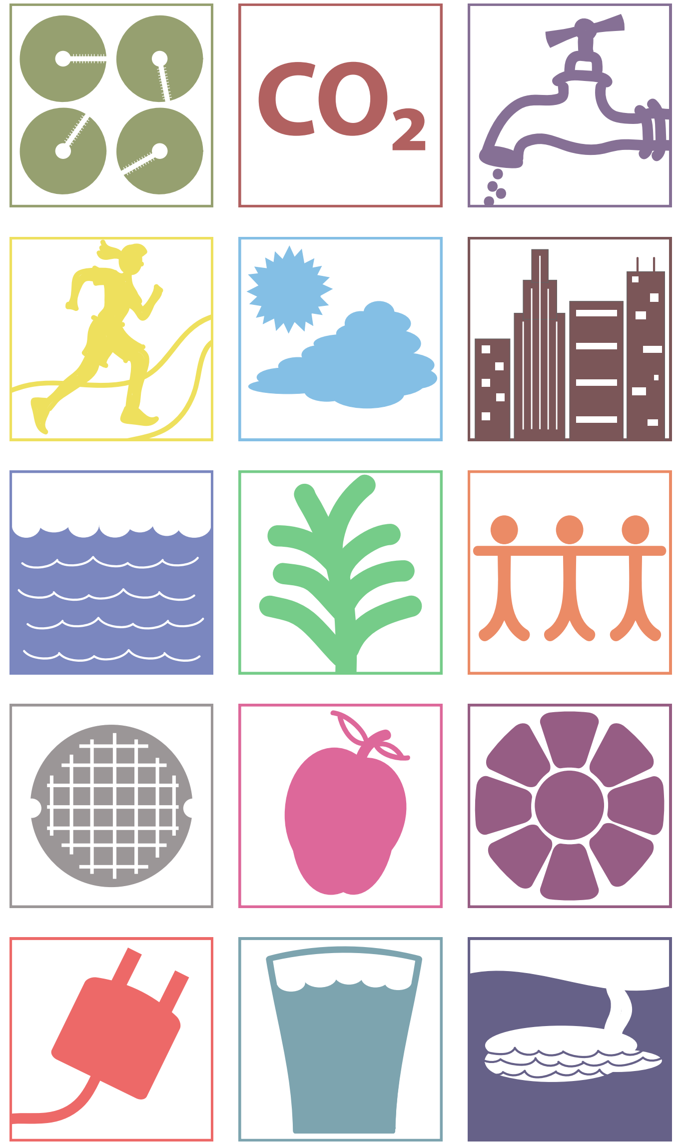
The following advisors shared their time and expertise in a variety of different ways including reviewing initial concepts and guidebook drafts, contributing to particular practice and benefit sections, and presenting at the 2010 workshop. Those include Dr. John Braden of the University of Illinois, Chris Kloss of the Low Impact Development Center, Ed MacMullen of EcoNorthwest, Dr. Franco Montalto of Drexel University, Dan Nees of Forest Trends, David Nowak of the U.S. Forest Service, Steven Peck of Green Roofs for Healthy Cities, Dr. Sabina Shaikh of the University of Chicago, Robert Goo of the U.S. EPA, Mike Alonso of Casey Trees and Jen McGraw of CNT.

This work also extends initial research in support of CNT's Green Values Calculator® (greenvalues.cnt.org), which identified additional values related to green infrastructure practices. Under funding from the Joyce Foundation, CNT's Bill Eyring, Julia Kennedy and Daniel Hollander documented a range of benefits that were the starting points for the research of this guide.



Introduction
What Is Green Infrastructure & Why Does It Matter?

Green infrastructure (GI) is a network of decentralized stormwater management practices, such as green roofs, trees, rain gardens and permeable pavement, that can capture and infiltrate rain where it falls, thus reducing stormwater runoff and improving the health of surrounding waterways. While there are different scales of green infrastructure, such as large swaths of land set aside for preservation, this guide focuses on GI's benefits within the urban context.

The ability of these practices to deliver multiple ecological, economic and social benefits or services has made green infrastructure an increasingly popular strategy in recent years. (See Case Study section.) In addition to reducing polluted stormwater runoff, GI practices can also positively impact energy consumption, air quality, carbon reduction and sequestration, property prices, recreation and other elements of community health and vitality that have monetary or other social value. Moreover, green infrastructure practices provide flexibility to communities faced with the need to adapt infrastructure to a changing climate.

Why This Guide?

Although valuation of green infrastructure's monetary benefits has advanced considerably in recent years, it is still a developing field. The EPA publication *Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices* (2007) documented the comparative construction costs of green infrastructure practices in residential construction but did not explore performance benefits. While numerous published studies address either the benefits coming from one type of practice, such as energy implications of green roofs, or the collective impacts of a single practice, such as urban forestry's impact on water, energy, and other elements, such studies do not achieve a cumulative assessment of multiple benefits.

Green infrastructure's value as a municipal or private investment depends in part on its effects beyond water management and thus upon a community's ability to model and measure these additional values. Short of conducting an intensive study and calculation of actions in a specific community, municipalities have generally lacked the tools to determine green infrastructure's multiple benefits. As such, defining or measuring the extent of green infrastructure's multiple benefits has remained a challenge. While a number of cities have begun to explore GI within their own municipal infrastructure programs, no general method for estimating or documenting such benefits has yet emerged.

Due to these gaps in information and methodology, decision-making regarding stormwater infrastructure investments has generally lacked recognition of the monetary benefits that GI provides communities. With limited ability to quantify GI's benefits, municipalities have often favored single-purpose grey infrastructure projects. However, any cost-benefit analysis comparing grey infrastructure with green infrastructure would be incomplete without factoring in the multiple benefits green infrastructure can provide.

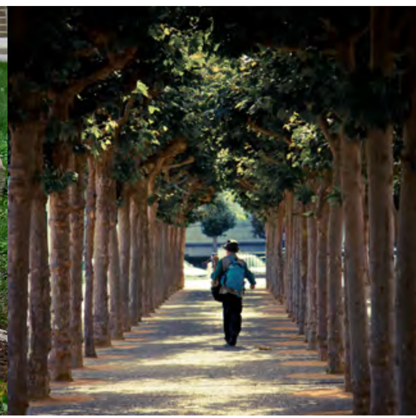
Purpose of the Guide

This guide distills key considerations involved in assessing the economic merits of green infrastructure practices. It examines the steps necessary to calculate a variety of performance benefits gained by implementing GI strategies and then, where possible, demonstrates simplified illustrative examples that estimate the magnitude and value of these benefits.

In clarifying how to assign value to potential green infrastructure benefits, this guide can assist decision-makers in evaluating options for water management. A more clear view of GI's values will help communities decide where, when and to what extent green infrastructure practices should become part of future planning, development and redevelopment.

The guide aims to:

- **Inform decision-makers and planners about the multiple benefits green infrastructure delivers to communities.**
- **Guide communities in valuing the benefits of potential green infrastructure investments.**

Green Infrastructure Benefits and Practices

This section, while not providing a comprehensive list of green infrastructure practices, describes the five GI practices that are the focus of this guide and examines the breadth of benefits this type of infrastructure can offer. The following matrix is an illustrative summary of how these practices can produce different combinations of benefits. Please note that these benefits accrue at varying scales according to local factors such as climate and population.

Benefit	Reduces Stormwater Runoff											Improves Community Livability						
Practice	Reduces Water Treatment Needs	Improves Water Quality	Reduces Grey Infrastructure Needs	Reduces Flooding	Increases Available Water Supply	Increases Groundwater Recharge	Reduces Salt Use	Reduces Energy Use	Improves Air Quality	Reduces Atmospheric CO_2	Reduces Urban Heat Island	Improves Aesthetics	Increases Recreational Opportunity	Reduces Noise Pollution	Improves Community Cohesion	Urban Agriculture	Improves Habitat	Cultivates Public Education Opportunities
Green Roofs	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Maybe	Yes	Maybe	Maybe	Yes	Yes
Tree Planting	Yes	Yes	Yes	Yes	No	Maybe	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Maybe	Yes	Yes
Bioretention & Infiltration	Yes	Yes	Yes	Yes	Maybe	Maybe	No	No	Yes	Yes	Yes	Yes	Yes	Maybe	Maybe	No	Yes	Yes
Permeable Pavement	Yes	Yes	Yes	Yes	No	Maybe	Yes	Maybe	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes
Water Harvesting	Yes	Yes	Yes	Yes	Yes	Maybe	No	Maybe	Maybe	Maybe	No	No	No	No	No	No	No	Yes

Yes Maybe No

Green Roofs

A green roof is a rooftop that is partially or completely covered with a growing medium and vegetation planted over a waterproofing membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems. Green roofs are separated into several categories based on the depth of their growing media. **Extensive** green roofs have a growing media depth of two to six inches. **Intensive** green roofs feature growing media depth greater than six inches (GRHC).

As green, or vegetated, roof systems become more prevalent in the United States, the benefits they can provide to a wide range of private and public entities become more apparent. These benefits are outlined below.

Reduces Stormwater Runoff:

- Green roofs can store significant amounts of water in their growing media. This water is eventually evaporated from the soil or transpired by the plants on the roof, thus reducing the runoff entering sewer systems and waterways, which can help alleviate the risk of combined sewer overflows (CSO).

Reduces Energy Use:

- Additional insulation provided by the growing media of a green roof can reduce a building's energy consumption by providing superior insulation compared to conventional roofing materials.
- The presence of plants and growing media reduces the amount of solar radiation reaching the roof's surface, decreasing roof surface temperatures and heat influx during warm-weather months.
- Evaporative cooling from water retained in the growing media reduces roof surface temperatures.

Improves Air Quality:

- Locally, the vegetation planted on green roofs takes up air pollutants and intercepts particulate matter.
- The cooling effect of vegetation lessens smog formation by

slowing the reaction rate of nitrogen oxides and volatile organic compounds.

- By reducing energy use, green roofs lessen the air pollution caused by electricity generation.

Reduces Atmospheric CO_2:

- Green roof vegetation directly sequesters carbon.
- By reducing energy use and the urban heat island effect, green roofs lower carbon dioxide emissions from regional electricity generation.

Reduces Urban Heat Island:

- The local evaporative cooling provided by green roofs can reduce elevated temperatures present in urban areas as a result of heat-absorbing surfaces such as streets and conventional roofs.

Improves Community Livability:

- Green roofs improve the local aesthetics of a community.
- Soil and vegetation help reduce sound transmission, thus reducing local noise pollution levels.
- Green roofs can increase recreational opportunities by providing outdoor areas for people to use and enjoy. They also have the potential to foster improved community interactions that help build social capital.
- Green roofs may also provide opportunities for urban agriculture.

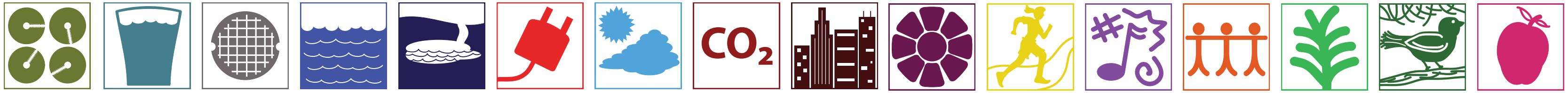
Improves Habitat:

- Increased vegetation helps to support biodiversity and provides valuable habitat for a variety of flora and fauna.

Cultivates Public Education Opportunities:

- Managing future economic and environmental constraints will require full community participation and partnership. Green infrastructure provides an opportunity to develop community awareness and understanding around the importance of sustainable water resource management.
- Green roofs increase community interest in green infrastructure through their aesthetic appeal, which provides a great opportunity for public education.

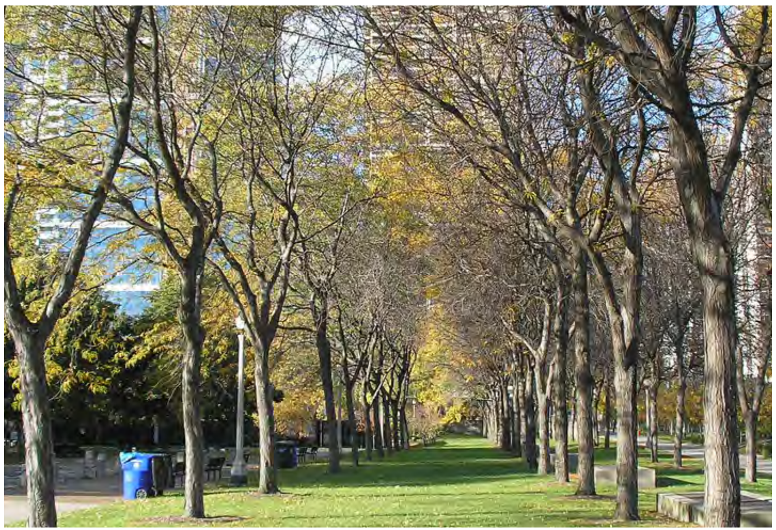
Tree Planting



Planting trees provides many services which have ecological, economic and social implications. Whether measured on a tree-by-tree basis or on a larger scale such as an urban forest, tree planting has a multitude of benefits.

Reduces Stormwater Runoff:

- Trees intercept rainfall and help increase infiltration and the ability of soil to store water.
- Tree canopies diminish the impact of raindrops on barren surfaces.
- Transpiration through leaves minimizes soil moisture, which reduces runoff.



Increases Groundwater Recharge:

- Trees can contribute to local aquifer recharge and to the improvement of watershed system health, from both quantity and quality standpoints.

Reduces Energy Use:

- When properly placed, trees provide shade, which can help cool the air and reduce the amount of heat reaching and being absorbed by buildings. In warm weather, this can reduce the energy needed to cool buildings.
- Trees reduce wind speeds. Wind speed, especially in areas with cold winters, can have a significant impact on the energy needed for heating.
- Trees release water into the atmosphere, resulting in cooler air temperatures and reduced building energy consumption.

Improves Air Quality:

- Trees absorb air pollutants (e.g. NO_2, SO_2, and O_3) and intercept particulate matter (PM10).
- Trees reduce energy consumption, which improves air quality and reduces the amount of greenhouse gases, including N_2O and CH_4.

Reduces Atmospheric CO_2:

- Through direct sequestration, trees reduce atmospheric carbon dioxide levels.
- Tree planting reduces energy consumption, which in turn reduces CO_2 levels.



Reduces Urban Heat Island:

- The various cooling functions of trees help to reduce the urban heat island effect, thereby reducing heat stress-related illnesses and fatalities.

Improves Community Livability:

- Trees provide beauty and privacy, which improve community aesthetics.
- Planting trees increases recreational opportunities for communities by improving pathways, creating places to gather and providing shade during warm weather.
- Trees provide a sense of place and well-being, which can strengthen community cohesion.
- Trees help to reduce sound transmission, reducing local noise pollution levels.
- Tree planting may provide opportunities for urban foraging and food production.

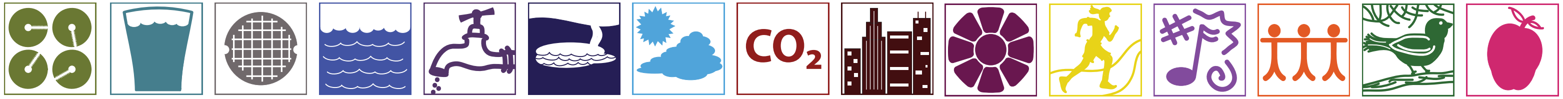
Improves Habitat

- Planting trees increases wildlife habitat, especially when plant species native to the region are used.

Cultivates Public Education Opportunities:

- Managing future economic and environmental constraints will require full community participation and partnership. Green infrastructure provides an opportunity to develop community awareness and understanding around the importance of sustainable water resource management.
- Community tree planting provides a valuable educational opportunity for residents to become more aware of the benefits of green infrastructure.

Bioretention and Infiltration Practices



Bioretention and infiltration practices come in a variety of types and scales, including rain gardens, bioswales and wetlands. Rain gardens are dug at the bottom of a slope in order to collect water from a roof downspout or adjacent impervious surface. They perform best if planted with long-rooted plants like native grasses. Bioswales are typically installed within or next to paved areas like parking lots or along roads and sidewalks. They allow water to pool for a period of time and then drain, and are designed to allow for overflow into the sewer system. Bioswales effectively trap silt and other pollutants that are normally carried in the runoff from impermeable surfaces. While the multitude of benefits provided by wetlands has been well documented elsewhere, this guide only addresses smaller scale practices.

Reduces Stormwater Runoff:

- These practices store and infiltrate stormwater, which mitigates flood impacts and prevents the stormwater from polluting local waterways.

Increases Available Water Supply:

- By reducing the amount of potable water used for outdoor irrigation, these practices may also increase available water supplies.

Increases Groundwater Recharge:

- Bioretention and infiltration practices have the potential to increase groundwater recharge by directing rainwater into the ground instead of pipes.

Improves Air Quality:

- Like other vegetated green infrastructure features, infiltration practices can improve air quality through uptake of criteria air pollutants and the deposition of particulate matter.
- By minimizing the amount of water entering treatment facilities, these practices also reduce energy use which, in turn, reduces air pollution by lowering the amount of greenhouses gases emitted.

Reduces Atmospheric CO_2:

- Bioretention and infiltration practices reduce carbon dioxide emissions through direct carbon sequestration.



- By reducing the amount of energy needed to treat runoff, as well as reductions in energy use for cooling purposes, bioretention and infiltration practices reduce atmospheric CO_2.

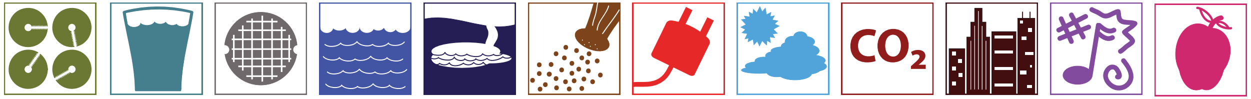
Reduces Urban Heat Island:
- Through evaporative cooling and reduction of surface albedo, these practices work to mitigate the urban heat island effect, reducing energy use.

Improves Community Livability:
- When well-maintained, bioretention and infiltration practices improve local aesthetics and enhance recreational opportunities within communities.
- There is also the potential for these practices to help reduce noise transmission through sound absorption and to improve social networks in neighborhoods.

Improves Habitat:
- Bio-retention and infiltration practices provide habitat and increase biodiversity.

Cultivates Public Education Opportunities:
- Managing future economic and environmental constraints will require full community participation and partnership. Green infrastructure provides an opportunity to develop community awareness and understanding around the importance of sustainable water resource management.
- Rain gardens and bioswales provide an opportunity for residents to contribute to the benefits of neighborhood place-making via green infrastructure.

Permeable Pavement



Permeable pavement allows for the absorption and infiltration of rainwater and snow melt onsite. There are several different names that refer to types of permeable pavement, including pervious or porous concrete, porous asphalt and interlocking permeable pavers.

Reduces Stormwater Runoff:

- Permeable pavement reduces surface runoff volumes and rates by allowing stormwater to infiltrate underlying soils.
- By reducing runoff volumes and rates, permeable pavement can lower water treatment costs and reduce flooding and erosion.

Increases Groundwater Recharge:

- By allowing rainfall to infiltrate, permeable pavement can help increase groundwater recharge.

Reduces Salt Use:

- Permeable pavement has been demonstrated to substantially delay the formation of a frost layer in winter climates, which mitigates the need for salt use. By reducing the need for salt, communities are able to save money and reduce pollution in local waterways and groundwater sources.

Reduces Energy Use:

- The use of permeable pavements also has the potential to reduce energy use by lowering surrounding air temperatures, which in turn reduces demand on cooling systems within buildings.

Improves Air Quality:

- Because permeable pavement captures rainfall onsite, communities can reduce the amount of water treatment needed, in turn reducing air pollution from power plants.



- By reducing the urban heat island effect, permeable pavement decreases ground level ozone formation, which directly impacts air quality.

Reduces Atmospheric CO_2:

- Permeable pavement captures rainfall onsite, enabling communities to reduce the amount of water treatment needed, in turn reducing CO_2 emissions from power plants.
- Permeable pavement also has the potential of reducing lifecycle CO_2 emissions compared to asphalt and cement, which produce high lifecycle CO_2 emissions.

Reduces Urban Heat Island:

- Permeable pavement absorbs less heat than conventional pavement, which helps to reduce the surrounding air temperature and decrease the amount of energy needed for cooling.

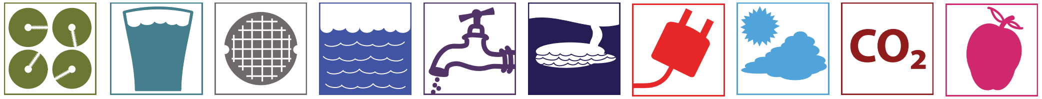
Improves Community Livability:

- Some types of permeable pavement reduce local noise pollution by increasing street porosity levels.

Cultivates Public Education Opportunities:

- Managing future economic and environmental constraints will require full community participation and partnership. Green infrastructure provides an opportunity to develop community awareness and understanding around the importance of sustainable water resource management.
- The installation of permeable pavement can provide an opportunity to further educate the public about the benefits of green infrastructure.

Water Harvesting



Water harvesting is defined as the redirection and productive use of rainwater by capturing and storing it onsite for irrigation, toilet flushing and other potential uses. Water harvesting treats rainwater as a resource rather than as a waste stream. There are two main water harvesting practices: downspout disconnection and the use of rain barrels or cisterns.

Downspout disconnection is the process of directing roof runoff away from sewer systems and onto local property for irrigation purposes. Using rain barrels or cisterns captures rainwater, diverting it directly into these storage containers. The stored water can be used onsite for multiple purposes such as flushing toilets and irrigation. The practice of water harvesting requires that catchment areas be sized according to projected water-use needs in order to maximize the benefits of this practice.

Reduces Stormwater Runoff:

- Water harvesting minimizes the negative impacts of stormwater runoff by capturing rainfall where it lands and reusing it onsite.
- Onsite reuse of rainwater helps to reduce water treatment needs, which allows communities to save on costs associated with potable water conveyance, treatment and use.

Increases Available Water Supply:

- It is estimated that, nationwide, outdoor irrigation accounts for almost one-third of all residential water use, totaling more than 7 billion gallons per day. Given this estimate, using rainwater for irrigation purposes can substantially reduce the amount of potable water used residentially, effectively increasing supply.

Increases Groundwater Recharge:

- Reusing rainwater for irrigation purposes can help increase groundwater recharge.

Reduces Energy Use:

- Water harvesting has the ability to reduce energy usage by cutting down on potable water use, which requires energy to produce, treat and transport.



Improves Air Quality:

- Because this practice can reduce energy usage, it can also reduce the amount of air pollutants being emitted from power plants.

Reduces Atmospheric CO_2:

- Water harvesting captures rainfall onsite, which can enable communities to reduce the amount of water treatment needed, in turn reducing CO_2 emissions from power plants.

Cultivates Public Education Opportunities:

- Managing future economic and environmental constraints will require full community participation and partnership. Green infrastructure provides an opportunity to develop community awareness and understanding around the importance of sustainable water resource management.
- By providing educational programs through fun activities such as rain barrel design and usage, communities can more effectively train residents in the benefits of green infrastructure.

Rainwater has been found to help improve plant health. Unlike potable water which contains salt, rainwater typically contains nutrients such as nitrogen and phosphorus, which is good for plants.

Economic Valuation in Action

Economic Valuation Methods & Tools

Comparing the benefits of different stormwater management practices requires a common unit of analysis. In making decisions about infrastructure investment, the value of a given set of possible investments is typically expressed monetarily.

One challenge inherent in valuing services provided by green infrastructure is that many of these services are not bought and sold. Fortunately, many techniques have been developed in order to economically value nonmarket ecosystem services. Nonmarket valuation methods include revealed preference methods, stated preference methods and avoided cost analysis.

Revealed preference methods attempt to infer the value of a nonmarket good or service using other market transactions. Hedonic pricing, for example, assumes that the price of a good is a function of relevant characteristics of that good and attempts to isolate the contribution of a given characteristic to the total price (most commonly used with housing prices).

Stated preference methods, such as contingent valuation, ask individuals how much they are willing to pay for a given good or service or how much they would be willing to accept as compensation for a given harm. These methods often assess non-use values; for example, what is the value of a protected wilderness for people who never see it?

Using previous estimates from other revealed or stated preference studies requires caution. These methods capture the value resulting from the complexity inherent in a specific study area. As such there is risk in applying these results to different contexts and subsequent benefit valuations.

Finally, avoided cost analysis examines the marginal cost of providing the equivalent service in another way. For example, rainfall retention and infiltration can offset a water utility's cost to capture, transport, treat and return each additional gallon of runoff. (Tomalty et al 2009; King and Mazzotta 2000).

Customized application of nonmarket valuation methods can be expensive and time consuming to perform. Contingent valuation, for example, can require conducting survey research; a hedonic pricing study may involve extensive data assembly.

There are many existing tools available to those interested in assessing the performance and value of green infrastructure practices, including online calculators, spreadsheet models and desktop software. These tools can be used as a companion to this guide and in many cases will be able to provide calculations with greater sensitivity to locally specific variables than those presented here. A full list and description of these tools can be found in Appendix A.

Our Framework

This guide outlines a framework for measuring and valuing green infrastructure's multiple ecological, economic and social benefits. The following sections integrate existing research on the benefits of five green infrastructure practices that are representative of the current vocabulary of GI in terms of applicable values and possible benefits. These sections explore how to:

- Measure the benefits from each particular practice
- Assign value to those benefits (in monetary terms when possible)

The guide follows a consistent sequence when analyzing each of the benefits defined in the previous section. This analysis allows users to evaluate the cumulative benefits of green infrastructure practices in a number of different benefit categories including water, energy, air quality and climate change. The following describes the two-step framework for this valuation process.

Step 1: Quantification of Benefits

It is first necessary to define a resource unit for the given benefit. For example, when evaluating energy benefits, the resource units are kilowatt hours (kWh) and British thermal units (Btu). Once the resource units are determined, the guide outlines the process for estimating the level of benefit for each practice. Step 1 concludes with an estimate of the total resource units received from a given benefit.

Step 2: Valuation of Quantified Benefits

In this step, values for each benefit are determined based on the resource units from the previous step. The method for translating resource units into a dollar figure differs for every benefit category. For example, the average cost of a kilowatt hour of electricity provides the direct cost saving value of reduced energy use. Because these values are extremely location and site specific, it is beyond the scope of this guide to demonstrate all parameters and local values. Examples demonstrated in this section illustrate the process necessary for determining the accrued value of green infrastructure implementation. Resources and guidance are provided where possible to help tailor these estimates to local projects, however much of the localized information must be gathered by the user. Please note, given the current state of valuation research, this step has not been addressed in the following benefit sections:

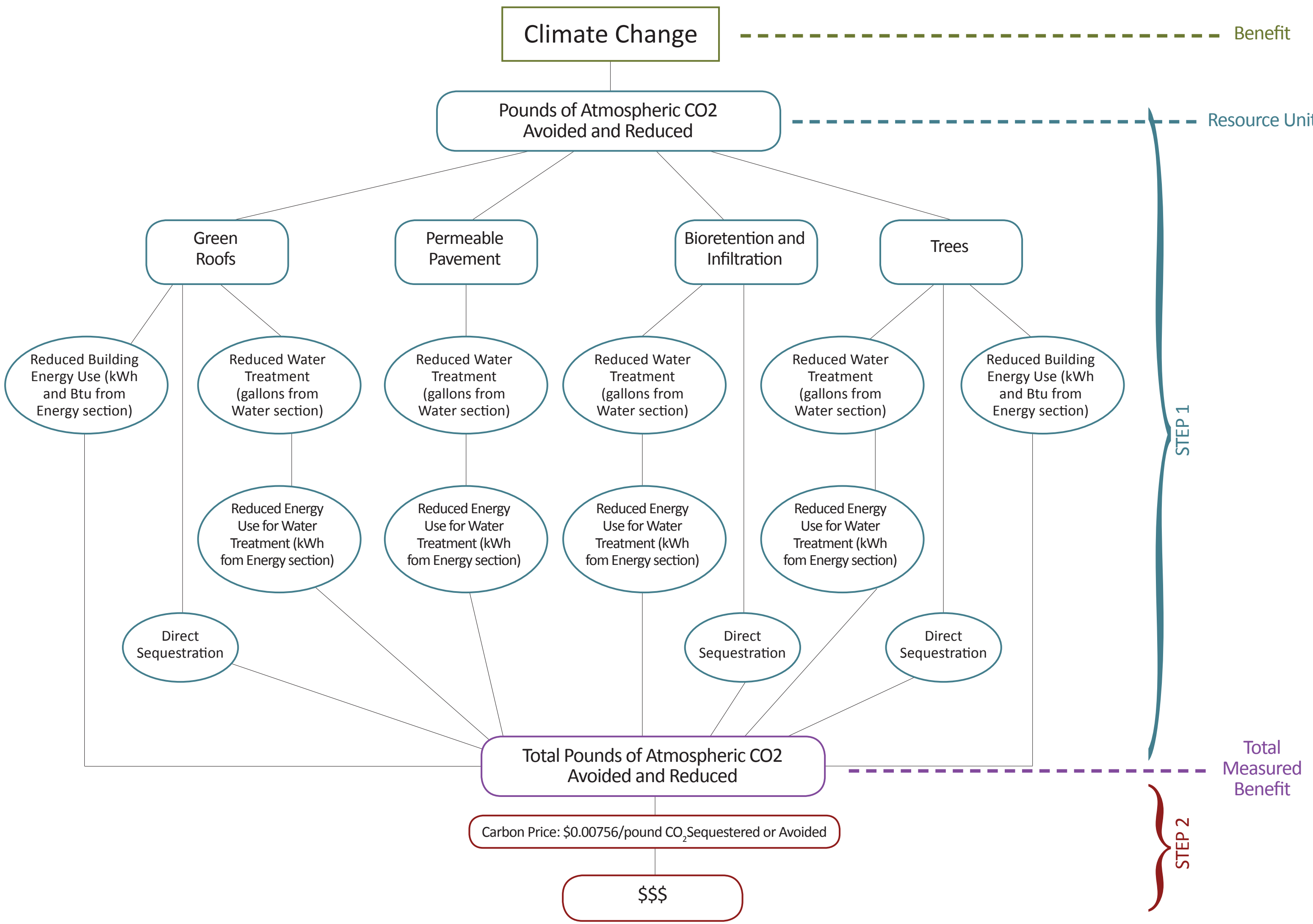
- Urban Heat Island
- Community Livability
- Habitat
- Public Education

Even if no monetary value can be assigned, these services provide valuable benefits which are still worth recognizing in a broader assessment of infrastructure investments.

It is important to keep in mind that the methods described here face a number of limitations. Although the discussion will focus on benefits, estimating the net value of a project would require a comparison of the net benefits compared to the lifecycle cost of constructing and maintaining a given green infrastructure practice. While life cycle cost analysis is beyond the scope of this guide, the Green Values™ Calculator (CNT 2009) can describe the relative cost of the green infrastructure practices (using cost data information through 2009).

Finally, several benefits face uncertainties about both spatial and temporal scale. The "Considerations and Limitations" section at the end this guide further addresses these and other concerns.

The figure below is an illustrative example of the process for valuing the Climate Change benefit section of green infrastructure.



Benefit Measurement and Valuation

1. WATER

STEP 1 - QUANTIFICATION OF BENEFIT: REDUCED STORMWATER RUNOFF

The first step in valuing the water benefits from green infrastructure is to determine the volume of rainfall (in gallons) retained on site; this volume becomes the resource unit for all water benefits. When working through the calculations, keep in mind that some of the ranges given are based on the compilation of multiple cases studies and there may be more site-specific numbers to plug into the given equations. Where possible, the guide will suggest strategies for determining site-specific information.

Practices that provide water benefits include green roofs, permeable pavement, bioretention and infiltration, trees and water harvesting.

GREEN ROOFS

To quantify the stormwater runoff retained from green roofs, it is necessary to know the following information:

- Average annual precipitation data (in inches) for the site
- Square footage of the green infrastructure feature
- Percentage of precipitation that the feature can retain

The highly site-specific variables influencing the percentage of annual rainfall that a green roof is capable of retaining, listed below, are important considerations:

- The most important variable influencing the runoff reduction performance of the green roof is the depth of the growing media. The deeper the roof, the more water retained in the media.
- The growing media's antecedent moisture content will influence stormwater retention for any given storm event. This means that irrigation practices and storm frequency affect overall performance.
- Local climate variables also influence stormwater retention performance. For example, hotter, less humid climates lead to less antecedent moisture and more stormwater retention capacity.
- All else being equal, flat roofs retain more stormwater than sloped roofs.
- Size and distribution of storm events affect total stormwater retention. For example, holding the retention rate and annual precipitation constant, a green roof in a place with many small storms retains a greater percentage of the total rainfall than a green roof in a place with fewer, larger storms.

The following equation relies on two conversion factors. The 144 sq inches/square foot (SF) will convert the precipitation over a given area into cubic inches. Then, the factor of 0.00433 gal/cubic inch (i.e. the number of gallons per cubic inch) will convert that volume of precipitation into gallons, which is needed to quantify the amount of runoff reduced.

[annual precipitation (inches) * GI area (SF) * % retained] * 144 sq inches/SF * 0.00433 gal/cubic inch = total runoff reduction (gal)

Empirical studies of green roof stormwater retention performance have found that green roofs can retain anywhere from 40 to 80 percent of annual precipitation. The calculation in Example 1.1

uses the average of this range, or a 60 percent retention rate, to demonstrate a mid-range performance number:

Example 1.1:
A green roof with an area of 5,000 SF, using a 60% retention rate, will reduce annual runoff in Chicago, Ill. as follows:

[38.01 inches annual precipitation * 5,000 SF area * 0.60 retention rate] * 144 sq inches/SF * 0.00433 gal/cubic inch = 71,100 gallons of runoff reduced annually

TREE PLANTING
Water interception estimates, determined on a per tree basis, are needed to calculate the amount of stormwater runoff reduced from a given project. Therefore, it is necessary to know the number of trees being planted and their size and type. For example, the larger leaf surface area on one kind of tree will intercept more rainfall than will a smaller tree or leaf. In addition, the rate at which trees intercept rainfall is significantly impacted by a site's climate zone, precipitation levels and seasonal variability, which affects evapotranspiration rates.

The Center for Urban Forest Research of the US Forest Services, utilizing its STRATUM model, has compiled a set of *Tree Guides* that take into account many of these factors and estimate the level of benefits provided by trees:
http://www.fs.fed.us/psw/programs/cufr/tree_guides.php

These guides are organized by STRATUM climate zone which can be determined from the map provided at:
http://www.fs.fed.us/psw/programs/cufr/images/ncz_map.jpg

Table 1.1
Annual Rainfall Interception in Gallons from 1 tree, 40-year average, Midwest Region

	Small tree: Crabapple (22 ft tall, 21 ft spread)	**Medium tree: Red Oak** (40 ft tall, 27 ft spread)	**Large tree: Hackberry** (47 ft tall, 37 ft spread)
Rainfall Interception	292 gallons	1,129 gallons	2,162 gallons

Source: McPherson, E. et al. (2006).

Once the climate zone is determined, the tables in the tree guides' appendices are structured according to size of tree, with an example tree type provided. Average annual volume of rainfall interception can then be estimated based on these factors on a per tree basis. Table 1.1 provides an example of this information.

Using these values, the following equation provides an estimate for the volume of runoff intercepted on site:

number of trees * average annual interception per tree (gal/tree) = total runoff reduction (gal)

Example 1.2:
This example demonstrates the annual reduction in runoff yielded from planting 100 medium red oaks in the Midwest Region.

100 medium trees * 1,129 gal/tree = 112,900 gallons of runoff reduced annually

BIORETENTION AND INFILTRATION

Well-designed bioretention and infiltration features capture all or nearly all of the precipitation which falls on the feature and its related drainage area. However, in an urban context, the percentage of rainfall that these features can accommodate depends on available square footage and locally determined maximum ponding times. Determining a more site-specific performance measure requires complex hydrological modeling. The equation for determining the capacity of a bioretention feature requires the following information:

- Area and depth of the bioretention feature
- Relevant drainage area contributing runoff to the infiltration area
- Average annual precipitation data (in inches)
- Expected percentage of retention

These variables also affect the feature's retention percentage:

- Rainfall amount and distribution
- Site irrigation practices
- Temperatures and humidity
- Soil infiltration rate (based on soil type)

The following equation provides a simplified estimate of the potential volume of runoff captured using bioretention and infiltration practices:

[annual precipitation (inches) * (feature area (SF) + drainage area (SF)] * % of rainfall captured] * 144 sq inches/SF * 0.00433 gal/cubic inch = total runoff reduction (gal)

Example 1.3:

A site in Chicago, Ill. that retains 80% of stormwater runoff, with an infiltration area of 2,000 square feet and a drainage area of 4,000 square feet, reduces the volume of runoff as follows:

[38.01 inches annual precipitation * (2,000 SF + 4,000 SF) * 0.80 retention rate] * 144 sq inches/SF * 0.00433 gallons/cubic inch = 113,760 gallons of runoff reduced annually

PERMEABLE PAVEMENT

To quantify the water retained from permeable pavement, it is necessary to know the following information:

- Average annual precipitation data (in inches) for the site
- Square footage of the green infrastructure feature
- Percentage of precipitation that the feature is capable of retaining

Depending on the intensity of the precipitation event, studies have shown that pervious pavement can infiltrate as much as 80 to 100% of the rain that falls on a site (Booth et al 1996; Bean et al 2005; MMSD 2007; USEPA and LID Center 2000). Example 1.2 uses the lower end of this range, or an 80% retention rate. To find a more site-specific percentage, the following factors must be considered:

- Slope of the pavement – flat surfaces typically infiltrate more water
- Soil content & aggregate depth below pavement
- Size and distribution of storm events
- Infiltration rate
- Frequency of surface cleaning

The following equation quantifies the total amount of runoff that a given permeable pavement installation can reduce annually. As with the bioretention and infiltration calculations, the percentage of rainfall that these features can accommodate depends on available square footage and locally determined maximum ponding times:

[annual precipitation (inches) * GI area (SF) * % retained] * 144 sq inches/SF * 0.00433 gal/cubic inch = total runoff reduction (gal)

Example 1.4:
A permeable pavement feature with an area of 5,000 SF, using an 80% retention rate, will reduce annual runoff in Chicago, Ill. as follows:

[38.01 inches annual precipitation * 5,000 SF area * 0.80 retention rate] * 144 sq inches/SF * 0.00433 gal/cubic inch = 94,800 gallons of runoff reduced annually

WATER HARVESTING

Benefits from water harvesting are based on the volume in gallons of stormwater runoff stored onsite. To determine this volume, the following information is necessary:

- Average annual precipitation data (in inches)
- Rainfall intensity
- Size of the water-collecting surface (in square feet)
- Capacity for temporary water storage and release
- Frequency of harvested water use for building needs, irrigation or evaporative cooling (e.g. whether the captured rainwater is used before a subsequent rain event)

For every square foot of roof collection area, it is possible to collect up to 0.62 gallons of runoff per inch of rain with perfect efficiency. However, an efficiency factor of 0.75–0.9 is included in the equation to account for water loss due to evaporation, inefficient gutter systems and other factors (Texas Water Development Board 2005).

Applying the following formula provides a basic understanding of how much rainwater could be captured by this practice, both for site specific measurement as well as a cumulative calculation across a community or region.

annual rainfall (inches) * area of surface (SF) * 144 sq inches/SF * 0.00433 gal/cubic inch * 0.85 collection efficiency = water available for harvest (gal)

Example 1.5:
The following equation illustrates how to determine the capacity of a water harvesting practice using annual rainfall data for Chicago, Ill.:

38.01 inches annual rainfall * 1,000 SF of surface * 144 sq inches/SF * 0.00433 gal/cubic inch * 0.85 collection efficiency = 20,145 gallons captured annually

After estimating the gallons of stormwater a particular site and practice can retain (i.e. the total resource units), this information should be used in Step 2.

STEP 2 - VALUATION OF QUANTIFIED BENEFITS: REDUCED STORMWATER RUNOFF

The valuation process in the "Water" section is divided into the following four subsections and outlines each separately:

- Reduced Water Treatment Needs
- Reduced Grey Infrastructure Needs
- Improved Water Quality
- Reduced Flooding

Methods for valuation will only be provided in the "Reduced Water Treatment Needs" and "Reduced Grey Infrastructure Needs" subsections. The other two sections discuss benefits and current research, but they do not present a formal valuation method, given the amount of varying factors required to value these benefits.

Reduced Water Treatment Needs

For cities with combined sewer systems (CSS), stormwater runoff entering the system combines with wastewater and flows to a facility for treatment. One approach to value the reduction in stormwater runoff for these cities is an avoided cost approach. Runoff reduction is at least as valuable as the amount that would be spent by the local stormwater utility to treat that runoff. In this case, the valuation equation is simply:

runoff reduced (gal) * avoided cost per gallon ($/gal) = avoided stormwater treatment costs ($)

Example 1.6:
The Metropolitan Water Reclamation District of Greater Chicago has a marginal cost of treating its wastewater and stormwater of $0.0000919 per gallon (CNT 2009). Using Example 1.1, in which the 5,000 SF green roof provided a runoff reduction of 71,100 gallons, the annual avoided cost for water treatment associated with this site becomes:

71,100 gallons * $0.0000919/gallon = $6.53 in annual avoided treatment costs

Keep in mind, the figure from this example is a single unit that can be aggregated to a larger scale, demonstrating the cumulative benefit that can be achieved within a neighborhood or region. Additionally, avoided cost approaches inevitably underestimate the full value of an ecosystem service. As such, this figure should be considered a lower bound for the monetary value of reduced stormwater runoff. More locally specific treatment costs are available from local water treatment utilities.

Reduced Grey Infrastructure Needs

Green infrastructure practices can reduce the volume of water needing treatment as well as the level of treatment necessary. Therefore, utilizing these practices can reduce the need for traditional or grey infrastructure controls for stormwater and combined sewer overflow (CSO) conveyance and treatment systems, including piping, storage and treatment devices. Similar to the approach taken in other sections of this guide, the value of reducing grey infrastructure derives from the benefits transfer method of avoided costs resulting from the use of green infrastructure. While the case studies below give examples of how these costs can be compared, it is beyond the scope of this guide to determine exact cost savings. This is due to the many site-specific variables that effect the monetary values involved, such as soil types, rainfall distribution patterns, peak flow rates and local materials costs.

One method of assessing avoided grey infrastructure costs when using green infrastructure practices is demonstrated by a case study in Portland, Oregon. In this study, the Bureau of Environmental Services estimated that it costs the city $2.71/SF in infrastructure costs to manage the stormwater generated from impervious areas (Evans 2008). The city uses the following equations to estimate the resulting avoided cost savings:

**conventional cost of structure ($/SF) *
total area of structure (SF)
= total expenditure for conventional approach ($)**

**total expenditure for conventional approach ($) *
% retained = avoided cost savings ($)**

Please note, while the typical resource unit used within this "Water" section is *gallons* of stormwater retained, this particular benefit instead considers *percent* of stormwater retained.

Example 1.7:
Using Portland, Ore. as an example, a 5,000 SF conventional roof would have a one-time expenditure of $13,550. However, by utilizing a green roof, which in this particular study has been shown to retain 56 percent of runoff, Portland can expect an avoided cost savings of $7,588:

$2.71/SF * 5,000SF = $13,550 in total conventional expenditure

$13,550 * 56% = $7,588 avoided cost savings

Groundwater Recharge

Green infrastructure practices that enable rainwater infiltration contribute to the recharge of both deep aquifers and subsurface groundwater. When rain falls on a permeable surface, some runs off, some returns to the atmosphere through evapotranspiration and the remainder is infiltrated into the ground. This infiltrated water either recharges aquifers or joins subsurface flows, which end up in local streams. Both aquifer recharge and subsurface flow are important components of a functional water cycle that sustains the ecosystem services on which human activity depends.

Aquifers provide water for drinking and irrigation. Aquifer levels are essentially a function of the relationship between discharge (withdrawal by humans, evaporation, interaction with surface waters) and recharge (primarily infiltrated precipitation). Over time, withdrawing more from an aquifer than is recharged through precipitation can cause declining aquifer levels, resulting in higher pumping costs, reduced water availability and even land subsidence that can result in sink holes.

Green infrastructure affects groundwater recharge in highly site-specific ways. Some infiltrated rainfall may discharge back into surface waters after a few days; in other cases, generations may pass before infiltrated water again becomes available for human use. For this reason, this work does not define specific guidelines for quantifying and valuing the groundwater recharge benefit of green infrastructure. Nonetheless, it is important for the future health of watersheds to monitor aquifer levels and stream flows and consider the benefits of restoring infiltration.

Another study, in the Blackberry Creek watershed near Chicago, Illinois, estimated the benefits attributable to green infrastructure practices resulting from avoided costs of infrastructure that would have been needed to control reduced peak discharges (Johnston, Braden and Price 2006). The study found that, based on Federal Highway Department pipe sizing requirements, reduced peak discharges within their low impact development scenario resulted in a downstream benefit of $340 per developed acre. This is an initial cost savings; performing a life-cycle cost analysis would better demonstrate long-term monetary benefits. The calculations for this method are dependent on access to the following variables and results are best determined through the use of hydrologic modeling:

- Peak flow rates
- Allowable ponding time
- Pipe size requirements

In the case of Seattle's Street Edge Alternatives (SEA) project, which utilizes bioswales to capture and treat stormwater runoff, Seattle Public Utilities found that bioretention combined with narrowing the roadway, eliminating the traditional curb and gutter, and placing sidewalks on only one side of the street garners a cost savings for the city of 15–25 percent, or $100,000–$235,000 per block, as compared to conventional stormwater control design (SPU). Additionally, Seattle Public Utilities has identified cost savings in terms of the life span of the project; SEA streets are designed to improve performance as plantings mature, whereas traditional systems tend to degrade over time (Wong and Stewart 2008).

Improved Water Quality

Using green infrastructure for stormwater management can improve the health of local waterways by reducing erosion and sedimentation and reducing the pollutant concentrations in rivers, lakes and streams. These effects, in turn, lead to improved overall riparian health and aesthetics—indicators of improved water quality and channel stabilization.

The impacts of green infrastructure on water quality, while well documented, are too place-specific to provide general guidelines for measurement and valuation. The water quality improvements associated with green infrastructure, furthermore, are not of sufficient magnitude to be meaningful at the site scale. This benefit, therefore, is best evaluated in the context of watershed-scale green infrastructure implementation, accompanied by hydrologic modeling, to estimate changes in sedimentation and pollutant loads resulting from a green infrastructure program.

Regulators measure water quality in a variety of ways. Damaging pollutants carried by stormwater runoff typically include nitrogen, phosphorous and particulate matter. Water quality monitors can measure concentrations of dissolved nitrogen and phosphorous, as well as total suspended solids (TSS), usually in milligrams per liter. In economic valuations, water *clarity* is often used as a proxy measure for water *quality*. While only an approximate measure, water clarity strongly correlates with the presence of phosphorous, nitrogen and TSS pollution. Suspended particulates directly decrease water clarity, while high concentrations of nitrogen and phosphorous lead to eutrophication—a process whereby increased nutrients in waterways lead to algae blooms which cloud the water and decrease dissolved oxygen. In extreme cases, eutrophication can lead to hypoxic conditions, characterized by the absence of sufficient oxygen to support any animal life. Water clarity is typically measured using the Secchi disk test, in which a black and white patterned disk is lowered into the water until no longer visible; this depth is considered the water clarity depth.

Previous research has applied a benefits transfer approach to quantify the expected improvement in water clarity resulting from a green infrastructure program. Several hedonic pricing studies estimated the impact of water clarity changes on lakefront property values. Studies in Maine and New Hampshire have estimated implicit marginal prices for a one meter change in water clarity ranging from $1,100 to $12,938 per lakefront property (Gibbs et al 2002; Boyle et al 1999; Michael et al 1996). A hedonic pricing study of the St. Mary's River Watershed in the Chesapeake Bay estimated home price impacts of water quality changes not merely for waterfront properties but for the entire watershed. It found marginal implicit prices for changes of one milligram per liter in total suspended solids (TSS) concentration of $1,086 and in dissolved inorganic nitrogen (DIN) concentration of $17,642 for each home in the watershed (Poor et al 2007).

Reduced Flooding

By reducing the volume of stormwater runoff, green infrastructure can reduce the frequency and severity of flooding. The impact of green infrastructure on flooding is highly site and watershed specific, and thus this guide does not provide general instructions for quantifying the reduction in flood risk resulting from a green infrastructure program.

There are several ways to assess the value of reduced flood risk provided by green infrastructure practices on a watershed-scale once the risk impacts have been modeled. Some studies use hedonic pricing to examine how flood risk is priced into real estate markets; others use the insurance premiums paid for flood damage insurance as a proxy for the value of reducing the risk of flood damage; others take an avoided damage cost approach and still others have employed contingent valuation methods.
The most robust literature on the economic valuation of flood risk uses hedonic pricing methods to investigate the housing price discount associated with floodplain location. Most of these studies estimate the impact on residential home prices of locations inside or outside of the 100-year floodplain. Those considering implementing a green infrastructure program who are able to model resulting changes in floodplain maps—in particular, to identify the area where annual flood risk is greater than one percent and can be reduced to less than one percent through the use of green infrastructure—can apply the results of these studies to get an estimate of the range of value provided by green infrastructure's flood risk reduction impact.

Until recently, hedonic price studies have found that homes within the 100-year floodplain are discounted between two and five percent compared with equivalent homes outside the floodplain (Braden and Johnston 2004; Bin and Polasky 2004; MacDonald et al 1990; Harrison, Smersh and Schwartz 2001; Shilling, Benjamin and Sermins 1985; MacDonald, Murdoch and White 1987).

In recent years, hedonic pricing techniques have evolved to recognize that hazard risk may be correlated with spatial amenities or disamenities. In the case of flooding, a correlation exists between proximity to waterways and flood risk. Studies that fail to disentangle this correlation will likely underestimate the amount that flood-prone properties are discounted in the marketplace and thus underestimate the value of flood risk

Reduced Salt Use

Research indicates that using pervious pavement can reduce the need for road salt use by as much as 75 percent (Houle 2006). Reducing salt use saves money for individual property owners and municipalities while also protecting water supplies and the environment as a whole. The following variables affect the performance of permeable pavement in reducing salt use:

- Infiltration rate
- Frequency of surface cleaning
- Soil content and aggregate depth below pavement

A study in Iowa comparing the temperature behavior of traditional concrete and Portland Cement Pervious Concrete (PCPC) found the following: "The results show that the aggregate base underneath the pervious concrete substantially delayed the formation of a frost layer and permeability was restored when melt water is present. . . . The melt water immediately infiltrated the pervious concrete pavement, eliminating the potential for refreezing and reducing the slip/fall hazard associated with impervious surfaces" (Kevern et al 2009b).

The National Research Council (NRC) indicates that road-salt use in the United States ranges from 8 million to 12 million tons per year with an average cost of about $30 per ton (Wegner and Yaggi 2001), although this cost has increased in recent years. In winter 2008, many municipalities paid over $150 per ton for road salt; projections for 2009 reported salt prices in the range of $50–$70 per ton (Associated Press 2009; Singer 2009).

reduction. One study applied these new techniques to account for the correlation of flood risk and coastal amenities and found that homes in the 100-year floodplain were discounted an average of 7.8 percent compared to equivalent homes outside the floodplain (Bin, Kruse and Landry 2008). Therefore, we recommend that users of this guide apply the 2–5 percent range as a conservative estimate of the value of flood risk reduction.

US Census Summary File 3[1] provides median home price data and the number of owner-occupied housing units at the block group level.

An example application of this method can be found in a study on green infrastructure implementation in Blackberry Creek Watershed in Kane County, Illinois (Johnston, Braden and Price 2006). The authors used the USEPA's *Hydrologic Simulation Program—Fortan* to model the difference in peak flows of a green infrastructure versus a conventional development scenario. They then input their peak flow results into the Army Corps of Engineers' Hydrologic Engineering Center River Analysis System and found that conventional development would add 50 acres to the floodplain compared to development using green infrastructure for stormwater management. Applying an anticipated density of 2.2 units/acre and the census bureau's reported median home value of $175,600, the study then used the benefits transfer approach to estimate a range of values for flood risk reduction. Using a range of 2–5 percent property value increase for removal from the floodplain yields total benefits of between $391,600 and $979,000 for the flood risk reduction impact of the green infrastructure scenario.

[1] US Census Bureau. American Factfinder: http://factfinder.census.gov/home/saff/main.html?_lang=en

Benefit Measurement and Valuation

2. ENERGY

STEP 1 - QUANTIFICATION OF BENEFIT: REDUCED ENERGY USE

The first step to valuing the benefits of reduced energy use is determining the amount of energy saved by each practice. This section quantifies the benefit of energy savings in terms of kilowatt hours (kWh) of electricity and British thermal units (Btu) of natural gas reduced.

Practices that reduce building energy use include green roofs and trees. In addition, green infrastructure can reduce off-site energy use by preventing runoff and by reducing the demand for potable water. Both of these benefits lead to a decrease in water treatment needs, thereby lowering energy use at treatment facilities. Because facility energy costs are incorporated into the cost of treatment, direct energy cost savings have already been captured. Thus, this section will not value the energy benefit from reduced water treatment, as this would result in double counting.

However, benefits from reduced treatment-plant energy use go above and beyond direct cost savings. This guide will provide methods for estimating the indirect benefits of reduced energy use from both air quality improvements and reduced climate change impacts. Therefore, refer to the "Air Quality" and "Climate Change" sections to quantify these.

GREEN ROOFS

When considering to what degree green roofs reduce building energy use, it is important to keep in mind that heat flux through the roof is only one of many factors influencing building energy consumption. A dramatic improvement in energy performance from green roofs compared to conventional roofs may have only a small impact on overall building energy use. That said, to provide a simple estimate of building energy savings, the suggested method treats green roofs as insulation and assumes that a reduction in heat flux translates directly into energy savings (Clark, Adriaens, and Talbot 2008). Equations for both cooling and heating savings can be derived as follows:

annual number of cooling degree days (°F days) * 24 hrs/day * ΔU = annual cooling savings (Btu/SF)

annual number of heating degree days (°F days) * 24 hrs/day * ΔU = annual heating savings (Btu/SF)

Where:
U = heat transfer coefficient, or 1/R; and
R = a measure of thermal resistance.

Therefore, the main pieces of information necessary for this calculation are the average degree days (both cooling and heating) and the ΔU, which will be calculated from R-values (for both the green roof and a conventional roof with which to compare it).

Determining Cooling and Heating Degree Days (°F days)

The EPA defines Cooling and Heating Degree Days as follows:

"*Cooling degree days* are used to estimate how hot the climate is and how much energy may be needed to keep buildings cool. CDDs are calculated by subtracting a balance temperature from the mean daily temperature, and summing only positive values over an entire year. The balance temperature used can vary, but is usually set at 65°F (18°C), 68°F (20°C), or 70°F (21°F).

Heating degree days are used to estimate how cold the climate is and how much energy may be needed to keep buildings warm. HDDs are calculated by subtracting the mean daily temperature from a balance temperature, and summing only positive values over an entire year. The balance temperature used can vary, but is usually set at 65°F (18°C), 68°F (20°C), or 70°F (21°F)."
http://www.epa.gov/hiri/resources/glossary.htm

To assign values for cooling and heating degree days, this guide recommends using the cooling and heating degree day "Normals" from the National Climatic Data Center of the National Oceanic and Atmospheric Administration.
http://lwf.ncdc.noaa.gov/oa/documentlibrary/hcs/hcs.html

Determining R-Values and ΔU

According the USEPA, "*R-value* or 'thermal resistance value' is a measure of the resistance of a material to heat flow. The term is typically used to describe the resistance properties of insulation. The higher the R-value, the greater the insulation's resistance to heat flow."
http://www.epa.gov/hiri/resources/glossary.htm

R-values are reported in the units of square feet * degrees Fahrenheit * hours per British thermal unit (SF * °F * hrs/Btu).

The U-value, or the overall heat transfer coefficient, is defined as the inverse of R. Therefore, to find the ΔU, R-Values for the given conventional and green roof are necessary. Clark, Adriaens and Talbot (2008) provide a valuable explanation for estimating R-values for conventional roofs as well as green roofs based on media depth (p. 2,156). For illustrative purposes, the subsequent example uses default values as follows:

For conventional roofs: **R = 11.34 SF * °F * hrs/Btu**
For green roofs: **R = 23.4 SF * °F * hrs/Btu**
(Clark, Adriaens, and Talbot 2008)

The ΔU can be calculated as follows:

$$\Delta U = \left(\frac{1}{R_{\text{conventional roof}}}\right) - \left(\frac{1}{R_{\text{green roof}}}\right) \quad \text{or} \quad \Delta U = \left(\frac{\text{Btu}}{11.34 \text{*SF*°F*hrs}}\right) - \left(\frac{\text{Btu}}{23.4\text{*SF*°F*hrs}}\right)$$

Example 2.1:
In this example, the annual cooling savings (kWh) of a 5,000 SF green roof in Chicago, Ill. is calculated as follows:

At Station 32: Illinois Chicago Botanical Garden, the 1971–2000 Normals for Annual Cooling Degree Days is 702 °F days.

annual number of cooling degree days (°F days) * 24 hrs/day * ΔU = annual cooling savings (Btu/SF)

$$702°\text{Fdays} \times \frac{24\text{hrs}}{\text{day}} \times \left[\left(\frac{\text{Btu}}{11.34{*}\text{SF}{*}°\text{F}{*}\text{hrs}}\right)\right] - \left[\left(\frac{\text{Btu}}{23.4{*}\text{SF}{*}°\text{F}{*}\text{hrs}}\right)\right] = \textit{annual cooling savings}$$

$$16{,}848°\text{F} * \text{hrs} \times \left[\left(\frac{\text{Btu}}{11.34{*}\text{SF}{*}°\text{F}{*}\text{hrs}}\right)\right] - \left[\left(\frac{\text{Btu}}{23.4{*}\text{SF}{*}°\text{F}{*}\text{hrs}}\right)\right] = \textit{annual cooling savings}$$

$$\frac{16{,}848\ \text{Btu}}{11.34\ \text{SF}} - \frac{16{,}848\text{Btu}}{23.4\ \text{SF}} = \textit{annual cooling savings}$$

$$\frac{1{,}485.71\ \text{Btu}}{\text{SF}} - \frac{720\ \text{Btu}}{\text{SF}} = \textit{annual cooling savings}$$

$$765.71\ \text{Btu/SF} = \textit{annual cooling savings}$$

In order to find how cooling savings results in electricity savings (kWh), the Btu units should be converted to kWh using the conversion rate of 1 kWh/3412 Btu. By converting Btu to kWh, annual cooling savings becomes:

$$\frac{765.71\ \text{Btu}}{\text{SF}} \times \frac{1\ \text{kWh}}{3{,}412\ \text{Btu}} = 0.2244\text{kWh/SF} = \textit{annual cooling savings}$$

Thus, for the 5,000 SF green roof, annual electricity cooling savings is: **5,000 SF * 0.2244 kWh /SF = 1,122 kWh**

Example 2.2:

In this example, the annual heating savings (Btu) of a 5,000 SF green roof in Chicago, Ill. is calculated as follows:

At Station 32: Illinois Chicago Botanical Garden, the 1971–2000 Normals for Annual Heating Degree Days is 6,630 °F days.

annual number of heating degree days (°F days) * 24 hrs/day * ΔU = annual heating savings (Btu/SF)

$$6{,}630°\text{Fdays} \times \frac{24\text{hrs}}{\text{day}} \times \left[\left(\frac{\text{Btu}}{11.34*\text{SF}*°\text{F}*\text{hrs}}\right)\right] - \left[\left(\frac{\text{Btu}}{23.4*\text{SF}*°\text{F}*\text{hrs}}\right)\right] = \textit{annual heating savings}$$

$$159{,}120°\text{F} * \text{hrs} \times \left[\left(\frac{\text{Btu}}{11.34*\text{SF}*°\text{F}*\text{hrs}}\right)\right] - \left[\left(\frac{\text{Btu}}{23.4*\text{SF}*°\text{F}*\text{hrs}}\right)\right] = \textit{annual heating savings}$$

$$\frac{159{,}120\ \text{Btu}}{11.34\ \text{SF}} - \frac{159{,}120\text{Btu}}{23.4\ \text{SF}} = \textit{annual heating savings}$$

$$\frac{14{,}031.75\ \text{Btu}}{\text{SF}} - \frac{6{,}800\ \text{Btu}}{\text{SF}} = \textit{annual heating savings}$$

$$7{,}231.75\ \text{Btu/SF} = \textit{annual heating savings}$$

Since the assumption here is that heating is provided by natural gas, the annual heating natural gas (Btu) savings for the 5,000 SF green roof is:

5,000 SF * 7,231.75 Btu/SF = 36,158,750 Btu

The actual benefits realized in terms of energy savings due to the implementation of a green roof will be significantly impacted by the following variables:

- Growing media composition, depth and moisture content
- Plant coverage and type
- Building characteristics, energy loads and use schedules
- Local climate variables and rainfall distribution patterns

TREE PLANTING

Many variables affect the ability of trees to reduce energy use in neighboring buildings. Perhaps the largest determinant is climate zone. Shading buildings in cool regions can actually increase energy demand, while reducing wind speeds in warm regions will have little to no impact. As the two following examples show, the location of tree plantings relative to buildings also plays a critical role in determining the level of benefits. Climate zone and building aspect must be considered in conjunction to realize the greatest building energy reduction benefits. The size, and therefore age, as well as the type of tree also significantly impacts the level to which trees evapotranspire, provide shade and act as windbreaks.

The Center for Urban Forest Research of the US Forest Service using its STRATUM model, compiled a set of *Tree Guides* that take into account many of these factors and estimate the level of benefits provided by trees:
http://www.fs.fed.us/psw/programs/cufr/tree_guides.php

These guides are organized by STRATUM climate zone which can be determined from the map provided at:
http://www.fs.fed.us/psw/programs/cufr/images/ncz_map.jpg

Once the climate zone is determined, the tables in the tree guides' appendices are structured according to size of tree (with an example tree type provided) as well as the location of the tree with respect to buildings. Average reductions in building energy use can then be estimated based on these factors on a per tree basis.

As an example, Tables 2.1 and 2.2 show the 40-year average electricity and natural gas savings from trees in the Midwest Region.

Table 2.1: 40-year Average Electricity Savings from Trees in the Midwest Region

	Residential Yard Opposite West-Facing Wall	Residential Yard Opposite South-Facing Wall	Residential Yard Opposite East-Facing Wall	Public Tree on a Street or in a Park
Small tree: Crabapple (22 ft tall, 21 ft spread)	96 kWh	54 kWh	68 kWh	48 kWh
Medium tree: Red Oak (40 ft tall, 27 ft spread)	191 kWh	99 kWh	131 kWh	67 kWh
Large tree: Hackberry (47 ft tall, 37 ft spread)	268 kWh	189 kWh	206 kWh	136 kWh

Source: McPherson, E. et al. 2006

Table 2.2: 40-year Average Natural Gas Savings from Trees in the Midwest Region

	Residential Yard Opposite West-Facing Wall	Residential Yard Opposite South-Facing Wall	Residential Yard Opposite East-Facing Wall	Public Tree on a Street or in a Park
Small tree: Crabapple (22 ft tall, 21 ft spread)	1,334 kBtu	519 kBtu	1,243 kBtu	1,534 kBtu
Medium tree: Red Oak (40 ft tall, 27 ft spread)	1,685 kBtu	-316 kBtu	1,587 kBtu	2,099 kBtu
Large tree: Hackberry (47 ft tall, 37 ft spread)	3,146 kBtu	2,119 kBtu	3,085 kBtu	3,430 kBtu

Source: McPherson, E. et al. 2006

Example 2.3:

Using the data in Tables 2.1 and 2.2, the estimated average annual energy savings from a large tree located opposite a west facing wall of a house in the Midwest Region will be 268 kWh in cooling (electricity) savings and 3,146 kBtu (or 3,146,000 Btu, as 1 kBtu = 1,000 Btu) in heating/natural gas savings.

REDUCED ENERGY FROM REDUCED WATER TREATMENT

As mentioned earlier, it is important to recognize the off-site means by which green infrastructure practices also reduce energy use through reduced water treatment needs in communities with combined sewer systems. While the "Water" section has already accounted for the cost savings of this reduction (i.e. the "valuation" step of this direct benefit), the reduction in energy use will also provide indirect air and climate benefits from reduced emissions, which will be discussed later. Because of these indirect benefits, it is necessary to quantify the amount of energy reduced from water treatment.

To estimate the energy savings from reduced water treatment needs, it is necessary to have calculated the nega-gallons (i.e. gallons of reduced stormwater runoff) resulting from green infrastructure practices, as estimated in the "Water" section.

Table 2.3 outlines how much energy (kWh) is consumed per million gallons of water treated by six different treatment plant sizes using four different types of treatment methods. These should be referenced as default values only when calculating the energy savings from reduced treatment. Local utilities can provide more site-specific figures.

Table 2.3

	Unit Electricity Consumption | kWh/million gallons			
Treatment Plant Size million gallons/day	**Trickling Filter**	**Activated Sludge**	**Advanced Wastewater Treatment**	**Advanced Wastewater Treatment Nitrification**
1 MM gal/day	1,811	2,236	2,596	2,951
5 MM gal/day	978	1,369	1,573	1,926
10 MM gal/day	852	1,203	1,408	1,791
20 MM gal/day	750	1,114	1,303	1,676
50 MM gal/day	687	1,051	1,216	1,588
100 MM gal/day	673	1,028	1,188	1,558

Source: EPRI 2002

Example 2.4:

Referring back to Example 1.1 and relying on the default values in Table 2.3, it is possible to estimate the energy saved from reduced water treatment needs from a green roof. If water treatment needs are reduced by 71,100 gallons in an area with an advanced wastewater treatment nitrification plant with a 100 MM gal/day capacity, electricity consumption could be reduced as follows:

71,100 gal saved = 0.0711 million gal saved

0.0711 million gal * 1,558 kWh/million gal = 110.77 kWh

Thus, the 5,000 SF green roof example contributes to an annual electricity savings from reduced water treatment needs of 110.77 kWh.

STEP 2 - VALUATION OF QUANTIFIED BENEFITS: REDUCED ENERGY USE

Having calculated the direct kWh and Btu saved in reduced building energy use, it is possible to assign a dollar value to these savings. Again, note that energy savings resulting from reduced water treatment needs have previously been accounted for and should NOT be valued here. The kilowatt hours of reduced energy from reduced water treatment should be carried directly to the "Air Quality" and "Climate Change" sections to be valued there. (In other words, the answer from Example 2.6 is not valued here, but this figure will be used later to calculate indirect emissions benefits.)

One may calculate the direct cost savings by multiplying the kilowatt hours or Btus of electricity and natural gas, respectively, by local utility rates. If local utility rates are not available, use national average retail electricity and natural gas prices.

The values below represent the U.S. average retail price for electricity for April 2010 and the 2010 forecast retail price for natural gas (US EIA 2010).

The following two equations provide a formula for calculating the value of cooling (kWh) and heating (Btu) savings respectively and rely on these national utility rate averages:

kWh reduced * $0.0959/kWh
= value of cooling or electricity savings

Btu reduced * $0.0000123/Btu
= value of heating natural gas savings

Example 2.5:

Using the cooling savings from Example 2.1 and the heating savings from Example 2.2, the following example calculates the annual direct cost savings provided by a 5,000 SF green roof:

0.2244 kWh/SF for cooling savings * 5,000 SF * $0.0959/kWh = $107.60 annual cooling or on-site electricity savings

7,231.75 Btu/ SF for heating * 5,000 SF * $0.0000123/Btu = $444.75 annual heating natural gas savings

The combined benefits from the green roof result in an average annual on-site energy savings of $552.35.

Example 2.6:

Referencing Tables 2.1 and 2.2 and the cost saving established in Example 2.5, if a house in the Midwest Region has one large tree located opposite a west-facing wall, the direct cost savings can be calculated as:

268 kWh * $0.0959 = $25.70 annual cooling or on-site electricity savings

3,146,000 Btu * $0.0000123 = $38.70 annual heating natural gas savings

The combined benefits from the large tree result in an average annual on-site energy savings of $64.40.

Benefit Measurement and Valuation

3. AIR QUALITY

STEP 1 - QUANTIFICATION OF BENEFIT: REDUCED CRITERIA POLLUTANTS

This section quantifies the direct (uptake and deposition) and indirect (avoided emissions) air quality impacts of green infrastructure and provides instructions for valuing these impacts in monetary terms. The criteria pollutants addressed here are nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2) and particulate matter of aerodynamic diameter of ten micrometers or fewer (PM-10).

Practices that provide a direct benefit of uptake and deposition include green roofs, trees and bio-infiltration.

GREEN ROOFS

Direct air quality benefits from green roofs depend on several local factors. Different plant species take up pollutants at different rates, so the type of species planted will influence the magnitude of air quality improvement. Local climate factors also influence plants' air quality effects. In cold weather climates, plant uptake will be lower during seasons when plants may be covered in snow. Climates with longer growing seasons will see greater air quality improvements, all else being equal, than those with shorter seasons.

To estimate the direct benefits of green roofs on air quality, we recommend the following range of values as an initial order of magnitude approximation of annual pounds of pollutant removed per square foot of practice installed:

Table 3.1

	Low (lbs/SF)	High (lbs/SF)
NO_2	3.00×10^{-4}	4.77×10^{-4}
O_3	5.88×10^{-4}	9.20×10^{-4}
SO_2	2.29×10^{-4}	4.06×10^{-4}
PM-10	1.14×10^{-4}	1.33×10^{-4}

Source: Currie and Bass (2008) and Yang, Qian and Gong (2008)

The following equation illustrates how to quantify the direct benefit received based on the area of the practice and the average pollutant uptake/deposition for that practice:

area of practice (SF) *
average annual pollutant uptake/deposition (lbs/SF)
= total annual air pollutant uptake/deposition (lbs)

Keep in mind that the subsequent example calculations will only walk through the quantification of reduced NO_2. Other criteria pollutants will not be illustrated, but they should be calculated when conducting a comprehensive benefit analysis.

Example 3.1:

Using the above equation, a 5,000 SF green roof could lead to an improved direct nitrogen dioxide (NO_2) uptake capacity as follows:

Lower Bound (using 3.00×10^{-4} lbs/SF/yr)
5,000 SF * 3.00×10^{-4} lbs/SF = 1.50 lbs total annual NO_2 uptake

Upper Bound (using 4.77×10^{-4} lbs/SF/yr)
5,000 SF * 4.77×10^{-4} lbs/SF = 2.39 lbs total annual NO_2 uptake

In this case, the 5,000 SF green roof would on average take up between about 1.50 and 2.39 pounds of NO_2 annually.

TREE PLANTING

Climate zone, existing air quality and pollutant levels, and the size, age and type of tree all play a role in determining the uptake potential of tree planting.

The Forest Service *Tree Guides* estimate the level of air quality benefits from trees according to climate zone. The tables in the guides' appendices are structured based on the size of the tree (with example tree types provided) and the location of the tree with respect to a surrounding building. One can then estimate air quality benefits based on these factors (on a per tree basis) using the "Uptake and Avoided" data provided in the *Tree Guides*' appendices.

As an example, Table 3.2 shows the 40-year average air quality impacts from trees in the Midwest Climate Region.

Table 3.2
Annual Criteria Pollutant Reductions (uptake and avoided) from 1 tree, 40-year average, Midwest Region

	Small tree: Crabapple (22 ft tall, 21 ft spread)	**Medium tree: Red Oak** (40 ft tall, 27 ft spread)	**Large tree: Hackberry** (47 ft tall, 37 ft spread)
NO_2 Uptake and Avoided	0.39 lbs	0.63 lbs	1.11 lbs
SO_2 Uptake and Avoided	0.23 lbs	0.42 lbs	0.69 lbs
O_3 Uptake	0.15 lbs	0.2 lbs	0.28 lbs
PM-10 Uptake and Avoided	0.17 lbs	0.26 lbs	0.35 lbs

Source: McPherson, E. et al. 2006

The following equation illustrates how to reach a quantified benefit from a tree planting:

no. of trees * average annual uptake and avoided pollutant emissions (lbs/tree) = total annual air pollutant reduction (lbs)

Example 3.2:

Given the data from Table 3.2, it is possible to use the above equation to determine the annual nitrogen dioxide (NO_2) benefit of 100 medium-sized trees planted in the Midwest Region.

100 medium trees * 0.63 lbs NO_2/tree = 63 lbs total annual NO_2 reduction

Figures provided by the *Tree Guides* for criteria air pollutant abatement include both the direct (uptake and deposition) and indirect (avoided power plant emissions) benefits, which must be kept in mind in order to avoid double-counting these benefits in later calculations. Once a total abatement figure is reached, it is possible to move directly to calculating the monetary value of that tree practice, as outlined in the "Valuation of Quantified Benefits" section.

BIORETENTION AND INFILTRATION

Although many studies agree that vegetative infrastructure elements such as bioswales, rain gardens and other bio-infiltration techniques can provide considerable air quality benefits, there is currently a lack of scientific research measuring and quantifying the direct air pollution uptake potential of these practices. Without studies that derive specific uptake values for bio-infiltration practices, this guide cannot provide the steps to calculate the direct uptake benefit at this time, as further field research and data collection is needed.

Once an average value is quantified (in lbs/SF), provided sufficient research data is published, it can be substituted into the equation below:

total area of practice (SF) * average annual uptake/deposition (lbs /SF)
= total annual pollutant uptake/deposition (lbs)

This equation could then be used to derive the total air pollutant uptake benefit for a given bioswale or rain garden and later to monetize the practice's direct uptake benefit.

Indirect Benefits

As stated above, this section quantifies not only the direct (uptake and deposition) means by which air quality is improved, but also the indirect means (avoided emissions) that provide air quality improvements.

Practices that indirectly lower emissions of air pollution include any practices that reduce energy consumption through decreased energy use in neighboring buildings or through reduced water treatment needs. These benefits are quantified in the "Energy" section, and they should be accounted for here to estimate in pounds the reduction of criteria air pollutants stemming ultimately from reduced water treatment.

The production of electricity in fossil fuel power plants entails the emission of nitrogen dioxide and sulfur dioxide. Furthermore, the burning of natural gas in homes and businesses produces additional indirect air pollutant emissions. In order to quantify this impact, multiply the estimated electricity use reduction calculated here in the "Energy" section by emissions factors provided by the US EPA. It is important to keep in mind that the net air quality benefit from trees was already calculated above, so to avoid double counting, do not recalculate the reduced pollutants from trees here.

The following equations are used to calculate the total avoided criteria pollutant emissions from reduced energy usage in terms of electricity and natural gas, respectively. Specific practice-based calculations follow from the calculations completed in the "Energy" section and do not require additional individual explanation.

Benefit from kWh of Electricity Saved

annual electricity reduction (kWh) * emissions factor (lbs/kWh)
= annual avoided pollutant emissions (lbs)

In its online eGRIDweb application, the USEPA provides the following figures for estimated annual output emissions rates of national electricity production:

- **NO_2: 1.937 lbs/MWh » 0.001937 lbs/kWh**
- **SO_2: 5.259 lbs/MWh » 0.005259 lbs/kWh**

Source: USEPA 2005

Please note that although power plants and electricity generators emit both ozone and certain particulates into the atmosphere, data could not be found to quantify the emissions factors for those variables.

Example 3.3:
Using the example 5,000 square foot green roof again, remember the annual cooling savings determined in Example 2.1:

5,000 SF * 0.2244 kWh/SF = 1,122 kWh in cooling savings annually

Given the reduced electricity use of 1,122 kWh, the NO_2 emission benefits from that reduction are:

1,122 kWh * 0.001937 lbs/kWh = 2.17 lbs avoided NO_2 emissions from cooling savings annually

More locally-specific figures can be found in the eGRIDweb application. This tool provides emission rates by state, grid region and power plant or generating company.

Benefit from Btu of Heating Natural Gas Saved

annual heating natural gas savings (Million Btu) * emissions factor (lbs/Million Btu) = annual avoided criteria pollutant emissions (lbs)

In the same online eGRIDweb application used previously, the USEPA provides the following figures for the national annual emission factors per Btu of natural gas input:

- **NO_2: 0.721 lbs/Million Btu**
- **SO_2: 0.266 lbs/Million Btu**

Source: USEPA 2005

Please note that although the burning of natural gas emits both ozone and certain particulates into the atmosphere, data could not be found to quantify the emissions factors for those variables.

Example 3.4:
Using the example 5,000 square foot green roof again, remember the annual heating natural gas savings (Btu) determined in Example 2.2:

7,231.75 Btu/SF * 5,000 SF = 36,158,750 Btu = 36.15875 Million Btu annually in heating natural gas savings

Given the reduced heating natural gas use of 36.15875 Million Btu and using the US EPA emissions factors above of 0.721 lbs NO_2 / Million Btu, the NO_2 emission benefits from that reduction are:

36.15875 Million Btu * 0.721 lbs NO_2/Million Btu = 26.07 lbs avoided NO_2 emissions from heating natural gas savings annually

Total Benefit from Electricity and Heating Natural Gas Savings

Now that the indirect air quality benefits from electricity and natural gas savings have been quantified, the pounds of criteria pollutants calculated from both can be added together. This summation will make the later valuation calculation less complicated.

annual avoided pollutant emissions from reduced electricity (lbs) + annual avoided criteria pollutant emissions from reduced heating natural gas (lbs) = total avoided criteria pollutant emissions from electricity and heating natural gas savings annually

Example 3.5:

Taking the answers from Examples 3.3 and 3.4, the total indirect benefit from electricity and heating natural gas savings can be quantified as:

2.17 lbs avoided NO_2 (Example 3.3) + 26.07 lbs avoided NO_2 (Example 3.4) = 28.24 lbs avoided NO_2 emissions from reduced cooling and heating energy use annually.

Now, one can quantify the total air quality benefit by adding together the total direct criteria pollutant uptake/deposition benefit and the total indirect avoided emissions benefit (from reduced energy use) for each practice.

∑ total criteria pollutant uptake/deposition benefit (lbs) + total avoided criteria pollutant emissions (lbs) = total annual criteria pollutant reduction benefit (lbs)

STEP 2 - VALUATION OF QUANTIFIED BENEFITS: REDUCED CRITERIA POLLUTANTS

In order to arrive at a value for the benefits of air quality improvements from green infrastructure, one must estimate the price or cost (per pound) of the standard air pollutants discussed in this guide.

The following numbers represent US Forest Service recommendations for valuation of criteria air pollutants:

- **NO_2 = \$3.34/lb**
- **O_3 = \$3.34/lb**
- **SO_2 = \$2.06/lb**
- **PM-10 = \$2.84/lb**

Source: McPherson et al. (2006), Wang and Santini (1995)

The equation below allows for valuation of air quality benefits derived from using green infrastructure practices:

total annual criteria pollutant reduction benefit (lbs) * price of criteria pollutant (\$/lb) = total value of pollutant reduction (\$)

Example 3.6:

Recall that Example 3.1 found that a hypothetical 5,000 SF green roof yields an annual nitrogen dioxide (NO_2) uptake benefit between 1.50 and 2.39 pounds of NO_2 reduction, or an average of 1.95 pounds. Furthermore, Example 3.5 found the same roof yields 28.24 pounds of indirect NO_2 reduction. Notice that these figures are the same resource unit and can be summed as follows:

∑ 1.95 lbs NO_2 + 28.24 lbs NO_2 = 30.19 lbs NO_2

Given the above valuation equation and a price per pound of NO_2 of \$3.34/lb, the following calculation determines the monetary value of the on-site uptake and off-site emissions benefits, as follows:

30.19 lbs NO_2 * \$3.34/lb NO_2 = \$100.83

Thus, the green roof would lead to a monetary benefit from on-site and off-site NO_2 benefits of about \$100.83 annually.

The Role of Permeable Pavement in Improving Air Quality

In addition to green roofs, trees, and bioretention and infiltration practices, permeable pavement can also improve air quality and reduce atmospheric CO_2. Permeable pavement reduces the amount of water treatment needed by allowing stormwater to infiltrate on site, in turn reducing air pollution and CO_2 emissions from power plants. It also decreases ground level ozone formation and helps to lower pavement surface temperatures by reducing the amount of heat absorbed. This helps to cool the air and decrease the amount of energy needed for cooling. It also mitigates the urban heat island effect.

A recent study comparing pervious concrete to traditional pavement found that "…while the pervious concrete becomes hotter than the surrounding air temperature during the daytime much less heat is transferred and stored in the underlying soil than the traditional pavement. Even though the pervious concrete became warmer than the traditional [concrete], at night the pervious concrete was equal to or cooler than the [traditional concrete] pavement. This indicates less heat storage potential and a greater rate of cooling in the pervious concrete versus the traditional system" (Kevern, J.T. et al. 2009b).

While research has demonstrated the ability of permeable pavement to improve air quality and reduce atmospheric CO_2, not enough data exists to walk through a valuation of these benefits at this time.

Benefit Measurement and Valuation

4. CLIMATE CHANGE

STEP 1 - QUANTIFICATION OF BENEFIT: REDUCED ATMOSPHERIC CO_2

This section provides instructions on how to quantify and value direct (sequestration) and indirect (avoided emissions) climate benefits. While recognizing that there are other types of greenhouse gases that contribute to climate change, the focus in this section is specifically on the climate benefits of reducing atmospheric CO_2, as this is the greenhouse gas most directly affected by green infrastructure. A similar framework can be used to value the climate impacts of those other gases, particularly when they are put in terms of CO_2-equivalents. Outlining those additional steps, however, is outside the scope of this guide.

Green infrastructure practices specifically addressed in this section for their direct benefit of carbon sequestration include green roofs, trees and bio-infiltration. The authors acknowledge that there are additional climate benefits from other practices, such as permeable pavement, which cannot be explicitly quantified at this time due to the infancy of the research surrounding this benefit within those practices. Finally, it is important to note that sequestration benefits only last as long as the plants or trees are alive and that they vary with the age of the vegetation.

The following equation is used to quantify the amount of carbon sequestered for a given area and green infrastructure practice, keeping in mind that the pounds of carbon sequestered per unit area depend on several local factors, including the specific practice, the types of species planted and the local climate:

total area of practice (SF) *
average annual amt. of carbon sequestered (lbs C /SF)
= annual amount of carbon sequestered (lbs C)

It is important to note that a common point of confusion when quantifying carbon sequestration benefits is how many pounds of CO_2 are avoided from a certain amount of stored carbon. Due to the molecular structures involved, the pounds of carbon stored in plants do not equal the pounds of carbon dioxide that are removed from the atmosphere (because an atom of carbon has a smaller atomic mass than a carbon dioxide molecule). Employ the following conversion factor ($^{44}/_{12}$ or 3.67) to arrive at the equivalent CO_2 impacts of a specific carbon sequestering practice.

GREEN ROOFS

Research synthesized in a Michigan State University report offers average carbon sequestration values provided by extensive green roofs' aboveground biomass (Getter et al. 2009). Using the data from that report, it is possible to arrive at an estimated range of carbon sequestration per square foot for similarly implemented extensive green roofs. Because one of the two studies lacks belowground sequestration figures, this guide does not take belowground biomass into account when determining the recommended range. (See below.) As such, the given range may provide an underestimate of the practice's full sequestration potential. Further field research and data collection are needed in order to more precisely determine the full carbon sequestration potential of green roofs.

The recommended range of grams of carbon sequestered per square meter from aboveground biomass, as determined by the averages of the two Michigan State University studies (which include data from extensive green roofs surveyed in both Michigan and Maryland), is as follows:

162 g C/m² to 168 g C/m² (Getter et al. 2009)

Converting to lbs C/SF from metric units[2], the range can be defined: 0.0332 lbs C/SF to 0.0344 lbs C/SF

Example 4.1:

A hypothetical 5,000 SF extensive green roof provides an estimated carbon sequestration capacity as follows:

Lower Bound (using 0.0332 lbs C/SF)
0.0332 lbs C/SF * 5,000 SF = 166 lbs of carbon per year

Upper Bound (using 0.0344 lbs C/SF)
0.0344 lbs C/SF * 5,000 SF = 172 lbs of carbon per year

In this case, the hypothetical 5,000 SF extensive green roof would sequester between about 166 and 172 pounds of carbon annually, or an average of 169 pounds of carbon per year.

TREE PLANTING

Local conditions—such as climate zone, existing air conditions and season—as well as size, age and species type all play a role in determining the carbon sequestration potential of a tree.

The referenced Forest Service *Tree Guides* provide an estimate of the level of CO_2-related benefits from trees according to climate zone. Once the climate zone is determined, the tables in the tree guides' appendices are structured on the basis of size of tree (with example tree types provided) as well as the location of the tree with respect to a surrounding building. Climate benefits can then be estimated based on these factors (on a per tree basis) using the "Net CO_2" data provided in the tree guides' appendices. These benefits vary by region and according to energy sources.

As an example, Table 4.1 shows the 40-year average CO_2 benefits from trees in the Midwest Climate Region.

Table 4.1: Annual Net CO_2 (lbs) Benefits from 1 tree, 40-year average, Midwest Region

Net CO_2 (lbs)	Residential Yard Opposite West-Facing Wall	Residential Yard Opposite South-Facing Wall	Residential Yard Opposite East-Facing Wall	Public Tree on a Street or in a Park
Small tree: Crabapple (22 ft tall, 21 ft spread)	390	226	335	336
Medium tree: Red Oak (40 ft tall, 27 ft spread)	594	212	487	444
Large tree: Hackberry (47 ft tall, 37 ft spread)	911	665	806	734

Source: McPherson, E. et al. 2006

[2] Converting g C /m² into lbs. C/SF, we multiply the metric units by a conversion factor 0.00220462262 lbs/g to arrive at lbs C/m², then we multiply by a conversion factor of 0.09290304 m² /SF to arrive at the desired lbs C/SF

Example 4.2:

Given the data in Table 4.1, it is possible to determine the benefits of planting 100 medium trees in a public space. In this case, the number of trees planted is used instead of the amount of vegetated area in the equation to arrive at the final figure:

number of medium trees planted * total CO_2 abated (lbs /tree) = total annual climate benefit (direct and indirect) (lbs CO_2)

100 medium trees * 444 lbs total CO_2/tree = 44,400 lbs of total annual CO_2 abatement

Please note that these "total CO_2" figures include both direct (sequestration) and indirect (avoided power plant emissions) benefits for trees, to avoid double-counting these benefits in later calculations. Once an abatement figure is reached, it is possible to calculate the monetary value of the green infrastructure practice following the steps outlined in the "Valuation of Quantified Benefits: Reduced Atmospheric CO_2" section. Notice also that the above figure is already in "pounds of CO_2,"thus no conversion from carbon to CO_2 will be necessary.

BIORETENTION AND INFILTRATION

Although many studies agree that vegetative infrastructure such as bioswales, rain gardens, and other bio-infiltration techniques can provide a considerable amount of carbon sequestration benefit, there is a current lack of scientific research measuring and quantifying the sequestration potential of those practices. Without studies that demonstrate average values for the carbon sequestration potential per square foot of certain bio-infiltration practices, this guide cannot provide the steps to estimate the direct benefit.

Once an average value is quantified (in lbs/SF), it can be used in the equation below:

total area of practice (SF) * average annual amt. of carbon sequestered (lbs C /SF) = annual amt. of carbon sequestered (lbs C)

Once it is possible to determine the total amount of carbon sequestration for a given bioretention or infiltration practice, the resulting pounds can be used to monetize the practice's direct sequestration benefit.

Indirect Benefits

As previously stated, this section quantifies the direct (sequestration) means by which CO_2 is reduced. It also quantifies the indirect means (avoided emissions) that provide climate change improvements.

Practices that provide an indirect benefit of avoided emissions include any practice that reduces energy consumption through reduced energy use in a neighboring building or through reduced water treatment needs. The "Energy" section quantifies these benefits, and they should now be accounted for to estimate the reduced pounds of criteria pollutants.

This section outlines a process for calculating the total avoided CO_2 emissions from reduced energy usage. Specific practice-based calculations follow from the calculations completed in the "Energy" section.

Benefit from kWh of Electricity Saved

The first step toward calculating the total avoided CO_2 emissions is to quantify the amount of electricity (in kWh) saved for a given area and green infrastructure practice. GI practices will reduce energy consumption on site as well as off site at water treatment facilities. These energy reductions depend on several local factors, including the specific practice, the types of species planted and local climate. The total annual electricity-saved calculation from the "Energy" section can be substituted into the equation below to calculate the total pounds of avoided CO_2:

total annual electricity saved (kWh) * lbs CO_2 /kWh = lbs annual avoided CO_2 emissions from practice's electricity savings

Because the amount of CO_2 emissions from power plants varies depending on the electricity source (e.g. coal, nuclear, wind, etc), use Table 4.2 to specify the appropriate figure for "**lbs CO_2 /kWh**" (in the above equation) given the specific region under consideration.

Example 4.3:

Using the example 5,000 SF green roof again, remember the annual building electricity savings determined in Example 2.1 and the water treatment electricity savings determined in Example 2.4:

total electricity savings from a 5,000 SF green roof = 1,122 kWh in building electricity savings + 110.77 kWh in water treatment electricity savings = 1,232.77 kWh annually

Using the U.S. average of 1.33 lbs CO_2/kWh from Table 4.2, the reduced electricity savings would provide the following indirect climate benefit:

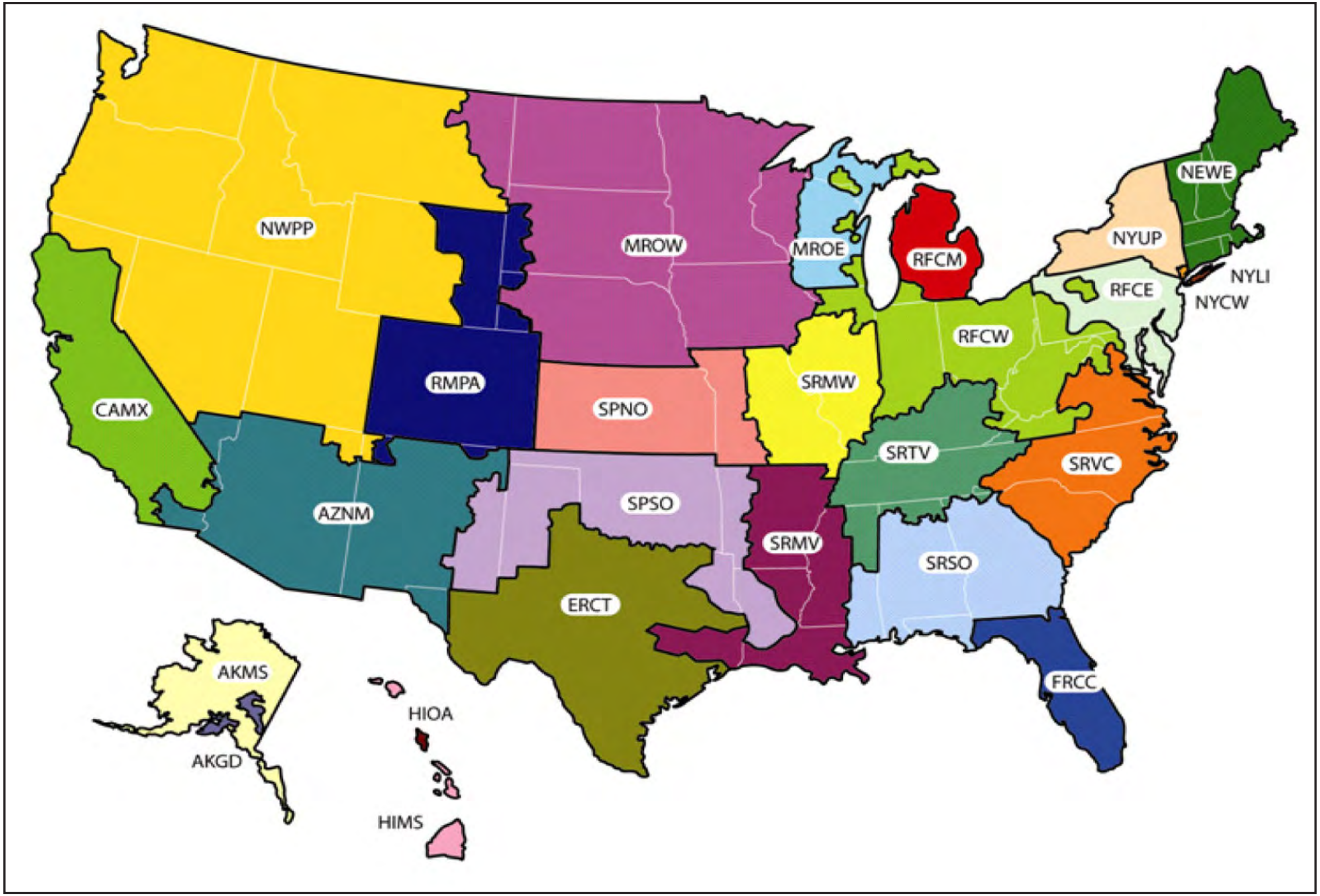
1,232.77 kWh * 1.33 lbs CO_2/kWh = 1,639.58 lbs avoided CO_2 emissions from reduced electricity annually

Table 4.2
Year 2005 eGRID Subregion Emissions, CO_2 Greenhouse Gas

eGRID Subregion Acronym	eGRID Subregion Name	CO_2 Output Emission Rate (lb CO_2/KWh)
AKGD	ASCC Alaska Grid	1.23236
AKMS	ASCC Miscellaneous	0.49886
AZNM	WECC Southwest	1.31105
CAMX	WECC California	0.72412
ERCT	ERCOT All	1.32435
FRCC	FRCC All	1.31857
HIMS	HICC Miscellaneous	1.51492
HIOA	HICC Oahu	1.81198
MORE	MRO East	1.83472
MROW	MRO West	1.82184
NEWE	NPCC New England	0.92768
NEWPP	WECC Northwest	0.90224
NYCW	NPCC NYC/Westchester	0.81545
NYLI	NPCC Long Island	1.5368
NYUP	NPCC Upstate NY	0.7208
RFCE	RFC East	1.13907
RFCM	RFC Michigan	1.56328
RFCW	RFC West	1.53782
RMPA	WECC Rockies	1.88308
SPNO	SPP North	1.96094
SPSO	SPP South	1.65814
SRMV	SERC Mississippi Valley	1.01974
SRMW	SERC Midwest	1.83051
SRSO	SERC South	1.48954
SRTV	SERC Tennessee Valley	1.51044
SRVC	SERC Virginia/Carolina	1.13488
U.S.		1.32935

Source: USEPA 2008c

Year 2005 eGRID Subregion Emissions, CO_2 Greenhouse Gas



Source: USEPA 2008c

Benefit from Btu of Natural Gas Saved

Using the calculation of reduced natural gas from the "Energy" section, the total amount of avoided CO_2 emissions for the given area and green infrastructure practice can be estimated using the following equation:

total heating natural gas saved (Million Btu) * lbs CO_2 /Million Btu = lbs of avoided CO_2 emissions annually from heating natural gas savings

Note that the previous equation relies on the CO_2 emissions factor of 116.89 lbs CO_2/Million Btu of natural gas[3] (i.e. the number of pounds of CO_2 released per million Btu) (US EPA 2009).

Example 4.4:

Using the example 5,000 SF green roof again, remember the annual heating natural gas savings (Btu) determined in Example 2.2:

7,231.75 Btu/SF * 5,000 SF = 36,158,750 Btu = 36.15875 Million Btu annually in heating natural gas savings

Using the CO_2 emissions factor above of 116.89 lbs CO_2/Million Btu, the reduced natural gas savings would provide the following indirect climate benefit:

36.15875 Million Btu * 116.89 lbs CO_2/Million Btu = 4,226.6 lbs avoided CO_2 emissions from reduced natural gas annually

[3] Converting the USEPA Code of Federal Regulations standard of 53.02 kg CO_2 / Million Btu into lbs CO_2 /Million Btu, multiply the metric units by a conversion factor of 2.20462262185 lbs/kg to arrive at the desired lbs CO_2/ Million Btu.

Total Benefit from Electricity and Heating Natural Savings

Now that the indirect benefits from electricity and natural gas savings have been quantified, the pounds of CO_2 from both calculations can be added together. This summation will make the later valuation calculation less complicated.

lbs avoided CO_2 emissions from electricity savings + lbs avoided CO_2 emissions from heating natural gas savings = total lbs avoided CO_2 emissions from electricity and heating natural gas savings annually

Example 4.5:

Recall that Example 4.3 calculated the annual avoided CO_2 from electricity of the 5,000 SF green roof and that the annual avoided CO_2 from natural gas savings was calculated in Example 4.4. Notice that these figures are the same resource unit and can be summed as follows:

1,639.58 lbs CO_2 + 4,226.6 lbs CO_2 = 5,866.18 lbs avoided CO_2 emissions from reduced building cooling and heating and reduced water treatment energy use annually

Now, the total benefit can be quantified by adding together the total carbon sequestered and the total CO_2 emissions avoided (from reduced energy use) for each practice. To do so, any carbon sequestration benefit (lbs C) must be converted, as previously mentioned, to its CO_2 equivalent.

To convert pounds of carbon sequestered into pounds of carbon dioxide equivalent:

total lbs carbon sequestered (lbs C) * 3.67 lbs CO_2/lb C = total annual equivalent sequestration benefit (lbs CO_2)

Then, the user can combine the direct (sequestration) and indirect (off-site avoided emissions) benefits into a figure for the total climate benefit, as follows:

∑ total equivalent sequestration benefit (lbs CO_2) + total avoided CO_2 emissions (lbs CO_2) = total annual climate benefit (lbs CO_2)

An example of this calculation will follow; please refer to Example 4.6.

STEP 2 - VALUATION OF QUANTIFIED BENEFITS: REDUCED ATMOSPHERIC CO_2

With the total pounds of CO_2 reduced, the following equation estimates the monetary value:

total climate benefit (lbs CO_2) * price of CO_2 (\$/lb) = total annual value of climate benefit (\$)

Example 4.6:

Following from Example 4.1, which quantified the direct and indirect climate benefits of a hypothetical 5,000 SF green roof, it was found that the green roof sequestered between 166 and 172 pounds of carbon per year. (An average of 169 pounds of carbon is used below.) In Example 4.5, this green roof had the indirect benefit of avoiding 5,866.18 lbs of CO_2 emissions from reduced energy use. One can calculate the monetary value of the total climate benefit as follows:

169.0 lbs C * 3.67 lbs CO_2/lb C = 620.23 lbs CO_2 in total annual sequestration benefit

5,866.18 lbs CO_2 in total annual indirect emissions benefit (Example 4.5)

∑ 620.23 lbs CO_2 + 5866.18 lbs CO_2 = 6486.41 lbs CO_2 in total annual climate benefits

This total climate benefit can be valued by multiplying by a price for carbon. In the following parts (4.6.a. and 4.6.b.), the guide walks through calculations of a lower and upper bound for valuing these carbon benefits.

Example 4.6.a:

Lower Bound: EU ETS Carbon Price of \$0.00756 / lb CO_2

*6,486.41 lbs CO_2 * \$0.00756 / lb CO_2 =*
\$49.04 monetary value of the total annual climate benefits

This lower-bound calculation shows that the hypothetical green roof could provide about \$49.04 in annual climate change benefits.

Example 4.6.b:

Upper Bound: Stern's Value of \$0.0386/lb CO_2

*6,486.41 lbs CO_2 * \$0.0386/lb CO_2 =*
\$250.38 monetary value of the total annual climate benefits

This upper-bound calculation shows that the hypothetical green roof could provide about \$250.38 in annual climate change benefits.

Pricing Carbon

To complete the valuation of the direct and indirect climate benefits for a given practice, a monetary price for carbon must be determined. In other words, it is necessary to assign a value to the **$/ lb of CO_2** figure found in the final equation.

Assigning a price for carbon is not an exact science, and a degree of uncertainty still exists about the "best" or true price of carbon. It is generally accepted within the scientific community, however, that one can arrive at a working price estimate for the purpose of economic valuation of climate change.

Existing literature concerning the price of carbon dioxide and other greenhouse gas emissions offers a wide range of values for the market price of carbon. The latest report by the Intergovernmental Panel on Climate Change (IPCC) surveyed 100 peer reviewed studies and found an average estimated price per metric tonne[4] (Mg) of $12 (or $0.00544/lb) in a wide range that tops out at $95/Mg (or $0.0431/lb) (IPCC 2007).

The European Union's Emissions Trading System (EU ETS) is an example of a fully functioning carbon cap and trade market. A current average price within this market is about 12€, which according to today's conversion rate is about $16.66[5] per metric tonne of carbon (Chevallier, J. 2010). However, it is important to note this is only a partial market given that it is not globalized and its prices are dependent upon specific regulatory parameters. In contrast, a widely read and cited report on the economic impact of climate change values carbon emissions at $85/Mg (or $0.0386/lb) (Stern 2006). However, this value is strictly academic since it has not been tested in the market.

The IPCC and other experts note that current carbon prices are very likely underestimated in the marketplace, given the exclusion of many unquantifiable risks associated with climate change (for example, future damages from more intense rain events) (IPCC 2007, Clarkson & Deyes 2002). Given the range of potential value for a unit of carbon in the market, the guide provides a low- and high-end valuation example that can be applied to the climate benefit calculations in this section.

[4] Mg=metric tonne or megagram; Conversion: 1 Mg = 2204.62262 lbs.

[5] currency conversion based on a rate of 1 EUR = 1.389 USD from Google Finance, 11/1/2010, 7:00PM

Example 4.7:

Following from the earlier tree example in Example 4.2, the 100 medium trees planted in a public space abated a net amount of 44,400 pounds of CO_2 annually.

Remember that because the *Tree Guide* value includes the net benefit from CO_2 abatement—the direct and indirect benefits—the indirect energy benefit for a given tree practice does not need to be recalculated here. (Otherwise, that calculation would double count the indirect energy benefit.) Instead, just multiply the total amount of CO_2 abatement (44,400 lbs in this case) by a given carbon price.

In the following (4.7.a. and 4.7.b.), the guide walks through calculations of a lower and upper bound for valuing these carbon benefits.

Example 4.7.a:

Lower Bound: EU ETS Carbon Price of $0.00756 / lb CO_2

44,400 lbs CO_2 * $0.00756 /lb CO_2 =
$335.66 in total annual climate benefits

This lower-bound calculation shows that 100 medium trees planted in a public space could provide about $335.66 in annual climate change benefits.

Example 4.7.b:

Upper Bound: Stern's Value of $0.0386/lb CO_2

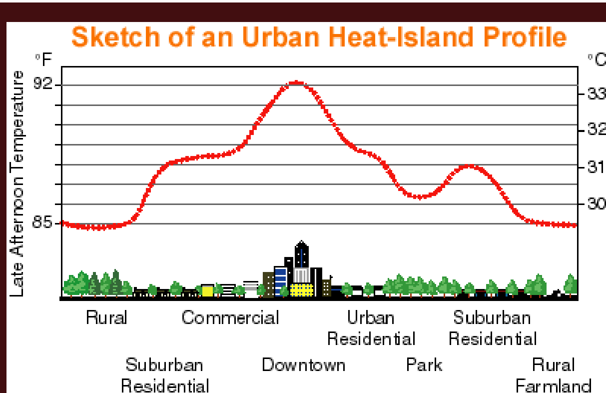
44,400 lbs CO_2 * $0.0386/lb CO_2 =
$1,713.84 in total annual climate benefits

This upper-bound calculation shows that 100 medium trees planted in a public space could provide about $1,713.84 in annual climate change benefits.

Benefit Measurement and Valuation

5. URBAN HEAT ISLAND

The USEPA describes the process by which urban heat islands form as follows: “As urban areas develop, changes occur in the landscape. Buildings, roads, and other infrastructure replace open land and vegetation. Surfaces that were once permeable and moist generally become impermeable and dry. This development leads to the formation of urban heat islands—the phenomenon whereby urban regions experience warmer temperatures than their rural surroundings” (US EPA n.d. a).



Source: Lawrence Berkeley National Laboratory

The urban heat island (UHI) effect compromises human health and comfort by causing respiratory difficulties, exhaustion, heat stroke and heat-related mortality. UHI also contributes to elevated emission levels of air pollutants and greenhouse gases through the increased energy demand (via greater air conditioning needs) that higher air temperatures cause. Additionally UHI puts a greater demand on outdoor irrigation needs thus increasing water demand and its associated energy uses. Green infrastructure practices within urban areas can help to mitigate UHI and improve air quality through increased vegetation, reduced ground conductivity and decreased ground level ozone formation.

Various studies have estimated that trees and other vegetation within building sites reduce temperatures by about 5°F when compared to outside non-green space. At larger scales, variation between non-green city centers and vegetated areas has been shown to be as high as 9°F. Likewise, recent studies done on permeable pavement have found that it reduces or lowers the negative impacts of UHI through its porosity, which serves to insulate the ground better and allow more water evaporation. Both of these effects aid in cooling temperatures and mitigating the UHI effect.

One study, evaluating the benefit of reduced extreme-heat events, estimates that, at a city level, 196 premature fatalities can be avoided in Philadelphia (over a 40-year period) by integrating green infrastructure throughout the city landscape to address its combined sewer overflows (McPherson et al 2006; Akbari et al 1992; Stratus 2009). According to figures from the USEPA (n.d. b), the value of a statistical life (VSL) is $7.4 million (in 2006 dollars). Thus, applied to the Philadelphia study, reductions in UHI-related fatalities could save over $1.45 billion. Likewise, the Lawrence Berkeley Lab Heat Island Group estimates that each one degree Fahrenheit increase in peak summertime temperature leads to an increase in peak demand of 225 megawatts, costing ratepayers $100 million annually (Chang 2000).

While the benefits of mitigating the UHI are important to community health and vitality, current valuation of these benefits is not extensive enough to work through quantifying methods and equations in this section.

Benefit Measurement and Valuation

6. COMMUNITY LIVABILITY

Using green infrastructure for stormwater management can improve the quality of life in urban neighborhoods. In addition to the ecological and economic values described elsewhere in this handbook, the goods and services provided by urban vegetation and other green infrastructure practices carry socio-cultural values—aspects that are important to humans because of social norms and cultural traditions. This set of related benefits is grouped under the umbrella category of 'community livability' to describe the many ways in which increasing the use of green infrastructure can improve neighborhood quality of life. Community livability is classified into four categories:

- Aesthetics
- Recreation
- Reduced noise pollution
- Community cohesion

While all of these benefits carry significant value in communities, the literature regarding how to quantify their economic value is not extensive, widespread or well agreed upon at this time. Given the high levels of uncertainty involved in quantifying community livability benefits, this guide does not present methods and equations for quantification or valuation in this section. It does, however, points to ranges of benefit values that have been presented and proposed in various studies.

AESTHETICS

Increased greenery within urban areas increases the aesthetic value of neighborhoods. The positive impact of green infrastructure practices on aesthetics can be reflected in the well-observed relationship between urban greening and property value. People are willing to pay more to live in places with more greenery. To measure this value, various studies employ a Hedonic price method (calculating increases in property value adjacent to green features).

Several empirical studies have shown that property values increase when an urban neighborhood has trees and other greenery. For example, one study reported an increase in property value of 2–10 percent for properties with new street tree plantings in front (Wachter 2004; Wachter and Wong 2008). Another study done in Portland, Oregon, found that street trees add $8,870 to sale prices of residential properties and reduce time on market by 1.7 days (Donovan and Butry 2009). An extensive study on the benefits of green infrastructure in Philadelphia also explores the effect that these practices have on property values (Stratus 2009). While the authors conclude that property values are notably higher in areas with LID and proximity to trees and other vegetation, they also note the difficulty in isolating the effect of improved aesthetics and avoiding double-counting of benefits such as air quality, water quality, energy usage (often relating to heat stress) and flood control that also impact property values. In this study, a range of 0– 7 percent is presented as suggested in literature, and a mean increase of 3.5 percent is chosen (Status 2009). Ward et al. (2008) estimate property values in the range of 3.5–5.0 percent higher for LID adjacent properties in King County, Washington.

The Forest Service *Tree Guides*, referenced previously, provide estimates of the property value benefits trees provide in an urban setting. The property value benefit is found to be the second largest component of the total benefits derived from trees. Benefits are presented on a per tree basis, based on type and size of each tree as well its location.

Table 6.1
Annual Property Value Gains from 1 tree, 40-year average, Midwest Region

	Small tree: Crabapple (22 ft tall, 21 ft spread)	**Medium tree: Red Oak** (40 ft tall, 27 ft spread)	**Large tree: Hackberry** (47 ft tall, 37 ft spread)
Residential Yard	$4.50	$10.73	$23.44
Public Space	$5.32	$12.67	$27.69

Source: McPherson, E. et al. 2006

User Day Methodology

User day estimates from the Philadelphia study, although not necessarily universal, may provide a helpful starting point for valuing improved recreation from green infrastructure and increased vegetation.

- 1 additional vegetated acre provides ~1,340 user days per year
- 1 additional vegetated acre provides ~27,650 user days over a 40-year period
- 1 user day provides ~$0.71 in present value for 40-year project period (Stratus 2009)

This translates to a benefit of about $951.40 for each additional vegetated acre per year and about $19,631.50 for each additional vegetated acre over a 40-year project period.

For a complete methodology, please refer to the Stratus (2009) report.

RECREATION

Green infrastructure has been shown to increase recreational opportunities (for example, walking the dog, walking or jogging on sidewalks, bench sitting or picnicking) when increased vegetation and treed acreage is added within a community. The value of added recreational opportunities is measured by the increase in recreational trips or "user days" gained from urban greening. Use values can then be assigned to the various recreational activity trips.

In one study, Philadelphia, Pennsylvania, estimated an increase of almost 350 million recreational trips (over a 40-year period) when utilizing green infrastructure within the proposed implementation of its *Green City Clean Waters* plan to control stormwater. The 2009 monetized present value of these added trips could amount to over $520 million (Stratus 2009). Furthermore, a report by the Trust for Public Lands for the Philadelphia Parks Alliance provided critical data on recreational uses, activities and visitation at parks in Philadelphia (Trust for Public Land 2008).

Another approach to valuing recreation is determining the avoided costs in connection to health benefits. An example of this would be studies that correlate lowered medical expenses with increased levels of routine physical activity. In a 2000 study, researchers found that when previously inactive adults regularly incorporated moderate physical activity into their routines, annual mean medical expenditures were reduced by $865 per individual (Pratt et al. 2000).

REDUCED NOISE POLLUTION

Green infrastructure, particularly vegetative practices and permeable pavement, have the added benefit of reducing noise pollution. Planes, trains and roadway noise are significant sources of noise pollution in urban areas—sometimes exceeding 100 decibels, which well exceeds the level at which noise becomes a health risk.

A study in Europe using porous concrete pavement found a reduction in noise level of up to 10 decibels (Olek et al 2003;

Gerharz 1999). Likewise, the British Columbia Institute of Technology's Centre for the Advancement of Green Roof Technology measured the sound transmission loss of green roofs as compared to conventional roofs. The results found transmission loss increased 5–13 decibels in low- and mid-frequency ranges, and 2–8 decibels in the high frequency range (Connelly and Hodgson 2008). Hedonic pricing studies assessing the impact of road and aircraft noise on property values find average reductions in property value per one decibel increase in noise level of 0.55 percent and 0.86 percent, respectively (Navrud 2003).

COMMUNITY COHESION

One way that green infrastructure can make communities better places to live is through its effect on 'community cohesion'—improving the networks of formal and informal relationships among neighborhood residents that foster a nurturing and mutually supportive human environment (Sullivan, Kuo and Depooter 2004).

A study done by the Landscape and Human Health Laboratory at the University of Illinois at Urbana/Champaign (UIUC) found that, "Exposure to green surroundings reduces mental fatigue and the feelings of irritability that come with it. . . . Even small amounts of greenery . . . helped inner city residents have safer, less violent domestic environments." (Kuo and Sullivan 2001b).

Another study documents a link between increased vegetation and the use of outdoor spaces for social activity, theorizing that urban greening can foster interactions that build social capital (Sullivan, Kuo and Depooter 2004). Related to this effect, a further study found a meaningful relationship between increased greenery and reduced crime (Kuo and Sullivan 2001a).

Urban Agriculture Opportunities

As urban populations grow and the costs associated with rural food production and distribution continue to increase, urban agricultural systems are being considered in order to address concerns related to food security and cost (Argenti 2000). According to the USDA, 15 percent of the world's food supply is currently produced in urban areas (AFSIC 2010).

Green infrastructure practices such as green roofs and tree planting can provide increased opportunities for urban agriculture and urban foraging. Urban agriculture can include a multitude of benefits to urban areas, including economic development, recreational and community-building activities, educational opportunities for youth and increased habitat within the urban ecosystem.

While local food production via green infrastructure provides a variety of valuable community benefits, the current state of its valuation is not extensive enough to work through quantifying methods and equations in the guide at this time.

7. HABITAT IMPROVEMENT

Many vegetated green infrastructure features can improve habitat for a wide variety of flora and fauna. Rain gardens and other vegetated infiltration features hold particular value in this regard insofar as they perform best when planted with native species. Ecological economists recognize two aspects of habitat which are preconditions for the provision of a whole array of ecosystem services. First, habitat is living space for both resident and migratory species. Second, habitat provides nurseries for species which live their adult lives elsewhere.

Habitats are typically economically valued using either contingent valuation methods (especially where the conservation of an endangered species is concerned) or using the market price of traded goods that are harvested at the habitat in question (or of traded goods that are harvested elsewhere but for which the relevant habitat provides breeding and/or nursery grounds). The latter method can be useful, for example, in the case of coastal estuaries that provide nurseries for commercially harvested fish, but this approach is less applicable to the relatively small-scale urban vegetated features in question here. Contingent valuation studies might be more useful, but unfortunately, few have been conducted examining the habitat value of urban green space. Thus, this guide does not attempt to provide a framework for valuing this benefit.

Benefit Measurement and Valuation

8. PUBLIC EDUCATION

The USEPA (2008b) has listed public education as one of its six stormwater best management practices, further supporting the need for communities to be educated about water conservation and stormwater management. This is particularly important given the public's lack of understanding about the primary causes of and solutions to water pollution problems. A 2005 report by the National Environmental Education & Training Foundation (NEEFT) came to the following conclusion:

"78 percent of the American public does not understand that runoff from agricultural land, roads, and lawns, is now the most common source of water pollution; and nearly half of Americans (47 percent) believes industry still accounts for most water pollution (NEEFT 2005)."

While quantifying and valuing public education is difficult and the guide does not attempt to do this, educating and informing the general public about the efficient use of water resources is a valuable service that can build support for better water management decisions in the future. It is a vital precursor to achieving widespread adoption of green infrastructure solutions and realizing the many benefits they offer to communities.

Example Demonstration 1: Benefit Assessment of a Single Green Roof

The demonstration below walks through the quantification and valuation steps for the benefits provided by the 5,000 square foot green roof example that recurs throughout this handbook. This example is not a full lifecycle analysis and therefore does not take into account long-term benefits such as extended longevity of the roof membrane.

The table below is set up such that one may easily compile the annual monetary gains from each benefit. Although the green roof's net monetary benefit is calculated at the end of the table, please keep in mind that this will be an underestimate of the green roof's true value. Some benefits, such as reducing the urban heat island effect or improving community livability, are not quantifiable or valued at this time. In addition, this example only considers the benefits from one relatively small project. Initiating a community-wide program that embeds green infrastructure throughout the urban landscape would provide far greater benefits.

Benefit	Step 1: **Benefit Quantification** resource unit(s)	Step 2: **Benefit Valuation** resource unit * price	Annual Benefit $
Reduces Stormwater Runoff	**Annual Stormwater Retention Performance:** 71,100 gal retained *(Example 1.1)*	**Value of Annual Avoided Treatment Cost:** 71,100 gal * $0.0000919/gal = $6.53 *(Example 1.6)*	$6.53
Reduces Energy Use	**Annual Building's Cooling (electricity) Savings (kWh):** 1,122 kWh *(Example 2.1)*	**Value of Annual Building's Cooling Savings:** 1,122 kWh* $0.0959/ kWh = $107.60 *(Example 2.5)*	
	Annual Building's Heating Natural Gas Savings (Btu): 36,158,750 Btu *(Example 2.2)*	**Value of Annual Building's Heating Savings:** 36,158,750 Btu * $0.0000123/Btu = $444.75 *(Example 2.5)*	
	Annual Off-site Water Treatment Electricity Savings (reduced treatment needs of 71,100 gal): 110.77 kWh *(Example 2.4)*	Annual Off-site Water Treatment Electricity Savings will not be valued here because the value has already been accounted for above *(Example 1.6).*	
	Total Annual Electricity Savings (kWh, from on-site and off-site benefits): ∑ 1,122 kWh in cooling savings + 110.77 kWh in water treatment electricity savings = 1,232.77 kWh	The Total Annual Electricity Savings will not be valued here to prevent double counting. Instead, it is used to quantify "Air" and "Climate" benefits.	$107.60 + $444.75
Improves Air Quality *Note: The figures used here only account for the benefits of reduced NO_2. Similar steps should be performed for the other criteria pollutants, when possible.*	**Annual Direct NO_2 Uptake:** Lower Bound = 1.50 lbs NO_2 Upper Bound = 2.39 lbs NO_2 Average = 1.95 lbs NO_2 *(Example 3.1)*	**Value of Total Annual NO_2 Benefit:** 30.19 lbs NO_2 * $3.34/lb NO_2 = $100.83 *(Example 3.6)*	
	Annual Indirect Reduction in NO_2 Emissions (from reduced electricity and natural gas): 28.24 lbs NO_2 *(Example 3.5)*		
	Total Annual NO_2 Benefit (Direct uptake using the average NO_2 uptake value + Indirect avoided emissions): ∑ 1.95 lbs NO_2 + 28.24 lbs NO_2 = 30.19 lbs NO_2 *(Example 3.6)*		$100.83
Reduces Atmospheric CO_2	**Total Annual Indirect Benefit** (from electricity and heating natural gas savings): 1,639.58 lbs CO_2 + 4,226.6 lbs CO_2 = 5,866.18 lbs CO_2 *(Example 4.5)*	**Value of Total Annual Climate Benefit:** 6,486.41 lbs CO_2 * $0.00756/ lb CO_2 = $49.04 in total annual climate benefits *(Example 4.6a)* *Note: Here the lower bound (EU's ETS Carbon Price) of the range of carbon pricing was used. Keep in mind that this provides a conservative estimate of the economic, environmental and other social values of carbon abatement.*	
	Annual Direct Carbon Sequestration Benefit in CO_2 Equivalent (multiplying lbs C from Example 4.1 by conversion factor): = 620.23 lbs CO_2 *(Example 4.6)*		
	Total Annual Climate Benefit (Direct + Indirect): ∑ 620.23 lbs CO_2 + 5,866.18 lbs CO_2 = 6,486.41 lbs CO_2 *(Example 4.6)*		$49.04
		Total Annual Benefit (∑ Annual Benefits)	**$708.75**

Example Demonstration 2: Benefit Assessment of a Neighborhood Scale

This demonstration will walk through the quantification and valuation steps for scaling up the benefits of converting a hypothetical area of Chicago rooftops to green roofs. Following from Example Demonstration 1, these calculations show, in simplified terms, how scaling up the build out of green roofs has the potential to provide significant benefits to a community or urban area.

In this hypothetical demonstration, the City of Chicago plans to implement a green roof program to cover 1,200,000 square feet of viable rooftop area (assuming each green roof is 5,000 square feet in area) and calculates the total annual value of implementing this program. For reference, this converted area covers approximately five city blocks, provided that the average size of a city block in Chicago is 239,580 square feet[6].

In order to scale up the green roof benefits found earlier, one must calculate the number of roofs affected over the converted area (which will become the multiplier used to scale up the benefits):

1,200,000 SF area to be converted / 5000 SF per roof = 240 converted rooftops

The table below summarizes the benefits and corresponding monetary value of converting these 240 rooftops into green roofs.

Benefit	Annual Benefit ($) per 5,000 SF green roof (Example Demonstration 1)	Annual Benefit ($) from scaled green roof program (= annual benefit per roof * 240 converted roofs)
Reduces Stormwater Runoff	$6.53	$6.53 * 240 = $1,567.20
Reduces Energy Use	$107.60 + $444.75= $552.35	$552.35 * 240 = $132,564.00
Improves Air Quality *Note: The figures used here only account for the benefits of reduced NO_2. Similar steps should be performed for the other criteria pollutants, when possible.*	$100.83	$100.83 * 240 = $24,199.20
Reduces Atmospheric CO_2	$49.04	$49.04 * 240 = $11,769.60
Total Annual Benefit (Σ Annual Benefits)	**$708.75**	**$708.75 * 240 = $170,100.00**

[6] Average block size for the City of Chicago was determined using U.S. Census block group data collected from the Center for Neighborhood Technology's H+T® Affordability Index: 5.5 acres = 239,580 SF. Since block size varies from city to city, it is important to use local numbers for block area when available (CNT 2010b).

The previous calculations rely on a few central assumptions. First, the entire area in question will be converted into working and viable green roofs. Second, any additional scaling of green roof area will yield proportional benefits (hence the constant multiplier). Although the economic, environmental and social benefits of green roofs are calculated here, the total benefit value does not include a number of benefit categories, most notably reduced urban heat island effect, improved community livability, enhanced water quality and reduced flood risk. This guide has not attempted to quantify and value these benefits at this time, but they can be expected to significantly increase the overall value of the green roof.

It is also important to note that this example only considers the benefits from a relatively small application of green roofs. Initiating an even larger community-wide program that includes other forms of green infrastructure spread throughout the urban landscape would provide even greater benefits.

A similar example of a scaled-up urban application of green roofs has been done for the city of Washington, D.C. This case study looks at the impacts of green roofs over different coverage scenarios and details a methodology for analyzing an "opportunity area" for green roof implementation within the city (Deutsch et al. 2005). Findings show that both stormwater and air quality benefits are significant for a 20 percent green roof coverage scenario. These benefits include a predicted 13 percent reduction in CSO discharges and the same air quality benefits as would be provided by approximately 19,500 trees. The report concludes that the 20 percent green roof coverage case is both a "reasonable" and "feasible" target for the District of Columbia (Deutsch, B. et al. 2005).

Considerations and Limitations

This section explains key considerations and limitations to the preceding quantitative research and analysis. Due to the nature and scope of this report, every local project will have its own set of case-specific variables and uncertainties that must be evaluated. Particularly when undertaking a more rigorous benefit analysis of a specific green infrastructure program, please keep the following considerations in mind.

Full Life-Cycle Analysis

While a full life-cycle analysis is an important piece of the decision making process, it is beyond the scope of this guide, which has focused only on benefits. That said, it is important to note that when performing this type of valuation analysis, consideration of the counterfactual comparison is necessary. In other words, clearly defining what is being compared is critical. For example, is the analysis comparing whether or not to use green infrastructure instead of conventional grey infrastructure, or is the comparison between no change and the implementation of a green infrastructure project? This counterfactual understanding is important when valuing the overall costs and benefits of an action and should be clearly defined prior to working through a life-cycle analysis comparison.

Local Performance and Level of Benefits Realized

Detailed considerations of local and site-specific variables that impact green infrastructure performance are largely addressed in the previous quantitative section on a case-by-case basis. However, the need for local data when working through a framework for valuing a green infrastructure project or program remains crucial.

Recall that, as stated previously, the placement of trees relative to neighboring buildings will impact the amount of energy saved or that the media depth of a given green roof will impact its water retention capacity. Site-specific considerations should be made (when possible) for each benefit analysis in order to more precisely calculate the benefits accrued from a given project.

Regional and local variables, such as climate, also play a large role. Two green infrastructure installations with the exact same specifications can result in drastically different levels of benefits when implemented in different locations. For example, climate largely determines the reduction in building energy use resulting from trees. As discussed in the “Energy” section, shading




buildings in cool regions can actually cause an increase in energy demand, while reducing wind speeds in warm regions has little to no impact.

Spatial Scaling and Thresholds

Given the lack of large-scale green infrastructure programs and research analyzing their performance, it is uncertain whether one can estimate potential benefits from a community-wide program simply by scaling up smaller-site data. In other words, the benefits from a specific practice may or may not have a linear relationship to the scale of a project.

Some examples used in this guide provide estimates for linear multipliers (for example, the energy saved per square foot of a green roof in the “Energy Section”) and rely on the assumption that the benefit from one unit of a practice is proportional to the benefit from 100 units of the same practice. The complexity of natural functions, however, does not necessarily lend itself to such a simplified aggregation, and system level considerations are important.

Instead of having a linear relationship, it is also possible that green infrastructure could function similarly to the concept of an “economy of scale.” This would be the case if the benefits accrued from a practice have a proportionately greater effect on a large scale than they would if practiced over a small area. In effect, the green infrastructure practice would provide the maximum level of benefit only after achieving a certain scale of implementation. For example, the water quality improvement from a constructed wetland would be significantly and disproportionately larger than the water quality improvement from a smaller-scale rain garden.

An equally important consideration within spatial scaling is the concept of an ecological threshold, which can be described as “the point at which there is an abrupt change in an ecosystem . . . or where small changes in an environmental driver produce large responses in the ecosystem” (Groffman et al 2006). For example, urban heat island mitigation benefits that result from green infrastructure practices may only be realized at an as yet unknown level of incremental spatial implementation. A forest may provide significant cooling benefits, while a smaller number of individual trees in an urban area may have a negligible impact.

Temporal Considerations and Scale

Discounting

When evaluating an investment, economists use a process known as discounting, or present-value determination, to calculate the present-dollar equivalent of an investment's future benefits. In other words, discounting "translate[s] the values of future impacts into equivalent values in today's monetary units" (Goulder and Stavins 2002).

The term "discounting" refers to the adjustment one makes to account for future uncertainty (or the opportunity cost of money: a dollar today is not worth the same as a dollar five years down the road). Our society generally values what an investment gives us in the present more than what we might get for it in the future. The reason for this is future uncertainty, and as such, the future value or benefit of an investment must be adjusted or discounted. It is a technique widely used in benefit-cost analyses to understand and compare a project's implications (its rate of return) over a given temporal scale. Please note, however, that "applying a discount rate is not giving less weight to future generations' welfare" (Stavins 2005). Instead, it simply converts the net impacts from an investment over time into common units (Stavins 2005).

The controversy over discounting arises not from the concept itself but from how one determines which "social discount rate" is appropriate to use, particularly when evaluating environmental considerations. When a discount rate is chosen, there is an implicit judgment made about the value of the future. Oftentimes, an individual and a community value future benefits from a given green infrastructure project or program differently. Furthermore each green infrastructure practice behaves differently over time and requires specific considerations when performing discounting calculations. For these reasons, this guide makes no specific discount rate recommendations.

When proposing a large or long-term green infrastructure project, an in-depth discounting analysis, tailored to the specific case at hand, should be performed.

Operation and Maintenance

As is the case with conventional stormwater controls, green infrastructure depends upon regular maintenance to realize maximum benefits. When undertaking a green infrastructure project, it is important to fully consider the life cycle of the vegetation or capital used. Understanding the amount of maintenance involved in achieving the full benefit from a given practice is extremely important when undertaking large-scale green infrastructure. Many benefits of GI depend on regular maintenance. For example, vegetated green infrastructure elements, like plants on a green roof or tree plantings, will only sequester carbon as long as someone properly and routinely maintains them.

Other more capital-intense green infrastructure may require operational maintenance (for example, regularly cleaning permeable pavement for optimal performance) and repair over time to extend the life of the practice and to ensure that maximum benefits are realized. Conventional grey infrastructure, however, requires regular maintenance as well. Full lifecycle analysis must also evaluate operation and maintenance costs of conventional projects, which periodically require intense capital investments themselves.

Pricing Variability

During the valuation step (Step 2) in each subsection of the "Economic Valuation in Action" part of this guide, market prices are needed to calculate a final monetary value for each benefit. Although recommendations or sample prices for water treatment, electricity, criteria air pollutants and carbon can be found in the "Water," "Energy," "Air" and "Climate" sections, respectively, it is important to tailor these values to specific local data numbers whenever possible. The prices used in these calculations will have a significant impact on the magnitude of monetary value realized.

In addition, it is often difficult to find a strict market value for variables that may be too abstract or complicated to put in a market setting or in monetary terms. This lack of certainty is most pronounced in sectors that currently have few or no markets from which to derive prices. Prominent examples of this uncertainty can be taken from the debate over the value of a statistical life or the price of carbon. Property values and hedonic pricing (i.e. the perceived value of a good or service) also have an inherent degree of uncertainty and subjectivity when used to derive the value of a good or service.

For the purpose of this guide, it is necessary to rely on existing estimates to value the benefits of green infrastructure. However, given local variations, pricing uncertainty and economic fluctuation, market prices will likely vary over time. Please keep these considerations in mind when undertaking any in-depth analysis of green infrastructure valuation.

Double Counting

Summing up the benefits from multiple green infrastructure practices can be extremely complex, as many of the benefits are interconnected and correlated. This creates the risk of double counting or capturing the value of the same benefit multiple times. For example, in the "Water" section, valuation estimates from a property value study may account for both water treatment costs and reduced risk of flooding. Many of these specific precautions are directly addressed in each of the valuation sections.

It is important to keep in mind which aspects of each benefit are being captured in each stage of the valuation. For example, valuing the benefit of direct cost savings from reduced water treatment needs captures the cost of the energy associated with the treatment. It is, therefore, not necessary to account for the direct cost savings from the reduced energy use associated with reduced water treatment. It is, however, important to still calculate the energy reduction associated with reduced water treatment needs, because it is unlikely that the reduced emissions associated with the reduced energy use are captured in the direct cost savings from the reduced water treatment needs.

Also, as discussed in detail in the "Climate Change" and "Air Quality" sections, remember that the direct and indirect benefits realized from trees are combined. Because the *Tree Guides* consider carbon sequestration and avoided carbon dioxide emissions from reduced energy use in conjunction, it is important to not include these benefits twice. The same holds true for pollutant uptake and avoided emissions resulting from trees.

Case Studies:
Valuing Green Infrastructure Across the United States

Throughout the United States, there is a growing recognition of the benefits green infrastructure provides to communities. Many municipalities have begun to recognize the additional benefits green infrastructure and effectively incorporate these practices. The following case studies illustrate the process these municipalities have implemented and what some of the findings have been.

Aurora, Illinois

Faced with aging infrastructure, an already impaired local water way and projected population growth, Aurora wanted to strengthen its downtown economy while providing environmentally and economically sustainable solutions to its stormwater management issues.

The City's leaders recognized the potential value green infrastructure could provide in solving some of these issues and began to analyze where GI might be appropriate. The resulting plan, highlighted in Aurora's *Rooftops to Rivers* program, seeks to bring green infrastructure to scale and attain quantifiable, replicable results.

Early estimates conclude that current stormwater runoff issues within the city could be substantially reduced, with "nearly 141 million cubic feet of stormwater (about 1.05 billion gallons) [diverted] from the sewer" (NRDC 2009). These results would yield about $108,632 in annual savings and reduce energy use by 1.37 million kWh, or the equivalent of 990 metric tons (about 2.2 million pounds) of carbon dioxide.

Chicago, Illinois

In an effort to address and plan for the future impacts of climate change, including increased flood risks and public health stresses, Chicago adopted and is currently implementing its *Chicago Climate Action Plan*. The plan emphasizes green infrastructure




(including green roofs, tree plantings and rainwater harvesting) as a strategy for adapting to the risks this region faces as climate change develops (Chicago 2008).

Chicago has also been a leader in promoting urban green roofs due to the combined sewer overflows problems within the region. The 20,000 square foot roof atop City Hall has helped decrease stormwater runoff and improve urban air quality by reducing the urban heat island effect around the site. Since its completion in 2001, the green roof has saved the city $5,000 a year in energy costs (Chicago Green Roofs 2006). Monitoring of local temperatures found that the "cooling effects during the garden's first summer showed a roof surface temperature reduction of 70 degrees and an air temperature reduction of 15 degrees" (ASLA 2003). To date, Chicago has over 400 green roof projects in various stages of development, with seven million square feet of green roofs constructed or underway.

Milwaukee, Wisconsin

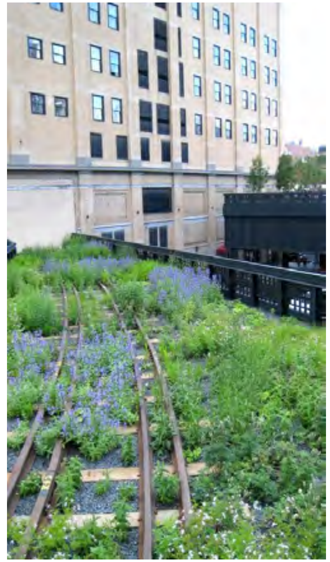
In an effort to reduce the occurrence of combined sewer overflows and reduce stress on aging grey infrastructure, the Milwaukee Metropolitan Sewerage District (MMSD) created a program called GreenSeams, which purchases upstream land for infiltration and riparian services. The program makes voluntary purchases of undeveloped, privately owned properties in areas expected to have major growth in the next 20 years. It also purchases open space along streams, shorelines and wetlands.

MMSD estimates that the total acreage holds over 1.3 billion gallons of stormwater at a cost of $0.017 per gallon. In contrast, one of its flood management facilities holds only 315 million gallons at a cost of $0.31 per gallon (MMSD 2010). While the comparison is not an apples-to-apples application, Milwaukee has found that, for managing stormwater and its potential flooding and overflow problems in urbanized areas, upstream conservation and the use of green infrastructure is cheaper than capital infrastructure build-out. This type of GI program works to save money for both the utility and its ratepayers.

New York, New York

Like most municipalities across the country, New York City (NYC) faces economic challenges. It must look at new strategies for getting the greatest amount of value out of every dollar invested in infrastructure. Due to its high percentage of impervious surfaces, the city generates a significant volume of stormwater runoff. In addition, NYC's aging infrastructure is under increasing pressure due to current and projected population growth. In an effort to address these issues while providing benefit to its residents, the city has adopted a Green Infrastructure Plan as part of its PlaNYC initiative. The plan presents "an alternative approach to improving water quality that integrates green infrastructure, such as swales and green roofs, with . . . smaller-scale grey or traditional infrastructure" (NYC 2010). One of its goals is to manage 10 percent of the runoff from impervious surfaces in combined sewer watersheds through these detention and infiltration approaches.

Additionally, since 1991, New York City has committed upwards of $1.5 billion toward maintaining and preserving its source waters in the Catskill and Delaware Watersheds (NYC DEP 2006). This initiative has thus far eliminated the need for a filtration plant that could cost as much as $10 billion. The city has not only improved its water quality, it has reduced the potential cost of water supply service to its ratepayers and reduced downstream flooding concerns. It has at the same time increased habitat and recreational opportunities for surrounding communities.



Philadelphia, Pennsylvania

Philadelphia faced the fact that conventional grey infrastructure approaches to managing the region's growing stormwater management issues would be cost prohibitive and would not adequately enable the City to meet its water quality standards. So, it turned to green infrastructure for possible solutions. The City hired Stratus Consulting to do a triple bottom-line assessment comparing traditional and green infrastructure. The final report's analysis shows that the net present-value of the benefits from green infrastructure greatly outweigh those of traditional grey infrastructure. For example, the city-wide implementation of green infrastructure at a 50 percent LID level—an option that would manage runoff from 50 percent of impervious surfaces in Philadelphia through green infrastructure—would provide a net benefit of $2,846.4 million. A 30-foot tunnel—the grey infrastructure option—would provide a net benefit of only $122 million (Stratus 2009).

In seeing the additional value that green infrastructure would provide its residents, Philadelphia has gone on to create a long-term combined sewer overflow control plan that invests heavily in GI initiatives. The program, titled *Green City Clean Waters*, is designed "to provide many benefits beyond the reduction of combined sewer overflows, so that every dollar spent provides a maximum return in benefits to the public and the environment" (PWD 2009).

Portland, Oregon

As in most urbanizing areas, Portland's increasing development has led to greater volumes and velocities of stormwater runoff, which has threatened critical waterways. Combined sewer overflows have also decreased water quality in the region. In search of methods to alleviate these environmental strains, the City of Portland Bureau of Environmental Services analyzed the key ecosystem benefits of replacing traditional grey infrastructure with green infrastructure in their ten year "Grey to Green" program, which encourages innovative stormwater management.

In addition to ecosystem benefits, the city has begun to research the many additional social and economic benefits that GI can provide. For example, in its "Energy and Greenhouse Gases" section, the report calculates the energy savings from the Grey to Green's proposed 43 acres of green roofs. The calculations estimate an annual savings of 63,400 kWh (ENTRIX 2010). The next step would be to translate this energy-savings benefit into a monetary value by multiplying by a price per kilowatt-hour. While as yet no monetary value has been assigned for these benefits, the city is working toward a better understanding of the underlying additional value green infrastructure can provide its communities.

Seattle, Washington

Since the late 1990s, the Seattle Public Utilities (SPU) agency has undertaken a variety of green infrastructure pilot programs including the well-known Street Edge Alternative (SEA) project. This and similar programs aim to reduce and treat runoff impacting water quality and aquatic habitat in the Puget Sound watershed by managing stormwater more effectively at a localized level. With this and other pilot programs, Seattle has collected performance data and made the case for substituting green infrastructure practices for traditional grey infrastructure in urban and suburban areas. For example, SPU estimates that a local street converted to the SEAStreet design saves $100,000 per block (330 linear feet) compared to a traditional street design, while achieving the same level of porosity (35 percent impervious area). In addition to these avoided-cost savings, the program claims these designs have provided additional community benefits such as traffic calming, improved neighborhood aesthetic and bioremediation (SPU 2010).

For more examples of communities implementing green infrastructure practices, please check-out The Conservation Fund's Green Infrastructure Leadership Program, which has assembled an online database of green infrastructure projects being planned and implemented across the country.
http://www.greeninfrastructure.net/content/projects

Conclusion

This guide distills some of the considerations involved in assessing the financial viability of common green infrastructure practices that are gaining ground in municipal water management. It aims to assist decision-makers in evaluating options and deciding where, when and to what extent green infrastructure practices should become part of future planning, development and redevelopment within communities.

In clarifying how to assign value to potential green infrastructure benefits, the guide begins to describe and demonstrate a process that works toward estimating the monetary value of GI, when possible, through the following steps:

Step 1: Quantification of Benefit
Step 2: Valuation of Quantified Benefit

By dividing this process into the above steps, this handbook allows for the cumulative assessment of the values associated with these practices. Clarifying these steps enables decision-makers to develop a better understanding of the potential benefits green infrastructure investments can provide their communities.

The field of green infrastructure and its valuation is still developing. Challenges in assigning value still exist. The following list outlines critical next steps in fully realizing the values of green infrastructure in the market place:

- More research regarding the social benefits of GI in order for these types of values to be included in the overall monetary valuation process
- A full life cycle analysis to recognize the long-term value of potential GI programs in municipal budgeting and infrastructure decisions
- Further development of tools, such as CNT's GreenValues Stormwater Calculator, to include the monetary benefits of GI in benefit-cost analysis
- Valuation of a range of GI practices beyond the five common practices listed in this guide
- Increased availability of local and regional data and modeling to more accurately assess the valuation of GI practices within a particular area
- The ability to better scale up the benefits of a proposed GI program in order to develop a clearer picture of the municipal or regional impact such practices can have on community's quality of life

While the above steps will help to improve the range and accuracy of benefit calculations from GI practices, the "Case Study" section demonstrates the growing trend of green infrastructure adoption throughout the country. Decision-makers are coming to understand the full range of infrastructure choices available to them. Recognizing green infrastructure's benefits will help municipalities make choices that not only provide solutions to urban stormwater management issues but also bring a plethora of additional benefits to their communities.

Appendix A

CNT's Green Values® Calculator

http://greenvalues.cnt.org/national/calculator.php

CNT's Green Values Calculator™ is a tool for quickly comparing the performance, costs, and some benefits of green infrastructure practices to those of conventional stormwater management practices. The GVC takes users through a step-by-step process of determining the average precipitation at the site, choosing a stormwater runoff volume reduction goal, defining the impervious areas of the site under a conventional development scheme and then choosing from a range of green infrastructure best management practices (BMPs) to find the combination that meets the runoff volume reduction goal in a cost-effective way. The calculator provides construction, annual maintenance and lifecycle (NPV) cost comparisons to manage a specified volume of stormwater for green infrastructure and conventional scenarios. The calculator also estimates some of the non-hydrologic benefits of using green infrastructure.

GreenSave Calculator

http://www.greenroofs.org

The *GreenSave Calculator*, developed by Green Roofs for Healthy Cities and the Athena Institute, allows for the analysis of various roof types over a set period of time in order to compare life-cycle costs. The tool is intended to help users examine future operating, maintenance, repair or replacement costs, as well as benefits such as energy savings. This enables users to determine whether higher initial costs are justified by reducing future costs. It also makes it possible to determine whether some roofs have lower initial costs that may increase over time.

Urban Forest Effects Model (UFORE)

http://www.ufore.org/

The UFORE model, developed by United States Department of Agriculture Forest Service researchers at the Northeastern Research Station in Syracuse, New York, is able to provide detailed, locally specific results regarding the air quality, building energy, greenhouse gas emissions, carbon storage and sequestration impacts of the existing urban forest. The model does, however, require substantial field data collection by users.

Street Tree Resource Analysis Tool for Urban Forest Managers (STRATUM)

http://www.fs.fed.us/psw/programs/cufr/stratum.shtml

Like the UFORE model, STRATUM, developed at the Center for Urban Forest Research at the Pacific Southwest Research Station of the US Forest Service, uses field data collected by the user in order to model tree impacts. Unlike UFORE, STRATUM is designed to assess not the entire urban forest but street trees in particular. The model not only quantifies benefits but also includes costs, making it more applicable as an asset management tool. In addition to quantifying and valuing the energy conservation, air quality improvement and climate benefits of trees, STRATUM also includes stormwater management benefits and property value impacts.

i-Tree Software Suite

http://www.itreetools.org/index.php

The i-Tree Software Suite from the USDA Forest Service is a helpful tool for analyzing and assessing the benefits of urban trees. Developed by adapting both the UFORE model (in i-Tree Eco) and the STRATUM model (in i-Tree Streets), the suite examines the pollution mitigation, reduction of stormwater run-off, and carbon sequestration benefits of urban trees.

The National Tree Benefit Calculator

http://www.treebenefits.com/calculator/

Casey Trees and Davey Tree Expert Co. have developed a National Tree Benefit Calculator which allows users to determine the stormwater, property value, energy (both electricity and natural gas), air quality and climate benefits and values for an individual tree. Users are required to input a zip code, the tree species, the tree's diameter and the land-use type.

Green Roof Energy Calculator

http://greenbuilding.pdx.edu/test.php#retain

The Green Building Research Laboratory at Portland State University is developing an online calculator to allow users to compare the energy performance of a building with a green roof to the performance of the same building with a conventional (black) or high-albedo (white) roof. Users input building location, roof area, and building type information, as well as green roof growing media depth and leaf area index. Users also have the option of inputting their own utility cost data or accepting default values. The calculator returns comparative annual electricity and natural gas consumption and total annual energy costs for the three roofing scenarios.

Low Impact Development Rapid Assessment Tool (LIDRA 2.0 model)

http://www.lidratool.org/

The Low Impact Development Rapid Assessment Tool is a model designed to compare the life-cycle values of implementing various green infrastructure techniques used in reducing runoff versus conventional stormwater management practices. The tool pulls from a database of performance and cost values derived from national data.

CITYgreen

http://www.americanforests.org/productsandpubs/citygreen/

American Forests' CITYgreen is an extension of ESRI's ArcGIS software. It converts stormwater and energy impacts (among others) from trees and other vegetation into monetary values based on local specifications.

Reference Materials

Advocates for Urban Agriculture. (2010). “Plan for Sustainable Urban Agriculture in Chicago.” <http://auachicago.files.wordpress.com/2010/03/aua-plan-updated-3-4-10.pdf>. Accessed 29 October 2010.

American Society of Landscape Architects (ASLA). (2003). “Chicago City Hall Green Roof.” <http://www.asla.org/meetings/awards/awds02/chicagocityhall.html>. Accessed 7 July 2010.

Akbari, H. and S. Konopacki. (2005). “Calculating energy-saving potentials of heat island reduction strategies.” Energy Policy. 33(6): 721–56.

Akbari, H., ed. et al. (1992). “Cooling Our Communities: A Guidebook on Tree Planting and Light-Colored Surfacing.” US EPA. Washington, DC.

Alternative Farming Systems Information Center (AFSIC). “Farms and Community.” United States Department of Agriculture. <http://afsic.nal.usda.gov>. Accessed 29 October 2010.

Argenti, O. (2000). “Food for the cities: Food supply and distribution policies to reduce urban food security.” Food and Agriculture Organization of the United Nations. Food into Cities Collection, DT /43-00E. Rome, Italy.

Associated Press (2009). “Indiana road salt supplies up, cost down for 2009.” 5 Dec 2009.

Bannerman, R. (2003). “Rain gardens: A How-To Manual for Homeowners.” Wisconsin Department of Natural Resources. Madison, WI.

Bean, E., W. Hunt, and D. Bidelspach. (2005). “A Monitoring Field Study of Permeable Pavement Sites in North Carolina.” NCSU Department of Biological and Agricultural Engineering. <http://www.bae.ncsu.edu/info/permeable-pavement/SWFWMD.pdf>. Accessed 12 July 2010.

Bin, O., J. Kruse, and C. Landry. (2008) “Flood Hazards, Insurance Rates, and Amenities: Evidence from the Coastal Housing Market.” The Journal of Risk and Insurance. 75(1), pp63-82.

Bin, O. and S. Polasky. (2004). “Effects of Flood Hazards on Property Values: Evidence Before and After Hurricane Floyd.” Land Economics. 80(4): 490-500.

Booth, D., J. Leavitt and K. Peterson. (1996). “The University of Washington Permeable Pavement Demonstration Project: Background and First-Year Field Results.” The Water Center at the University of Washington. Seattle, WA.

Boyle, K., P. Poor and L. Taylor. (1999). “Estimate the Demand for Protecting Freshwater Lakes from Eutrophication”. American Journal of Agricultural Economics. 81(5):1118-1122.

Braden, J. and D. Johnston. (2004). “Downstream Economic Benefits from Storm-Water Management.” Journal of Water Resources Planning and Management. 130(6): 498-505.

Carter, T. and A. Keeler. (2008). “Life-cycle Cost–benefit Analysis of Extensive Vegetated Roof Systems.” Journal of Environmental Management. 87(3): 350-363.

Carter, T. and T. Rasmussen. (2006). “Hydrologic Behavior of Vegetated Roofs.” Journal of the American Water Resources Association. 42(5):1261-1274.

CASQA. (2003). “California Stormwater BMP Handbook.” Menlo Park, CA.

CEC. (2005). “California’s Water-Energy Relationship.” California Energy Comission. Sacramento, CA.

Chang, S. (2000). “Energy Use”. Lawrence Berkeley Lab Heat Island Group. <http://eetd.lbl.gov/HeatIsland/EnergyUse/>. Accessed 16 July 2010.

Chaplowe, S.G. (1996). “Havana’s Popular Gardens: Sustainable Urban Agriculture.” World Sustainable Agriculture Association. Fall 5(22).

Chevallier, J. (2010). “Climate Change Section Examples Carbon Prices during the EU ETS Phase II: Dynamics and Volume Analysis.” Université de Paris Dauphine. <http://halshs.archives-ouvertes.fr/docs/00/45/91/40/PDF/chevallier_phaseII.pdf>. Accessed 7 October 2010.

Chicago Green Roofs. (2006). “Guide for Building Green Roofs in Chicago: Featured Project.” <http://www.artic.edu/webspaces/greeninitiatives/greenroofs/main.htm>. Accessed 10 Aug 2010.

City of Chicago. (2008). “Chicago Climate Action Plan: Our City. Our Future.” <www.chicagoclimateaction.org>. Accessed 11 July 2010.

Clark, C., P. Adriaens and F. B. Talbot. (2008). “Green Roof Valuation: A Probabilistic Economic Analysis of Environmental Benefits.” Environmental Science and Technology. 42: 2155-2161.

Clarkson, R. and K. Deyes. (2002). “Estimating the Social Cost of Carbon Emissions.” Department of Environment, Food and Rural Affairs: Environment Protection Economics Division. London, UK.

CNT. (2010a). “Integrating Valuation Methods to Recognize Green Infrastructure's Multiple Benefits.” Chicago, IL.

CNT. (2010b). H+T® Affordability Index. <http://htaindex.cnt.org>. Accessed 22 September 2010.

CNT. (2009). “Benefits Details.” Green Values Calculator. <http://greenvalues.cnt.org/national/benefits_detail.php#reduced-treatment>. Accessed 16 July 2010.

Cole, S. (1998). “The Emergence of Treatment Wetlands.” Small Flows. 12(4): 6.

Connelly, M. and M. Hodgson. (2008). “Sound Transmission Loss of Green Roofs”. Green Rooftops for Sustainable Communities. Conference presentation.

Conservation Fund. (2009). “Kansas City Green Infrastructure Case Study.” Green Infrastructure — Linking Lands for Nature and People: Case Study Series. <http://www.greeninfrastructure.net/sites/greeninfrastructure.net/files/10%20-%20Kansas_City_MetroGreen_lores%20%282%29.pdf>. Accessed 17 Aug 2010.

Conservation Research Institute. (2005). “Changing Cost Perceptions: An Analysis of Conservation Development.” Report prepared for the Illinois Conservation Foundation and Chicago Wilderness. Chicago, IL.

Currie, B. and B. Bass. (2008). “Estimates of air pollution mitigation with green plants and green roofs using the UFORE model.” Urban Ecosystems. 11:409-422.

Deutsch, B. et al. (2005). “Re-Greening Washington, DC: A Green Roof Vision Based on Quantifying Storm Water and Air Quality Benefits.” Casey Trees Endowment Fund and Limno-Tech, Inc.

Deutsch, B. et al. (2007). “The Green Build-Out Model: Quantifying the Stormwater Management Benefits of Trees and Green Roofs in Washington, DC.” CaseyTrees and Limnotech. Washington, DC.

Reference Materials, continued

Donovan, G. and D. Butry. (2010). “Trees in the city: Valuing street trees in Portland, Oregon.”Landscape and Urban Planning. 94(2): 77-83.

EIA. “CO2 from Electricity by State and Region.” <http://www.eia.doe.gov/oiaf/1605/ee-factors.html>. Accessed 20 July 2010.

EIA. “Voluntary Reporting of Greenhouse Gases Program.” <http://www.eia.doe.gov/oiaf/1605/coefficients.html>. Accessed 20 July 2010.

ENTRIX, Inc. (2010). “Portland’s Green Infrastructure: Quantifying the Health, Energy, and Community Livability Benefits.” Prepared for the Bureau of Environmental Services, City of Portland. Portland, OR.

EPRI. (2002). “U.S. Electricity Consumption for Water Supply & Treatment-the Next Half Century.” Water and Sustainability. Electric Power Research Institute. vol. 4. Palo Alto, CA.

Evans, D. and Associates, Inc. (2008). “Cost Benefit Evaluation of Ecoroofs.” City of Portland Bureau of Environmental Services: Sustainable Stormwater Group. Portland, OR.

Explore Chicago. (2010). “Green Chicago: Green Roofs.” <http://www.explorechicago.org/city/en/about_the_city/green_chicago/Green_Roofs_.html>. Accessed 18 Aug 2010.

Farber, S. and R. Constanza. (2002). “Economic and Ecological Concepts for Valuing Green Infrastructure.” Ecological Economics. 41: 375-90.

Friedman, N, ed. et al. (2008). “Chicago Climate Action Plan.” Chicago Climate Task Force, City of Chicago. Chicago, IL. <http://www.chicagoclimateaction.org>. Accessed 11 Aug 2010.

Gaffin, S. et al. (2005). “Energy Balance Modeling Applied to a Comparison of White and Green Roof Cooling Efficiency.” Proceedings of the 3rd Annual Greening Rooftops for Sustainable Cities Conference. May 4-6, 2005. Washington, DC.

Ganges, D. (2006). “Seattle Green Roof Evaluation Project.” Magnusson Klemencic Associates. Spring 2006. Seattle, WA.
Gerharz, B. (1999). “Pavements On the Base of Polymer-modified Drainage Concrete.” Colloids and Surfaces A: Physicochemical and Engineering Aspects. 152: 205-209.

Getter, K. et al. (2009). “Carbon Sequestration Potential of Extensive Green Roofs.” Environmental Science and Technology. 43: 7564-7570.

Gibbs, J. et al. (2002). “An Hedonic Analysis of the Effects of Lake Water Clarity on New Hampshire Lakefront Properties.” Agricultural and Resource Economics Review. 31(1): 39-46.

Gill, S. et al. (2007). “Adapting Cities for Climate Change: The Role of the Green Infrastructure.” Built Environment. 33(1): 115-133.

“Glossary of Climate Change Acronyms.” United Nations Framework Convention on Climate Change. <http://unfccc.int/essential_background/glossary/items/3666.php>. Accessed 6 July 2010.

Goulder, L. H. and R. N. Stavins. (2002) “An Eye on the Future.” Nature Magazine.vol 419 <http://www.nature.com/nature>. Accessed 20 May 2010.

Green Roofs for Healthy Cities (GRHC). <www.greenroofs.org>. Accessed 11 October 2010.

Groffman, P. et al. 2006. “Ecological thresholds: the key to successful environmental management or an important concept with no practical application?” Ecosystems. 9(1):1–13.

Harrison, D., G. Smersh and A. Schwartz, Jr. (2001). “Environmental Determinants of Housing Prices: The Impact of Flood Zone Status.” Journal of Real Estate Research. 21: 3-20.

Heaney, J. et al. (2002). “Costs of Urban Stormwater Control.” National Risk Management Research Laboratory, Office of Research and Development: EPA-600/R-02/021.

Houle, K. (2006). “Winter Performance Assessment of Permeable Pavements: a comparative study of porous asphalt, pervious concrete and conventional asphalt in a northern climate.” Thesis submitted to the University of New Hampshire in Partial Fulfillment of the Requirements for the Degree of Master of Science in Civil Engineering. <http://www.unh.edu/erg/cstev/pubs_specs_info/unhsc_houle_thesis_9_08.pdf>. Accessed 7 July 2010.

Huff, F. A., and J. R. Angel. (1989). “Rainfall Distributions and Hydroclimatic Characteristics of Heavy Rainstorms in Illinois (Bulletin 70).” Illinois State Water Survey. <http://www.isws.illinois.edu/atmos/statecli/RF/rf.htm>. Accessed 4 October 2010.

Hutchinson, D. et al. (2003). “Stormwater Monitoring Two Ecoroofs in Portland, Oregon, USA.” Greening Rooftops for Sustainable Communities. Conference paper.

IPCC. (2007). “Climate Change 2007: Synthesis Report.” Cambridge University Press. Cambridge, UK: 25-73.

Johnston, D., J. Braden and T. Price. (2006). “Downstream Economic Benefits of Conservation Development.” Journal of Water Resources Planning and Management. 35-43.

Johnston, D. and J. Braden. (2004). “Downstream Economic Benefits from Storm-Water Management.” Journal of Water Resources Planning and Management.

Kadas, G. (2006). “Rare Invertebrates Colonizing Green Roofs in London”. Urban Habitats. 4(1): 66-86.

Kevern, J.T. et al. (2009a). “Hot Weather Comparative Heat Balances in Pervious Concrete and Impervious Concrete Pavement Systems.” Second Annual Conference on Countermeasures to Urban Heat Islands.

Kevern, J.T. et al. (2009b). “Temperature Behavior of a Pervious Concrete System.” Transportation Research Record. 2098: 94-101.
King, D.M., and M. Mazzotta. (2000). Ecosystem Valuation. <http://www.ecosystemvaluation.org/benefit_transfer.htm>. Accessed 20 Oct 2009.

Köhler, M. (2006). “Long-term Vegetation Research on Two Extensive Green Roofs in Berlin.” Urban Habitats. 4(1): 3-25.

Kosareo, L. and R. Ries. (2007). “Comparative environmental life cycle assessment of green roofs.” Building and Environment. 42: 2606-2613.

Kuo, F. and W. Sullivan. (2001a). “Environment and crime in the inner city: does vegetation reduce crime?” Environment and Behavior. 33(3):343-367.

Kuo, F.E. and W.C. Sullivan. (2001b). “Aggression and violence in the inner city: Impacts of environment via mental fatigue.” Environment & Behavior. 33(4): 543-571.

Limburg, K. and R. O’Neill. (2002). “Complex Systems and Valuation.” Ecological Economics. 41: 409-418.

Reference Materials, continued

Liu, K. and B. Baskaren. (2003). “Thermal performance of green roofs through field evaluation.” Proceedings for the First North American Green Roof Infrastructure Conference, Awards and Trade Show, May 29-30 2003. 1-10. Chicago, IL.

MacDonald, D., J. Murdock and H. White. (1987). “Uncertain Hazards, Insurance and Consumer Choice: Evidence from Housing Markets.” Land Economics. 63: 361-371.

MacDonald, D. et al. (1990). “Flood Hazard Pricing and Insurance Premium Differentials: Evidence from the Housing Market.” The Journal of Risk and Insurance. 57: 654-663.

MacMullan, E. and S. Reich. (2007). “The Economics of Low-Impact Development: A Literature Review.” ECONorthwest. Eugene, OR.

McIntosh, A. (2010). “Green Roofs in Seattle: A Survey of Vegetated Roofs and Rooftop Gardens.” City of Seattle. University of Washington Green Futures Lab. Seattle, WA.

McPherson, E. et al. (2006). Midwest Community Tree Guide: Benefits, Costs, and Strategic Planting. United States Department of Agriculture, Forest Service, Pacific Southwest Research Station. Davis, CA.

Michael, H., K. Boyle and R. Bouchard. (1996). “Water Quality Affects Property Prices: A Case Study of Selected Maine Lakes.” Maine Agricultural and Forest Experiment Station. Miscellaneous Report 398.

Mid-America Regional Council (MARC). (2010) “MetroGreen.” <http://www.marc.org/metrogreen>. Accessed 18 Aug 2010.

Milwaukee Metropolitan Sewerage District (MMSD). (2007). “Stormwater Runoff Reduction Program: Final Report.” Milwaukee, WI.

Milwaukee Metropolitan Sewerage District (MMSD). “Fresh Coast Green Solutions: Weaving Milwaukee’s Green and Grey Infrastructure into a Sustainable Future.” <http://v3.mmsd.com/Sustainability.aspx>. Accessed 16 Aug 2010.

Milwaukee Metropolitan Sewerage District (MMSD). Sands, Karen. "GreenSeams Program." Message to author. 19 May 2010. E-mail.

Montalto, F.A., C.T. Behr, K. Alfredo, M. Wolf, M. Ayre and M. Walsh. (2007). “A Rapid Assessment of the Cost-effectiveness of Low Impact Development for CSO Control.” Journal of Landscape and Urban Planning. 82: 117-131.

Montalto, F.A., C.T. Behr and Z. Yu. (2010). “Accounting for Uncertainty in Determining Green Infrastructure Cost-effectiveness.” In Thurston, H., ed. Economic Incentives for Stormwater Control. Island Press.

Morikawa, H. et al. (1998). “More than 600-fold variation in nitrogen dioxide assimilation among 217 plant taxa.” Plant, Cell and Environment. 21: 180-190.

Mulvaney, P. (2009). Chicago Department of Water Management, personal communication.

Murray, F., L. Marsh and P. Bradford. (1994). “New York State Energy Plan Vol. II: Issue Reports. New York State Energy Office. Albany, NY.

National Environmental Education & Training Foundation (NEETF). (2005). “Environmental Literacy in America.”

Navrud, Ståle. (2003). “State-of-the-art on economic valuation of noise.” ECE/WHO Pan-European Program on Transport, Health and Environment, Workshop on Economic Valuation of Health Effects due to Transport, June 12-13, 2003. Stockholm, Sweden.

New York City (NYC). (2010). “NYC Green Infrastructure Plan: A Sustainable Strategy for Clean Waterways.” <http://www.nyc.gov/html/dep/pdf/green_infrastructure/NYCGreenInfrastructurePlan_ExecutiveSummary.pdf>. Accessed 21 October 2010.

New York City Department of Environmental Protection (NYC DEP). (2006) “2006 Long-Term Watershed Protection Program.” Prepared by the Bureau of Water Supply. <http://www.epa.gov/region2/water/nycshed/2007wp_program121406final.pdf >. Accessed 21 October 2010.

NRDC. (2006). “Rooftops to Rivers: Green Strategies for Controlling Stormwater and Combined Sewer Overflows.” New York, NY.

NRDC. (2009). “Rooftops to Rivers: Aurora, a Case Study in the Power of Green Infrastructure.” New York, NY.

Olek, J. et al. (2003). “Development of Quiet and Durable Porous Portland Cement Concrete Paving Materials.” Purdue University Report No. SQDH 200-5. West Lafayette, IN.

Philadelphia Water Department (PWD). (2009). “Green City, Clean Waters: A Long Term Control Plan Update.” City of Philadelphia. <http://www.phillywatersheds.org/ltcpu/LTCPU_Complete.pdf>. Accessed 5 Aug 2010.

Poor, P., K. Pessagno and R. Paul. (2007). “Exploring the hedonic value of ambient water quality: A local watershed-based study.” Ecological Economics. 60: 797-806.

Pratt, M., C. A. Macera, and G. Wang. (2000). “Higher Direct Medical Costs Associated With Physical Inactivity.” Physician and Sportsmedicine, 28(10): 63-70.

Rosenblum, J. (2009). “Climate Change in the Golden State.” Water Efficiency. May/June: 50.

Saiz, S. et al. (2006). “Comparative Life Cycle Assessment of Standard and Green Roofs.” Environmental Science and Technology. 40:4312-4316.

Seattle Public Utilities. (2010). “Green Stormwater Infrastructure.“ <http://www.seattle.gov/util/About_SPU/Drainage_&_Sewer_System/GreenStormwaterInfrastructure/index.htm>. Accessed 19 Aug 2010.

Seattle Public Utilities. “Seattle Public Utilities-Natural Drainage System Program.” <http://www.seattle.gov/util/groups/public/@spu/@usm/documents/webcontent/spu02_019986.pdf>. Accessed 19 September 2010.

Sharma, R. (2006). “Economic Analysis of Stormwater Management Practices.” Thesis presented to the Graduate School of Clemson University. Clemson, SC.

Shilling, J., J. Benjamin and C. Sirmans. (1985). “Adjusting Comparable Sales for Floodplain Location.” The Appraisal Journal. 53: 429-436.

Singer, J. (2009). “Road salt price comes down, but local governments still limiting supply.” Sandusky Register. 16 December 2009.

SMRC. (2009). Wetland Fact Sheet. <http://www.stormwatercenter.net/>. Accessed 18 July 2010.

Stavins, R. (2005) “Does Econ Analysis Shortchange Future?” Environmental Law Institute, Washington, D.C.

Reference Materials, continued

Stern, Nicholas. (2006). “Executive Summary.” Stern Review: The Economics of Climate Change. Cambridge University Press. Cambridge, UK: i-xxvii.

Stratus Consulting, Inc. (2009). “A Triple Bottom Line Assessment of Traditional and Green Infrastructure Options for Controlling CSO Events in Philadelphia's Watersheds: Final Report.” Prepared for the Office of Watersheds, City of Philadelphia Water Department, Philadelphia, PA. Boulder, CO.

Sullivan, W., F. Kuo and S. Depooter. (2004). “The Fruit of Urban Nature: Vital Neighborhood Spaces.” Environment and Behavior. 36:678.

Tanner, C. (2002). “Status of Wastewater Treatments in New Zealand.” EcoEng Newsletter, No. 1. <http://www.iees.ch/EcoEng021/EcoEng021_F4.html>. Accessed 11 July 2010.

Texas Water Development Board. (2005). “The Texas Manual on Rainwater Harvesting.” Third edition. Austin, TX. <http://www.twdb.state.tx.us/publications/reports/RainwaterHarvestingManual_3rdedition.pdf>. Accessed 5 October 2010.

Tomalty et al. (2009). “The Monetary Value of the Soft Benefits of Green Roofs.” Cooperative Research and Policy Services (CORPS).
Trust for Public Land. (2008). “How Much Value Does the City of Philadelphia Receive from its Park and Recreation System?” Philadelphia, PA.

US Census Bureau. American Factfinder Website: <http://factfinder.census.gov/home/saff/main.html?_lang=en>. Accessed 29 October 2010.

USDA. (1967). “Groundwater Recharge.” Conservation Service, Engineering Division, Technical Release. Geology. 18.

US Energy Information Administration (USEIA) (2010). “Annual Energy Outlook 2010 with Projections to 2035.” <http://www.eia.doe.gov/oiaf/aeo/electricity.html>. Accessed 9 July 2010.

US EPA. (2009). “Mandatory Reporting of Greenhouse Gases.” Code of Federal Regulations. Title 40, Part 98. Table C-1. October 30, 2009.

US EPA. (2008a). “Clean Watersheds Needs Survey 2004: Report to Congress.” Washington, D.C.

US EPA. (2008b). “Public Education and Outreach on Stormwater Impacts.” <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=min_measure&min_measure_id=1>. Accessed 25 July 2010.

US EPA. (2008c). “eGRID2007 Version 1.1 Year 2005 Summary Tables.” <http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2007V1_1_year05_SummaryTables.pdf>. Accessed 6 October 2010.

US EPA. (2007a). “Outdoor Water Use in the United States”. <http://www.westlaketx.org/images/EPA_outdoor_water_use_176_4323.pdf>.Accessed 22 July 2010.

US EPA. (2007b). “Reducing Stormwater Costs through Low Impact Development Strategies and Practices.” Nonpoint Source Control Branch: EPA 841-F-07-006. Washington, DC.
US EPA. (2005). “eGRIDweb.” United States Total Emissions Profile Data. <http://cfpub.epa.gov/egridweb/view_us.cfm>. Accessed 6 October 2010.

US EPA. (2002). “The Clean Water and Drinking Water Infrastructure Gap Analysis.” Office of Water. Washington, DC.

US EPA. (1999). “Free Water Surface Wetlands for Wastewater Treatment: A Technology Assessment.” Phoenix, AZ: 5-13.

US EPA and Low-Impact Development Center. (2000). “Low Impact Development (LID): A Literature Review.” Washington, DC.

US EPA (n.d. a). “Reducing Urban Heat Islands: Compendium of Strategies Urban Heat Island Basics.”

US EPA (n.d. b). “Mortality Risk Valuation.” <http://yosemite.epa.gov/ee/epa/eed.nsf/pages/MortalityRiskValuation.html#currentvsl> Accessed 27 October 2010.

VanWoert, N. et al. (2005). “Green Roof Stormwater Retention: Effects of Roof Surface, Slope, and Media Depth.” Journal of Environmental Quality. 34:1036-1044.

Voicu, I. and V. Been. (2008). “The Effect of Community Gardens on Neighboring Property Values.” Real Estate Economics. 36(2): 241-283.

Wachter, S. (2004). “The Determinants of Neighborhood Transformations in Philadelphia – Identification and Analysis: the New Kensington Pilot Study.” The Wharton School, University of Pennsylvania.

Wachter, S. and G. Wong. (2008). “What is a Tree Worth? Green-City Strategies, Signaling and Housing Prices.” Real Estate Economics. 36(2): 213-239.

Walker, C. (2004). “The Public Value of Urban Parks.” Beyond Recreation: A Broader View of Urban Parks. The Urban Institute. Washington, DC.

Wang, M. and D. Santini. (1995) “Monetary Values of Air Pollutant Emissions in Various U.S. Regions.” Transportation Research Record. 1475: 33-41.

Ward et al. (2008). “The Effect of Low-Impact-Development on Property Values.” WEF Publication.

Weber, T. (2007). “Ecosystem Services in Cecil County’s Green Infrastructure.” The Conservation Fund. Annapolis, MD.

Wegner, W. and M. Yaggi. (2001). “Environmental Impacts of Road Salt and Alternatives in the New York City Watershed.” Stormwater. July-Aug.

Wong, G. and O. Stewart. (2008). “SEA Street Precedent Design Study.” Washington State University. <http://courses.washington.edu/gehlstud/Precedent%20Studies/SEA_Street.pdf>. Accessed 18 Aug 2010.

Wossink, A. and B. Hunt (2008). “The Economics of Structural Stormwater BMPs in North Carolina.” Report funded by the North Carolina Urban Water Consortium, through the Water Resources Research Institute of the University of North Carolina, Chapel Hill, NC.

Wossink, A. and B. Hunt. (2003). “An Evaluation of Costs and Benefits of Structural Stormwater Best Management Practices in North Carolina.” NC Cooperative Extension Service. Raleigh, NC.

Yang, J., Y. Qian and P. Gong. (2008). “Quantifying air pollution removal by green roofs in Chicago.” Atmospheric Environment. 42:7266-7273.

Yu, Z., M. Aguayo, M. Piasecki and F.A. Montalto. (2009). “Developments in LIDRA 2.0: A Planning Level Assessment of the Cost-effectiveness of Low Impact Development.” Proceedings of the ASCE Environment and Water Resources Institute Conference. May 16-20, 2010. Providence, RI.

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The Economics of Low-Impact Development: A Literature Review

November 2007

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EXECUTIVE SUMMARY

Low-impact development (LID) methods can cost less to install, have lower operations and maintenance (O&M) costs, and provide more cost-effective stormwater management and water-quality services than conventional stormwater controls. LID also provides ecosystem services and associated economic benefits that conventional stormwater controls do not.

The available economic research on some of these conclusions is preliminary or limited in scope. For example, most economic studies of LID describe the costs of installing LID, or compare the costs of installing LID with the costs of installing conventional controls. Few reports quantify the economic benefits that LID can provide in addition to managing stormwater. Fewer researchers report results of studies that measure at least some costs *and* at least some benefits of LID vs. conventional controls.

The costs and benefits of LID controls can be site specific and will vary depending on the LID technology (e.g., green roof vs. bioswale), and local biophysical conditions such as topography, soil types, and precipitation. Including developers, engineers, architects and landscape architects early in the design process can help minimize the LID-specific construction costs.

Despite the fact the LID technologies have been promoted and studied since the early 1990s, for many stormwater managers and developers, LID is still a new and emerging technology. As with most new technologies, installation and other costs of LID are highest during the early phases of development and adoption. Over time, as practitioners learn more about the technology, as the number of suppliers of inputs expands, and as regulations adapt to the new technology, costs will likely decline.

Combined sewer overflows (CSO), and the resulting biophysical and economic consequences, are major concerns for municipal stormwater managers. LID can help minimize the number of CSO events and the volume of contaminated flows by managing more stormwater on site and keeping flows out of combined sewer pipes. Some preliminary evidence exists that LID can help control CSO volumes at lower cost than conventional controls.

Many municipalities have zoning and building-inspection standards in place that were adopted many years ago, long before LID was an option. Municipalities with outdated stormwater regulations typically require that builders file variances if they want to use LID controls. This can increase a builder's design and regulatory costs, which delays construction and can increase a builder's financing costs. Updating building regulations to accommodate LID can help reduce the regulatory risk and expense that builders face.

The large majority of the economic studies on LID focus on the costs of including LID in new construction. Replacing curbs, gutters and stormwater pipes with bioswales, pervious pavers and other LID controls can reduce construction costs. Protecting a site's existing drainage patterns can reduce the need for pipe infrastructure and a developer may be able to do away with surface stormwater ponds, which also increases the number of developable lots. Some researchers report that developments that emphasize LID controls and protected natural grass and forest drainage areas cost less to develop and sell for more than traditionally-developed lots with conventional stormwater controls.

Few studies considered the economic outcomes of including LID in urban redevelopment projects. Some evidence exists that LID controls cost more than conventional controls under these conditions, however, these studies excluded O&M costs of the two alternatives and the economic benefits that the LID controls can provide.

I. INTRODUCTION

Conventional stormwater controls collect stormwater from impervious surfaces, including roads, parking lots and rooftops, and transport the flow off site through buried pipes to treatment facilities or directly to receiving bodies of water. This approach efficiently collects and transports stormwater, but also can create high-velocity flows polluted with urban contaminants, including sediment, oil, fertilizers, heavy metals, and pet wastes. Such flows can erode stream banks and natural channels, and deposit pollutants that pose ecosystem and public health risks (Kloss and Calarusse 2006).The resulting ecosystem and public health consequences can create significant economic costs.

A study of the biophysical and public health damages and associated economic costs of stormwater runoff in the Puget Sound estimates these costs at over $1 billion during the next decade (Booth et al. 2006). These costs include flood-related property damage and financial losses, capital costs of new stormwater infrastructure, cleaning up stormwater-polluted water resources, and habitat restoration and protection efforts. The Natural Resources Defense Council (Kloss and Calarusse 2006) describes similar impacts attributed to conventional controls across the U.S.: stormwater sewers collect and discharge untreated stormwater to water bodies, while combined sewer and stormwater systems overflow during heavy rains, discharging both untreated sewage and stormwater into the nation's rivers and lakes. Both contribute to impaired water quality, flooding, habitat degradation, and stream bank erosion. The U.S. Environmental Protection Agency (EPA) estimates the costs of controlling combined sewer overflows (CSO) throughout the U.S. at approximately $56 billion. Developing and implementing stormwater-management programs and urban-runoff controls will cost an additional $11 to $22 billion (Kloss and Calarusse 2006).

In contrast to conventional stormwater controls, low-impact development (LID) techniques emphasize on-site treatment and infiltration of stormwater. The term low-impact development encompasses a variety of stormwater-management techniques. Examples include bioswales, rain gardens, green streets, and pervious pavers (U.S. EPA 2000). The name LID came into use around the late 1990s, however stormwater managers employed LID techniques prior to this. Technicians in Prince George's County, Maryland were some of the first to install what eventually became known as LID techniques in the early 1990s as an alternative to conventional stormwater controls. Soon after, a few communities in the Chesapeake Bay area followed, experimenting with a number of LID demonstration projects. Over time, interest in LID as an alternative or complement to conventional controls grew, and so did the number of LID demonstration projects and case studies across the United States. The EPA reviewed the early literature on LID and described their assessment of this literature in a report released in 2000 (U.S. EPA and Low Impact Development Center 2000). Their review assessed the availability and reliability of data on LID projects and the effectiveness of LID at managing stormwater. While this report focused primarily on the potential stormwater-management benefits of LID, it concluded that LID controls can be more cost effective and have lower maintenance costs than conventional stormwater controls. In December of the following year, the Center for Watershed Protection published one of the earliest studies that focused primarily on the economic aspects of "better site design," which included many LID principles (Center for Watershed Protection 2001).

The amount of information available on the economics of managing stormwater using LID has grown since the publication of these first reports. Most studies describe the costs of installing LID, or compare the costs of installing LID with the costs of installing conventional controls. Other reports focus on the economic benefits that LID can provide in addition to managing stormwater. These benefits include mitigating flooding, improving water-quality, and providing amenity values for properties adjacent to LID, such as green streets. A few—very few—researchers report results of studies that attempt to characterize at least some costs *and* at least some benefits of LID vs. conventional controls in a *single* study. In this report we summarize our review of the literature on the economic costs and benefits of managing stormwater by LID.

This literature review has three objectives. First, to describe briefly, and in plain language, the methods economists use when measuring the costs and benefits of LID and conventional stormwater controls. This information provides the reader with a context for the economic descriptions of costs and benefits that follow. Second, to summarize the literature that identifies and measures the economic costs and benefits of managing stormwater using LID, or that compares costs or benefits, or both, between LID and conventional controls. Third, to organize and present this information in a way that non-economist municipal officials, stormwater managers, ratepayer stakeholders and others can use as they consider and deliberate stormwater-management plans.

This literature review differs from literature reviews that accompany academic studies. Typically, academic literature reviews provide an introduction and a context for an analysis of a specific economic issue, e.g., a new analytical technique that measures economic benefits. In this case, the literature review is a stand-alone document that summarizes information on the broad issue of economic costs and benefits of LID. Academic literature reviews also target academic and professional economists. This literature review targets non-economist readers.

The technical effectiveness of LID stormwater controls is outside the scope of our review. Our analysis assumes that the LID techniques described in the economic studies that we reviewed provide the necessary or expected stormwater controls. As we understand, there is a growing body of literature on LID effectiveness, and we include some of these references in the Appendix to this report. Also, the more general topic of the economic values of ecosystem services, while somewhat related, was outside the scope of our review. Our analysis focused on the values of ecosystem services as affected by LID techniques.

We began our search for relevant literature by developing a list of key words with which to find reports or articles that contained relevant information. After a cursory search of LID literature, we identified LID- and economics-related key words that researchers and practitioners use when describing LID projects and analyses. The list includes words often used synonymously with LID (i.e., source control, natural drainage systems, sustainable stormwater management), or that describe a set of conservation-design strategies that include LID techniques (i.e., green infrastructure and conservation development). We also searched the literature using economics-related terms (i.e., costs, benefits, and savings). Table 1-1 lists the LID- and economics-related search terms we used in our search of the literature.

Using the terms listed in Table 1-1, we searched databases that contained the widest-possible range of sources including academic literature, reports produced by government agencies and non-profit organizations, news coverage, and articles in the popular press. These databases include information published in peer-reviewed articles, books, reports, conference papers and presentations, and web pages. Table 1-2 lists the databases included in our search.

Table 1-1: Search Terms

LID-Related Search Terms	Economics-Related Search Terms
Low-impact development	Economics
Source control	Benefits, economic benefits
Green infrastructure	Costs, economic costs
Natural drainage systems	Cost comparison
Sustainable stormwater management	Savings
Conservation development	Benefit cost analysis, cost benefit analysis
Alternative stormwater management	Cost effectiveness
Better site design	
Low-impact urban design and development	

Source: ECONorthwest

Table 1-2: Databases

Database	Description
Academic Search Premier	Index of 8,000 academic journals in the social sciences, humanities, and general science, back to 1965.
Article First	Index of 16,000 journal titles in business, humanities, popular culture, science, social science, and technology, back to 1990.
Econlit	American Economic Association's index of economic research, back to 1969.
Environmental Protection Agency (EPA) website	Database of studies, reports, educational material, and newsletters authored or supported by the EPA.
Environmental Valuation Reference Inventory (EVRI)	Database of empirical studies conducted internationally on the economic values of ecosystem services.
Google	Source for non-peer reviewed reports, articles, websites and other publications.
Journal Storage (JSTOR)	Index of over 100 major research journals in a variety of academic disciplines, some back to 1870.
Web of Science	Index of science and social science journals, back to 1975.
WorldCat	Index of bibliographic records of books, journals, manuscripts, etc. archived in university, public and private library catalogs around the world.

Source: ECONorthwest

We reviewed potential sources for relevance. If a source contained LID-related cost or benefit information, we indexed it in our own database, summarized the information on costs or benefits, and reviewed its bibliography for additional sources of information.

This report of our review of the literature is organized as follows. The next two sections provide background information to the discussion of the economic costs and benefits of managing stormwater. This background information provides a context or economic frame-of-reference that will help the reader consider the descriptions of costs and benefits that follow.

In **Section II** we list the range of benefits associated with LID, as identified in the LID literature, along with illustrations of the values of these benefits as reported in the economic literature. We found that many more reports simply list these benefits rather than quantify them.

In **Section III** we describe two of the more common methods of measuring the economic costs and benefits of stormwater controls: the cost-effectiveness and benefit-cost methods. As the names imply, cost-effectiveness studies compare alternatives looking exclusively at the alternatives' costs. This method assumes away benefits or holds them constant across alternatives. A benefit-cost analysis considers the range of costs and benefits for each alternative. The benefit-cost method has greater data demands and can be more expensive than the cost-effectiveness approach—primarily because it adds benefits into the analysis—but it can also yield a more accurate economic picture of the full range of economic consequences of implementing the alternatives.

In **Section IV** we summarize the literature that considers the costs and benefits of LID. The large majority of these studies focus exclusively on the costs of installing LID, or compare the costs of installing LID with the costs of installing conventional controls. Some studies look beyond installation costs to include operations and maintenance costs. Few studies consider both the costs and benefits of LID or compare costs and benefits of LID with conventional controls.[1] When the literature allowed, we described the economic aspects of adopting LID from the perspective of municipal decisionmakers, ratepayer stakeholders, and private developers.

In **Section V** we describe LID from the perspective of property developers. As with other new technologies, adopting LID includes opportunities and risks. We describe the risks and challenges that developers face when they include LID controls in their projects and the successes developers have had adopting LID.

In **Section VI** we discuss areas of future research that would increase our understanding of the economics of LID. For example, limited information exists on the life-cycle costs of LID, the economic benefits of LID beyond stormwater control, and the economic impacts of installing LID in urban-redevelopment settings.

The **Bibliography** lists the references we cite in this report. During our search for information on the economic aspects of LID, we encountered non-economic information that supports the use of LID. We list this information in the **Appendix** to this report.

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[1] We list the reported dollar amounts of costs and benefits without converting to current, 2007-year, dollars because in most cases, the available information prevented such a conversion.

II. ECOSYSTEM SERVICES PROVIDED OR ENHANCED BY LOW-IMPACT DEVELOPMENT

Conventional controls and LID techniques both manage stormwater flows. By promoting stormwater management on site using a variety of techniques, LID controls can provide a range of ecosystem services beyond stormwater management. Braden and Johnston (2004), Coffman (2002), and the Natural Resources Defense Council (Lehner et al. 2001) list and describe the kinds of ecosystem services that LID can provide or enhance. Taken together, these researchers describe the following ecosystem services: reduced flooding, improved water quality, increased groundwater recharge, reduced public expenditures on stormwater infrastructure, reduced ambient air temperatures and reduced energy demand, improved air quality, and enhanced aesthetics and property values. We briefly describe each of these services below.

Reduced Flooding

Braden and Johnston (2004) studied the flood-mitigation benefits of managing stormwater on site, including reduced frequency, area, and impact of flooding events. In a follow-up study, Johnston, Braden, and Price (2006) focus on the downstream benefits accrued from flood reduction accomplished by greater upstream on-site retention of stormwater. These benefits include reduce expenditures on bridges, culverts and other water-related infrastructure.

Improved Water Quality

Brown and Schueler (1997), Center for Watershed Protection (1998), U.S. EPA and Low Impact Development Center (2000), and Braden and Johnston (2004) describe the water-quality benefits that LID stormwater controls can provide. These benefits include effectively capturing oil and sediment, animal waste, landscaping chemicals, and other common urban pollutants that typically wash into sewers and receiving water bodies during storm events. Plumb and Seggos (2007) report that LID controls that include vegetation and soil infiltration, e.g., bioswales, can prevent more stormwater pollutants from entering New York City's harbor than conventional controls.

Increased Ground Water Recharge

On-site infiltration of stormwater helps recharge groundwater aquifers. According to a report by American Rivers, the Natural Resources Defense Council, and Smart Growth America (Otto et al. 2002), areas of impervious cover can significantly reduce ground water recharge and associated water supplies. The study found that impervious surfaces in Atlanta reduced groundwater infiltration by up to 132 billion gallons each year—enough water to serve the household needs of up to 3.6 million people per year.

Braden and Johnston (2004) distinguish between two services associated with increased groundwater recharge: the increased volume of water available for withdrawal and consumption, and maintaining a higher water table, which reduces pumping costs and increases well pressure.

Reduced Public Expenditures on Stormwater Infrastructure

The Center for Watershed Protection (1998), Lehner et al. (2001), and U.S. EPA (2005) report that LID techniques, such as bioswales, rain gardens, and permeable surfaces, can help reduce the demand for conventional stormwater controls, such as curb-and-gutter, and pipe-and-pond infrastructure. Braden and Johnston (2004) report that retaining stormwater runoff on site reduces the size requirements for downstream pipes and culverts, and reduces the need to protect stream channels against erosion.

Two recent studies by the Natural Resources Defense Council (Kloss and Calarusse 2006) and Riverkeeper (Plumb and Seggos 2007) report that by managing stormwater on site, LID techniques can help reduce combined sewer overflows. Combined sewer systems transport both sewage and stormwater flows. Depending on the capacity of the pipes and the amount of rainfall, the volume of combined sewer and stormwater flows can exceed the capacity of the pipes when it rains. When this happens, overflows of sewage and stormwater go directly to receiving bodies of water untreated. LID helps to keep stormwater out of the combined system, which reduces CSO events. Thurston (2003) found that decentralized stormwater controls, such as LID, can control CSO events at a lower cost than conventional controls.

Reduced Energy Use

LID techniques, such as green roofs and shade trees incorporated into bioswales and other controls can provide natural temperature regulation, which can help reduce energy demand and costs in urban areas. Plumb and Seggos (2007) estimate that covering a significant amount of the roof area in New York City with green roofs could lower ambient air temperatures in summer by an estimated 1.4 degrees Fahrenheit. The U.S. EPA and Low Impact Development Center (2000) report that the insulation properties of vegetated roof covers can help reduce a building’s energy demand, and notes that green roofs in Europe have successfully reduced energy use in buildings.

Improved Air Quality

Trees and vegetation incorporated into LID help improve air quality by sequestering pollutants from the air, including nitrogen dioxide, sulfur dioxide, ozone, carbon monoxide, and particulate matter (American Forests 2000-2006). In a study by Trees New York and Trees New Jersey, Bisco Werner et al. (2001) report similar air-quality benefits of trees and vegetation in urban areas. Plumb and Seggos (2007) cite one study that found that a single tree can remove 0.44 pounds of air pollution per year.

Enhanced Aesthetics and Property Values

Several studies including Lacy (1990), Mohamed (2006), U.S. Department of Defense (2004), and Bisco Werner et al. (2001) report that the natural features and vegetative cover of LID can enhance an area’s aesthetics, and increase adjacent property values. The U.S. Department of Defense (2004) highlights how LID can improve the aesthetics of the landscape and increase adjacent property values by providing architectural interest to otherwise open spaces. On commercial sites, Bisco Werner et al. (2001) found that LID on commercial sites provided amenities for people living and working in the area and complemented the site’s economic vitality, which improved its competitive advantage over similar establishments for customers and tenants.

III. ECONOMIC FRAMEWORK: MEASURING COSTS AND BENEFITS OF LOW-IMPACT DEVELOPMENT

Researchers and practitioners assess the economic aspects of LID using several methodologies. These methodologies range from rough cost evaluations, that compare a subset of costs of LID against the same costs for conventional management techniques, to benefit-cost analyses, that compare a range of costs and benefits of LID to the same for conventional stormwater controls. This section examines the differences in these methodologies.

Most economic evaluations of LID reported in the literature emphasize costs. The overwhelming majority of these studies confined their analyses to measuring installation costs. Evaluators prefer this method perhaps because from a developer's perspective, installation cost is one of the most important considerations when choosing between LID or conventional controls. LID can compare favorably with conventional controls in a side-by-side analysis of installation costs (*see for example* Foss 2005; Conservation Research Institute 2005; U.S. EPA 2005; Zickler 2004), however, focusing on installation costs misses other relevant economic information. For example, such a focus excludes operation and maintenance (O & M) costs, differences in the effectiveness of LID versus conventional systems, and the environmental and economic benefits that LID can provide, but which conventional controls cannot.

Evaluating projects based on installation costs has advantages of costing less than studies that include other economic factors, e.g., O & M costs, taking less time than more extensive analyses, and relying on readily available construction-cost data. The tradeoff for stormwater managers is an incomplete and possibly biased description of economic consequences, especially over the long term.

Some researchers look beyond comparisons of installation costs and evaluate LID and conventional controls using a method know as a life-cycle cost analysis (LCCA) (Powell et al. 2005; Sample et al. 2003; Vesely et al. 2005). This approach considers a comprehensive range of stormwater-management costs including planning and design costs, installation costs, O & M costs, and end-of-life decommissioning costs. An LCCA method requires more data than a comparison of installation costs, and this data, particularly data on lifetime O & M costs, may not exist or is difficult and costly to obtain. The tradeoff for policy makers is more accurate information on the cost implications of alternative stormwater-management options. However, LCCA, like more limited cost comparisons, excludes measures of economic benefits.

Another limitation of cost comparisons is that they ignore differences in effectiveness between LID and conventional controls. For this reason, researchers recommend that LCCA should compare projects that provide the similar levels of services (Powell et al. 2005). Brewer and Fisher (2004), Horner, Lim, and Burges (2004), and Zielinski (2000) found, however, that LID approaches can manage stormwater quantity and quality more effectively than the conventional approaches, either controlling more flow, or filtering more pollutants, or both. In these cases, an LCCA study could conclude that an LID option costs more than the conventional control, without accounting for the fact that the LID option can manage a larger volume of stormwater.

The benefit-cost approach overcomes the limitations of simple cost comparisons or LCCA by considering the full range of costs and benefits of alternative management options. The tradeoff is that the benefit-cost approach requires more data than cost comparison, which increases the time and costs of conducting the economic analysis.

The benefit-cost approach evaluates the net economic benefits of a project, or compares outcomes among projects, by comparing relevant costs with relevant economic benefits (Boardman et al. 2005; Field and Field 2006; Gramlich 1990; Kolstad 2000). Economic researchers in academic, business, and public-policy sectors have for many years conducted benefit-cost analyses in a wide variety of applications. Since at least the middle of the twentieth century, economic evaluations of large-scale public projects included some type of benefit-cost analysis, and since 1981, the federal government required that new programs and regulations include a benefit cost analysis (Freeman 2003). The U.S. Office of Management and Budget (OMB) considers the benefit-cost method the "recommended" technique when conducting formal economic analyses of government programs or projects (U.S. OMB 1992). Over the years, the technique has grown more sophisticated, especially with respect to measuring and incorporating non-market goods and services, such as the values of ecosystem services (Croote 1999).

The economic literature on benefit-cost analysis is voluminous and growing, but the basic process can be broken into four steps (Field and Field 2006).[2]

1. The first step defines the scope of the analysis, including the population that will experience the benefits and costs, and the elements of the project, including location, timing, and characteristics of the work to be done.

2. The second step determines a project's full range of inputs and effects, from the planning and design phase through the end of the project's lifespan.

3. The third step identifies and, where possible, quantifies the costs and benefits resulting from the project's inputs and effects. Where quantification is not possible, qualitatively describe the cost or benefit in as much detail as possible, including degree of uncertainty and expected timing of impacts (long-term or short-term).

4. The final step compares the benefits and costs of the project, either in terms of net benefits (the total benefits minus the total costs) or in terms of a benefit-cost ratio (the amount of benefits produced per unit of cost). If relevant, compare results among alternative projects.

We found few benefit-cost evaluations of LID projects. The large majority of studies estimate installation costs, a few consider additional costs, such as O & M costs, and a handful compared some measures of costs against some measures of benefits. The reported benefit-cost studies of LID include Bachand (2002) and Fine (2002),[3] Devinny

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[2] For a more complete discussion of benefit-cost analysis, see Field and Field (2006), Gramlich (1990) and Harberger and Jenkins (2002).

[3] We reviewed summaries of Bachand (2002) and Fine (2002) because we were unable to acquire copies of the full articles.

et al. (2005), and Doran and Cannon (2006). Data limitations may explain part of the reason for the limited number of benefit-cost analyses of LID. This is especially true for lifetime O & M costs and the economic importance of LID benefits. Sample et al. (2003), Powell et al. (2005), Johnston, Braden, and Price (2006), and Conservation Research Institute (2005), among others, describe the need for more research quantifying the benefits of LID practices.

Another reason may be that economic benefits or lifetime O & M costs have no relevance to a given economic study. For example, property developers pay installation costs of stormwater controls, but not lifetime O & M costs. Nor do they benefit directly from the ecosystem services that LID can enhance or provide. Economic results reported by developers will therefore likely focus exclusively on installation costs of LID or compare installation costs for LID and conventional controls.

Using the benefit-cost approach has challenges that the other analytical methods do not. However, benefit-cost analysis has advantages in that it can provide decisionmakers, ratepayers and other stakeholders with a more complete picture of the economic consequences of stormwater-management alternatives than other analytical methods. This is especially true for costs and benefits of alternatives over the long term. In situations in which time, budget, or other information constraints limit quantifying economic benefits or costs, the next best alternative is identifying the range of costs and benefits, quantifying what can be measured and describing the remaining impacts qualitatively. The federal government takes this approach in that the OMB recommends that when benefits and costs cannot be quantified, agencies should provide qualitative descriptions of the benefits and costs. These qualitative descriptions should include the nature, timing, likelihood, location, and distribution of the unquantified benefits and costs (U.S. OMB 2000).

IV. Costs and Benefits of Low-Impact Development

The large majority of literature that describe economic assessments of LID focus on the costs of installing the technology. Most studies report the costs of building LID stormwater controls, or compare the costs of installing LID to the costs of conventional controls. The organization of this section reflects this emphasis in the literature. We begin by summarizing studies that list the costs of installing various LID techniques. Most of these reports describe the outcomes of case studies of LID installed as new or developing stormwater-management technologies. We then discuss studies that compare the costs of building LID controls with the costs of building conventional controls.

A number of researchers looked beyond installation costs and considered the impacts that operations and maintenance costs can have on economic evaluations of LID. Analysts sometimes refer to these as life-cycle studies because they consider the relevant costs throughout the useful life of a technology. We summarize three studies that took this approach with LID evaluations.

Combined sewer overflows, and the resulting biophysical and economic consequences, are major concerns for municipal stormwater managers. LID can help minimize the number of CSO events and the volume of contaminated flows by managing more stormwater on site and keeping flows out of combined sewer pipes. We summarize five studies that evaluated the costs of managing CSO events using LID.

A relatively small percentage of the economic evaluations of LID reported in the literature include assessments of the economic benefits of the technology. We summarize a number of these reports at the end of this section.

A. Cost of Low-Impact Development

Brown and Schueler (1997) surveyed construction costs for different methods of managing stormwater in urban areas. Their survey emphasized conventional controls but also included a number of LID techniques. At the time of their study, LID techniques were considered “next generation” best-management practices (BMPs). The report lists construction costs for sixty-four BMPs including wet and dry stormwater ponds, bioretention areas, sand filters and infiltration trenches. The authors’ major conclusion is that a BMP’s construction cost increases with the volume of stormwater the BMP stores. The report’s construction costs may be out-of-date, however they provide insights into relative cost differences between LID and other controls listed in the report.

In a more recent study, Tilley (2003) reports construction costs for LID case studies implemented in Puget Sound and Vancouver, B.C. The report describes a range of case studies from small-scale projects implemented by homeowners to large installations completed by universities, developers and municipal governments. The LID techniques studied include rain gardens, permeable pavement and green roofs. The amount of cost information varies by case study. In some cases the report lists per-unit costs to install an LID, e.g., a pervious concrete project cost $1.50 per square foot for materials (excluding labor). Other descriptions report costs generally, but not costs specific to the case study described, e.g., the cost for pervious concrete is typically $6 to $9 per square foot. Some descriptions have no cost information, and others list total construction costs without a detailed breakdown of cost components.

The U.S. Department of Defense (DoD) (2004) developed a manual of design guidelines to incorporate LID into DoD facilities. The manual describes 13 stormwater-management techniques and their most appropriate uses, maintenance issues, and cost information. The list of LID techniques includes bioretention, grassed swales, and permeable pavers. The manual describes costs in some detail but also notes the site-specific nature of construction costs and factors that can influence construction costs for certain LIDs.

Liptan and Brown (1996) describe one of the earliest comparisons of construction costs for LID with that for conventional controls.[4] They focus on two projects in Portland, Oregon, which they refer to as the OMSI and FlexAlloy projects, and the Village Homes development in Davis, California. In all cases, the LID option cost less. The LID design implemented at the OMSI project saved the developer $78,000 in construction costs by reducing manholes, piping, trenching, and catch basins. At the FlexAlloy site, the City of Portland conducted a retrospective study of LID vs. conventional development, after the builder installed conventional controls. The City calculated that the developer could have saved $10,000 by implementing the LID option. The description of the FlexAlloy case study includes a detailed comparison of construction costs for the two options. The Village Homes case study concluded that by using vegetated swales, narrow streets, and a cluster layout of building lots, the developer saved $800 per lot, or $192,000 for the development. The Village Homes description includes no additional details on construction costs for the two options. The report also includes brief descriptions of other LID case studies, some with cost comparisons for LID vs. conventional controls. The authors conclude that involving developers, engineers, architects and landscape architects early in the design of a development that includes LID can help minimizing the LID-specific construction costs.

Hume and Comfort (2004) compared the costs of constructing conventional roads and stormwater controls with the costs of building LID options, such as bioretention cells and pervious pavement. The researchers added complexity to some of their comparisons by paring the same conventional and LID controls, e.g., infiltration trench (conventional) vs. bioretention cell (LID) on a different soil types and with different sources of stormwater runoff (e.g., driveway vs. roof top) to see how this affected construction costs. In some comparisons the LID option cost more than the conventional option, in other cases the results were opposite. These comparisons illustrate the site-specific nature of LID construction costs. Local conditions, e.g., less pervious soils, can influence the costs of LID controls.

In some cases, LID can help lower construction costs by making use of a site's existing or undisturbed drainage conditions in ways that conventional controls cannot. Planners of a 44-acre, 80-lot residential development in Florida took advantage of the site's natural drainage patters to help lower stormwater-management costs (PATH 2005). The site's low-lying areas convey the large majority of stormwater runoff to forested basins. The developer minimized disturbing natural drainage patterns by clustering building sites and connecting sites with narrow roads. Relying on natural infiltration and drainage patterns help the developer save $40,000 in construction costs by avoiding the costs of constructing stormwater ponds.

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[4] In this Section we describe some of the developments associated with costs comparisons reported in the LID literature. The next Section focuses on LID from the perspective of property developers and contractors. In that Section we list results for a larger number of cost comparisons

Comparing construction costs between LID and conventional options, while informative, provides no information on the relationship between the cost and effectiveness. For example, in cases where the LID option costs more to build, it may also control a larger volume of stormwater relative to the conventional option. LID that keeps stormwater out of pipes and treatment facilities help lower operations and maintenance (O & M) costs, and help extend the useful life of the infrastructure, which can reduce future construction costs. The relative importance of construction or O & M costs depends on who pays for them. Builders likely focus exclusively on construction costs, however, cost and effectiveness information would help stormwater managers better evaluate control options and plan for future demands on stormwater infrastructure.

Brewer and Fisher (2004) report the results of four case studies that compared the cost and effectiveness of LID to that of conventional controls. The case studies modeled stormwater costs and conditions on four developments: high- and medium-density residential, an elementary school, and a commercial development. In both residential developments LID controls cost less than conventional controls. LID cost more for the school and commercial development. However, in all four cases, the LID option managed a larger volume of stormwater than the conventional option. We reproduce Brewer and Fisher's results in Table 4-1.

Table 4-1: Comparison of Runoff Controlled and Cost Savings for Conventional and LID Design.

Site Example	Runoff Storage (acre-feet)		LID Net Cost or Savings
	Conventional	LID	
Medium Density Residential	1.3	2.5	$476,406
Elementary School	0.6	1.6	$(48,478)
High Density Residential	0.25	0.45	$25,094
Commercial	0.98	2.9	$(9,772)

Source: Brewer and Fisher 2004

We calculated the economic value of the additional storage provided by the LID designs reported in Brewer and Fisher (2004), using data on the national average of construction costs as reported by American Forests. American Forests' CITYgreen analyses calculate the national-average cost of storing 1 acre-foot of runoff at $87,120.[5] American Forests uses a value of $2.00 per cubic foot of storage, obtained from national estimates of stormwater construction costs. This amount represents the avoided costs of not building stormwater detention ponds. This value may vary, depending on a project's location. In some of its analyses, American Forests uses local estimates of construction costs, which can be lower or higher than the national average. For example, American Forests uses

[5] *See, for example,* American Forests. 2003. *Urban Ecosystem Analysis: San Diego, California*. July. Retrieved August 2, 2007, from http://www.americanforests.org/downloads/rea/AF_SanDiego.pdf, American Forests. 2003. *Urban Ecosystem Analysis: Buffalo-Lackawanna Area, Erie County, New York*. June. Retrieved August 2, 2007, from http://www.americanforests.org/downloads/rea/AF_Buffalo.pdf.

$0.66 per cubic foot of storage in Houston, TX,[6] $5.00 per cubic foot of storage in the Washington D.C. Metro Area,[7] and $6.00 per cubic foot of storage in Portland, OR.[8] Table 4-2 shows the results of our calculation.

Table 4-2: Value of the Difference in Runoff Storage Provided by LID Designs.

Site Example	Runoff Storage (acre-feet) Conventional	LID	Difference	Runoff Storage Difference (cubic-feet)[a]	Value of Difference in Runoff Storage ($2/cf)
Medium Density Residential	1.3	2.5	1.2	52,272	$104,544
Elementary School	0.6	1.6	1	43,560	$87,120
High Density Residential	0.25	0.45	0.2	8,712	$17,424
Commercial	0.98	2.9	1.92	83,635	$167,270

Source: ECONorthwest
Notes: [a] To convert from an acre foot to cubic feet, multiply by 43,560 (the number of cubic feet in an acre-foot).

Based on the results reported in Table 4-1, and taking the perspective of a builder, LID is the higher-cost alternative for the school and commercial development. Including the results from Table 4-2, and taking the perspective of a municipal stormwater manager—that is, considering construction costs and the cost savings associated with reductions in stormwater volume in our example calculation above—the LID option dominates the conventional choice in all four cases. The LID options control a larger volume of stormwater, which helps avoid municipal expenditures on stormwater management.

Doran and Cannon (2006) studied the relationship between construction costs of LID and conventional controls and effectiveness as measured by improvements in water quality. They studied the impacts of incorporating LID into a downtown redevelopment project in Caldwell, Idaho. The analysis modeled construction costs and improvements to water quality as measured by reduced concentrations of sediment and phosphorus in stormwater runoff. The LID techniques used in the project included permeable pavers, bioretention swales, riparian wetlands, and plantings of restored native vegetation. The study evaluated the LID and conventional controls using the cost of a 1-percent reduction in sediment and phosphorus concentrations. Conventional stormwater controls had lower

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[6] American Forests. 2000. *Urban Ecosystem Analysis for the Houston Gulf Coast Region*. December. Retrieved August 2, 2007, from http://www.americanforests.org/downloads/rea/AF_Houston.pdf.

[7] American Forests. 2002. *Urban Ecosystem Analysis: The District of Columbia*. February. Retrieved August 2, 2007, from http://www.americanforests.org/downloads/rea/AF_WashingtonDC2.pdf.

[8] American Forests. 2001. *Regional Ecosystem Analysis for the Willamette/Lower Columbia Region of Northwestern Oregon and Southwestern Washington State*. October. Retrieved August 2, 2007, from http://www.americanforests.org/downloads/rea/AF_Portland.pdf.

installation costs, but also had a lesser impact on water quality. Conventional controls cost $8,500 and reduced sediment and phosphorus concentrations by 5 percent, or $1,700 per percent reduction. LID stormwater controls cost more, $20,648, but had a greater impact on water quality, reducing sediment by 32 percent and phosphorus by 30 percent. The authors calculated a cost of $645 per percent reduction for the LID option. The LID option produced a better return on initial investment, as measured by improvements to water quality, than did investments in conventional controls.

As the previous two studies illustrate, comparing LID and conventional controls based on costs may bias the assessment against the most effective management option, and the option that yields the greatest return on investment. LID may cost more to build, but from an investment perspective, it may also control more stormwater and better improve water quality. The studies above considered separately LID effectiveness as measured by volume of stormwater managed and improvements in water quality of stormwater runoff. A more complete and accurate assessment of effectiveness and costs would consider the impacts on both in a single study. That is, compare LID and conventional controls based on costs and effectiveness as measured by volume of stormwater *and* water quality. We found no such studies in the literature.

Looking beyond construction costs to O & M and other costs gives a more complete description of the economic consequences of adopting LID or conventional controls. Sample et al. (2003) promotes evaluating stormwater BMPs using life-cycle-cost (LCC) analysis. LCC analysis includes the initial capital expenditures for construction, planning, etc., and the present value of lifetime O & M costs, and the salvage value at the end of the BMP's useful life. In addition, the authors suggest including the opportunity cost of land in the cost analysis. BMPs that occupy more land area have a higher opportunity cost valued at the next-best use for the land, e.g., residential value.

Vesely et al. (2005) compared the LCC for LID controls in the Glencourt Place residential development in Auckland, New Zealand with LCC results for conventional controls. The LID option had the added benefit of reusing stormwater collected on site as grey water for laundry, flushing toilets and irrigation. The LID option had LCCs that were 4 to 8 percent higher than the conventional option, depending on the discount rate and number of years in the analysis. These results do not account for the value of recycled stormwater. Including the avoided cost associated with water saved by recycling stormwater as household gray water, the LCC for the LID option were 0 to 6 percent higher, again, depending on the discount rate and number of future years in the analysis. The authors conclude that accounting for the value of water saved, the LID option was cost competitive with the conventional approach, as measured by the LCC method.

Data constraints on this study included difficulty estimating current and future maintenance costs and future decommissioning costs. Accounting for the opportunity cost of land also proved challenging give the available data. Data limitations also prevented the authors from considering the economic aspects of environmental externalities associated with the LID and conventional options.

LCC evaluations are an improvement over comparisons of construction costs in that they provide a more comprehensive assessment of relevant costs. On the other hand, LCC analyses require more data and results are sensitive to the discount rate applied to future values and the number of years of the analysis. Powell et al. (2005) underscore these advantages and challenges associated with LCC analysis. They recommend a checklist of factors to consider when conducting a LCC for LID and conventional controls. The checklist includes *quantitative* assessments of the components of LCC costs including acquisition, construction, O & M, and salvage value. Also included are *qualitative* assessments of the effectiveness of managing stormwater and the benefits attributed to the management option. The authors note that effectively and accurately implementing LCC analyses for LID will require more research into the costs of LID design, construction and O & M. Further research is also need in assessing the monetary benefits of LID controls.

Despite the fact that LID technologies have been promoted and studied since the early 1990s, in many ways, and to many stormwater managers, LID is still a new and emerging technology (Coffman 2002). As with most new technologies, installation and other costs for LID are highest during the early phases of development and adoption. Over time, as practitioners learn more about the technology, as the number of suppliers of inputs increases, and as regulations adapt to the new technology, costs will likely decline.

Foss (2005) describes this relationship between a learning curve and construction costs for greenstreet technology in Seattle. The city spent $850,000 implementing a greenstreet pilot project, known as the "Street Edge Alternative" (SEA) street. The City's street planners expect that based on their experience with the pilot project, building greenstreets in the future will cost substantially less. Foss quotes the manager of the City's surface water program on this point:

> *"You could take $200,000 off the price just from what we didn't know. … The pilot phases that we are currently in are more expensive, but as the project becomes institutionalized, all the costs will come down. Even still, these projects are less expensive than standard projects." (p. 7)*

B. Costs of Managing Combined Sewer Overflows By Low-Impact Development

One of the earliest studies of the economic aspects of managing combined sewer overflows by LID evaluated a project that disconnected downspouts as a means of reducing the number of CSO events and costs (Kaufman and Wurtz 1997). In 1994, the Beecher Water District (BWD) near Flint, Michigan, provided free downspout diversions from home sites to sanitary-sewer pipes for the 6,020 residential customers in their service area. The purpose of the program was to reduce the volume of sewer flows from the BWD to the City of Flint's stormwater facility—and reduce the fees that BWD paid the city to manage these flows—and reduce the number and volume of CSO events in the BWD.

The program was a success on many levels and is an example of a small-scale and inexpensive approach that effectively managed CSO events. Disconnecting downspouts cost the BWD just over $15,000. After the diversions, the mean volume of sewer flows measured across all precipitation events decreased 26 percent. The program saved the BWD over $8,000 per month in reduced fees to the City of Flint's stormwater facility, and in reduced costs of managing CSO events. The program paid for itself in two months. Other benefits included reduced CSO-related customer complaints, improved recharge of groundwater and reduced pollution of the Great Lakes, the receiving waters for CSO from the District.

In another study looking at controlling CSO events on a smaller scale, Thurston et al. (2003) modeled the costs of CSO controls for a small watershed in Cincinnati, Ohio. The modeling exercise was part of a study that evaluated the theoretical considerations of developing a market for tradable stormwater credits as a means of reducing CSO events and costs. One part of the study compared the construction costs of controlling CSO events by building tunnels and storage vaults with the costs of building LID controls on each of the 420 mostly-residential lots in the study area.

They calculated that building the tunnel and vault option would cost between $8.93 to $11.90 per cubic foot of storage capacity. Building LID controls on individual lots would cost $5.40 per cubic foot of capacity. Based on these results the researchers suggest that the costs of managing CSOs by implementing LID throughout the watershed would cost less than building a large centralized tunnel and vault system to store excess flows. They also note, however that their analysis does not include the opportunity cost of land that the LID controls would occupy, and so the cost of the LID option would be higher than they report. Their analysis also excludes O & M costs for both options, as well as the costs of education and outreach to property owners, and managing the construction of a large number of dispersed LID projects as components of the LID option. The project also excludes the economic benefits of the LID option.

Kloss and Calarusse (2006) developed a set of policy guidelines for decisionmakers interested in implement LID controls as a means of reducing CSO events in their jurisdictions. Regarding the costs of LID controls, the authors distinguish between new and retrofit construction projects. In new developments, they conclude, LID typically cost less than conventional stormwater controls. They note, however, that retrofit developments in urban areas that include LID typically cost more than conventional controls. This is especially true for individual, small-scale retrofit projects. The relative costs of LID controls can be reduced when they are incorporated into larger-scale redevelopment projects. The report provides conclusions with limited details on cost information. The report also describes the experiences of nine municipalities across the country that include LID in their policies to control CSO events and related costs.

Montalto et al. (2007) described the relationship between public agencies tasked with controlling CSO events, and private land owners on whose property the large majority of LID controls would be sited. The public agencies benefit from the reduced stormwater flows and CSO events that LID provides. The land owner, however, pays the LID installation and O & M costs, but may see little benefit beyond reduced stormwater fees or increased property values from LID such as greenstreets. These benefits may not outweigh the costs to the land owner, and so they may choose not to install LID controls. Given this disconnect, the authors note the benefits of public policies, incentives and subsidies to promote LID adoptions by private-property owners.

In an effort, in part, to measure the amount of subsidy that may be required, the authors developed a model to assess the cost-effectiveness of mitigating CSO events in urban areas using LID. They applied their model to a case study in the Gowanus Canal area of Brooklyn, NY. The case study compared the costs of installing porous pavement, green roofs, wetland developments and other LID throughout the study area to the costs of installing storage tanks to catch excess stormwater flows. As part of their analysis they collected and report installation and O & M costs for a range of LID techniques.

They conclude that under a range of cost and performance assumptions, LID installed throughout the study area could potentially reduce the number of CSO events and volume at a cost that would be competitive or less than the costs of the conventional storage-tank option. They note that they could improve the performance of their model if more data were available on LID performance, costs and public acceptance.

Plumb and Seggos (2007) studied the impacts of diverting monies currently designated to building storage tanks and other conventional CSO controls for New York City to building LID controls throughout the city. They compared the effectiveness of storage tanks and LID controls based on gallons of stormwater managed per $1,000 invested. We reproduce their results in Table 4-3 below. Except for greenroofs, the LID options control more stormwater per $1,000 invested than the conventional storage-tank option.

Table 4-3: Gallons of Stormwater Managed per $1,000 Invested.

Stormwater Control	Gallons per $1,000 Invested
Conventional Storage Tanks	2,400
Greenstreet	14,800
Street Trees	13,170
Greenroof	810
Rain Barrel	9,000

Source: Plumb and Seggos 2007

They describe their analysis as a simple and preliminary cost comparison and conclude that their results demonstrate that LID controls can be cost competitive with conventional controls, if not more so. The authors recommended further detailed study of the issue. Their analysis focused on the costs of LID vs. conventional controls and did not consider economic benefits of the LID techniques.

C. Economic Benefits of Low-Impact Development

Many reports and articles describe the potential benefits that LID stormwater controls can provide—benefits that conventional controls can not offer.[9] Very few studies, however, quantify these benefits, either in biophysical measures or in dollar amounts. A study by CH2MHill (2001) is a typical example. The analysis compared the costs and benefits of managing stormwater in two residential developments using LID or conventional controls. The cost analysis included detailed information for the LID and conventional controls. In this case, results of the cost analysis were mixed. In one development the LID option cost less to build and in the other development the conventional control cost less. In both cases the LID option had higher maintenance costs but homeowners would benefit from lower stormwater and water fees.

[9] We list a number of these sources in Section II of this report.

The analysis of benefits included much less detailed information. The study lists the benefits that the LID option would provide, benefits that the conventional approach would not. These benefits include reduced auto traffic, increased open space, improved downstream water quality, and increased groundwater recharge. However, the benefits were not quantified in dollar amounts.

In another example, Bachand (2002) studied the costs and benefits of developing wetlands as a stormwater management option. The analysis described the construction and O & M costs associated with the wetlands option, and the benefits including adding new recreational opportunities, increased wildlife habitat and increase property values for near-by homeowners. However, they did not measure the benefits in economic terms. An accompanying study by Fine (2002) quantified some of the recreational benefits that derive from wildlife watching in the wetlands, but left unquantified the benefits of other direct uses of the wetlands, as well as the value of habitat improvements and other non-use benefits.[10]

When researchers cite the needs for further research into LID-related topics, quantifying benefits and measuring their economic importance invariably makes the list. For example, Sample et al. (2003) cites the need for more research into measuring the technical and economic benefits of LID, including benefits to downstream receiving waters. Powell et al. (2005) note the need for more research into monetary measures of the benefits of LID, e.g., the impact that a greenstreet can have on adjacent property values. Vesely et al. (2005) state that future studies should include not only the economic benefits of LID but also the negative economic impacts of conventional controls. Failing to do so will continue biasing management decisions in favor of conventional controls:

> *"Exclusive reliance on profitability and market value will favour [sic] the conventional approach to stormwater management by disregarding both the negative environmental externalities associated with this approach, and the positive environmental externalities associated with the low impact approach." (page 12)*

A number of studies do measure some of the economic benefits of on-site stormwater controls. For example, Braden and Johnson (2004) studied the economic benefits that on-site stormwater management could have on properties downstream. The researchers first estimated the impacts that on-site stormwater controls could have on the frequency and extent of downstream flooding. Using information reported in the literature on the extent to which property markets discount the value of properties in a floodplain, they approximated the economic value of reduced flooding attributed to on-site management of stormwater. They then calculated the value of avoided flood damage as a percentage of property values. They estimate that a marginal reduction in flooding would increase property values 0 to 5 percent for properties in a floodplain, depending on the extent to which the on-site controls reduce stormwater runoff.

They then took a similar approach to valuing improvements in water quality. Based on values reported in the literature, they estimate that the benefits of improved water quality could reach 15 percent of market value for properties that border the water body at issue

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[10] We were unable to obtain a copy of the full report. We base our description on a summary of the analysis.

if water quality improves significantly. The increase is much less for smaller improvements in water quality, for undeveloped properties, and for properties not adjacent to the water body.

They conclude with a best-guess estimate of a 2 to 5 percent increase in property values for properties in a floodplain from on-site management of stormwater. Other benefits that could not be quantified or valued given available information include reduced infrastructure expenditures for culverts, bridges and other drainage infrastructure.

In a follow-up case study, Johnston, Braden, and Price (2006) applied the analytical method developed in the previous study to properties in the one-hundred-year floodplain portion of a watershed in the Chicago area. They estimate the economic benefit of avoided flooding two ways and extend the analysis to approximate reduced municipal expenditures on culverts.

Applying the 0 to 5 percent impact on property values calculated in the previous study to properties in the case study, the researchers estimated an economic benefit of $0 to $7,800 per acre of increased property value attributed to reduced flooding. They also calculated the economic benefit of reduced flooding based on the avoided flood damage to structures and contents for properties in the floodplain. This analytical method included data compiled by the U.S. Army Corps of Engineers on the relationship between flooding and damages to properties in floodplains. This approach yields an economic benefit of avoided flooding of $6,700 to $9,700 per acre for properties in the floodplain.

The researchers approximate that for the case-study portion of the watershed, conservation-design practices such as LID techniques that retain more stormwater on site and reduce flooding could generate $3.3 million in avoided costs for road culverts.

The estimated economic benefit of increased on-site management of stormwater for properties in the case study for both avoided flooding and reduced municipal expenditures on culverts is $380 to $590 per acre.

A series of analyses by American Forests (2000-2006) report the economic benefits of stormwater services provided by trees in various cities and regions throughout the United States. These reports describe results from American Forests' CITYgreen model, which calculates the volume of stormwater absorbed by existing tree canopies and estimates the avoided costs in stormwater management that the trees provide. The model includes city-specific per-unit stormwater-management costs when available. The model substitutes national per-unit costs when city-specific data are not available. In Table 4-4 below we report the results for some of American Forests' city and regional analyses. The dollar amounts represent the costs of expanding stormwater infrastructure to manage the stormwater that existing trees otherwise absorb and transpire.

Table 4-4: Avoided stormwater-construction costs attributed to trees, as measured by the American Forests' CITYgreen model.

Urban Area	Amount that trees save in one-time stormwater-construction costs
Houston, Texas	$1.33 billion
Atlanta, Georgia	$2.36 billion
Vancouver, Washington/ Portland-Eugene, Oregon	$20.2 billion
Washington D.C. Metro Area	$4.74 billion
New Orleans, Louisiana	$0.74 billion
San Antonio, Texas	$1.35 billion
San Diego, California	$0.16 billion
Puget Sound Metro Area, Washington	$5.90 billion
Detroit, Michigan	$0.38 billion
Chesapeake Bay Region	$1.08 billion

Source: American Forests 2000-2006

The Bisco Werner et al. (2001) analysis of the economic benefits of trees attributed to stormwater management also employed the CITYgreen model. Researchers applied the CITYgreen model to a case study that included the commercial corridor along a major highway through central New Jersey. The analysis modeled the change in tree canopy between 1975 and 1995, and calculated the value of lost stormwater services. During this time, the value of services declined from $1.1 million to $896,000, a 19-percent reduction. If existing trends continue, the expected value in 2015 will be $715,000, a 35-percent reduction relative to the value of services available in 1975. As services supplied by street trees declines, demand on municipal stormwater controls, and associated costs, increase.

The researchers extended their study to include the economic benefits of tree cover attributed to removing air pollutants. This portion of their analysis studied the tree cover at a number of commercial properties in the New York and New Jersey area. In this case the CITYgreen model calculated avoided stormwater-construction costs associated with stormwater services provided by trees on site and, using values reported in the literature, the amounts of air pollutants absorbed by trees, and the per-unit value for each pollutant.

In one case study of a shopping mall, the analysis estimated that the trees currently on the site manage approximately 53,000 cubic feet of stormwater. The CITYgreen model estimated the value of the associated avoided infrastructure costs at just over $33,000. The value of air-pollutant removed is estimated at $1,441 per year. The report lists results for fifteen such case studies.

Wetlands that absorb stormwater runoff can help minimize stormwater-related management and infrastructure costs. Depending on their location and makeup, wetlands may provide other benefits, such as wildlife habitat and recreational opportunities. Fine (2002)[11] studied the recreational benefits provided by wetlands proposed as part of the Treasure Island redevelopment in San Francisco Bay. The analysis assumes that the wetlands will attract visitors year round, with the winter months providing the best opportunity to view migratory birds. Based on recreational expenditures for similar sites in the San Francisco Bay area, Fine calculates that area visitors will spend $4 to $8 million annually. Other benefits that Fine was unable to quantify and value include fisheries enhancement and water-quality services.

Devinny et al. (2005) developed a first-approximation of a benefit-cost analysis of complying with water-quality requirements throughout Los Angeles County using LID and other stormwater BMPs. They present their analysis as an alternative to the approach described by Gordon et al. (2002), which relies on collecting and treating the county's stormwater using conventional controls. The Devinny et al. approach assumes widespread adoption of LID and other on-site stormwater BMPs.

The Devinny et al. analysis accounts for the fact that the density of existing development will limit the extent to which LID and other BMPs can be retrofitted into developments. As an alternative they propose a combination of LID and BMPs along with directing stormwater to regional wetlands and other infiltration systems. As the density of development increases, so does the size and costs of developing regional wetlands.

This study differs from other benefit-cost analyses of stormwater-management options in that the researchers quantify a range of potential benefits associated with the approach that emphasizes on-site treatment of stormwater. They estimate the cost of their approach at $2.8 billion if disbursed LID and other on-site BMPs sufficiently control stormwater quality. Costs increase to $5.7 to $7.4 billion if regional wetlands and other infiltration systems are needed. This approach costs less than the estimated cost of $44 billion to implement the option that emphasizes conventional controls (California Department of Transportation 2005).

The estimated value of the economic benefits of implementing LID, other on-site BMPs and regional wetlands range from $5.6 to $18 billion. Benefits include the economic aspects of reduced flood control, increased property values adjacent to new greenspaces and wetlands, additional groundwater supplies, improved beach tourism, and reduced sedimentation of area harbors. The conventional approach would provide none of these economic benefits.

[11] We were unable to obtain a copy of the full report. We base our description on a summary of the analysis.

V. Developers' Experiences With Low-Impact Development

Baring regulations that mandate LID controls, developers adopt LID because they help reduce construction costs, increase sales, boost profits, or some combination of the three. These deliberations focus primarily on the extent to which local property markets account for the direct costs and benefits that LID can provide. Typically these deliberations do not include indirect costs and benefits and the potential non-market impacts of LID that may be important to others such as municipal stormwater managers and area residents. These non-market impacts may include reduced downstream flooding, improved water quality and habitat of water bodies that receive stormwater, reduced CSO events, or impacts on the costs of operating municipal-stormwater infrastructure.

In this section we summarize developers' experiences installing LID. As with other new technologies, adopting LID includes opportunities and risks. We begin by describing the risks and challenges that developers face by including LID in their projects. These risks include uncertain construction delays as the developer applies for variances to local zoning codes because the codes do not explicitly recognize LID as an accepted stormwater control.

Next, we describe some of the efforts by municipal governments to reduce the developers' regulatory risk and uncertainty of using LID. Finally, we list some of the successes developers have had adopting LID and the resulting impacts on construction costs, sales, and profits.

A. Challenges Developers Face Using LID

Much of the general public is still unaware of LID attributes, the benefits they can provide, or their O & M costs. As such, they may not understand or appreciate why a developer included LID in a project. This may give developers pause because they supply products that they believe their customers—homebuyers—want and will purchase. Potential buyers may shy away from homes that include an unfamiliar technology.

A general lack of understanding of LID may concern developers in part because including on-site treatment of stormwater will also require on-site management of stormwater facilities, the LID technologies. Homeowners unfamiliar with LID likely will have no understanding of their maintenance requirements (Lewis 2006; England 2002; Foss 2005). For example, a bioswale clogged with sediment may not control stormwater volume or quality, which could negatively reflect on the builder. Another concern has to do with the lack of understanding as to the life-expectancy of LID controls (Lewis 2006). A builder may be concerned that an untimely failure of stormwater controls could negatively affect their reputation.

Similar to the public's general lack of understanding of LID, many builders are also unfamiliar with the technology. A builder may not be able to identify the most effective and least-cost LID technology for a given development from the wide variety of possible LID controls (Foss 2005; Lewis 2006). A related point is that construction costs for LID technologies are site specific. For example, not all soils can support LID technologies that emphasize stormwater infiltration. Assessing a site and designing LID technologies that will function on the site may also increase a builder's design costs (Coffman 2002; Strassler et al. 1999).

A much-mentioned impediment to builders' adoption of LID is building codes that do not account for LID as stormwater controls. Many municipalities have zoning and building-inspection standards in place that were adopted many years ago, long before LID was an option (Coffman 2002; NAHB Research Center Inc. 2003; Foss 2005; Lewis 2006). These standards emphasize conventional stormwater controls that collect stormwater and transport it off site to a receiving body of water or to a treatment facility. Municipalities with outdated stormwater regulations typically require that builders file variances if they want to use LID controls. Filing variances for LID increases design and regulatory costs, which delays construction and can increase a builder's financing costs (Clar 2004; Coffman 2002; Lewis 2006; NAHB Research Center Inc. 2003).

A related constraint in some jurisdictions with outdated regulations is a lack of technical expertise or understanding by regulators regarding LID stormwater controls. In some cases, regulators unfamiliar with LID technology must be convinced of their effectiveness, which also increases a builder's design and regulatory costs (Coffman 2002; NAHB 2003; Lewis 2006).

B. Municipal Actions To Increase LID Adoption On Private Developments

Some jurisdictions help promote LID adoption on private lands and take steps that reduce the regulatory uncertainty and risk that builders face when including LID in private developments. These jurisdictions may have CSO problems, or are trying to extend the useful life of their stormwater infrastructure in the face of increasing population and economic activity. In any case, they recognize the importance of managing as much stormwater on site as possible and keeping it out of the jurisdiction's stormwater pipes.

One way that jurisdictions promote LID adoption on private lands is by updating their zoning codes and building-inspection standards to explicitly address LID stormwater controls (Coffman 2002; NAHB Research Center Inc. 2003; Foss 2005; Lewis 2006). This helps reduce a builder's regulatory risk because it eliminates the need to file variances. Rather than spending time convincing regulators as to the desirable stormwater attributes or effectiveness of LID controls, builders can instead proceed with their development.

Granting density bonuses for developments that install LID stormwater controls is another way jurisdictions encourage the proliferation of LID techniques. In this case, the jurisdiction grants the developer a greater number of individual building lots than would have been allowed if the development relied on conventional stormwater controls (Coffman 2002; NAHB Research Center Inc. 2003). This type of incentive not only reduces a builder's regulatory risk, and associated costs, but also increases the number of lots that can be sold, which can increase the builder's revenue and profits. Jurisdictions also promote LID installation on private lands by reducing development-related fees, such as inspection fees (Coffman 2002; NAHB Research Center Inc. 2003).

C. Benefits To Developers of Including LID Controls in Their Projects

Developers who accept the regulatory uncertainty and other challenges of adopting LID do so with the expectation that controlling stormwater on site can have economic advantages. These advantages include increasing the number of developable lots and reducing expenditures associated with stormwater infrastructure. Managing stormwater on site using LID controls can mean doing away with stormwater ponds, thus increasing a site's developable area (Coffman 2002; NAHB Research Center Inc. 2003). Selling additional lots can increase a builder's revenues and profits. Replacing curbs, gutters and stormwater pipes with bioswales, pervious pavers and other LID controls reduces construction costs for some developers (Coffman 2002; NAHB Research Center Inc. 2003; Center for Watershed Protection 2001).

An analysis of a development in Prince George's County, Maryland, documented the impacts that controlling stormwater on site with LID can have on the site's buildable area and construction costs. The Somerset Community development installed rain gardens, grass swales along streets, and other LID controls. Substituting LID for conventional controls saved the developer approximately $900,000. Doing away with the site's stormwater ponds gave the developer six additional lots (Foss 2005).

A study of the Pembroke Woods Subdivision in Frederick County, Maryland found similar results (Clar 2004). The developer substituted LID for conventional controls, doing away with curbs, gutters, sidewalks, and eliminated two stormwater ponds. Eliminating the curbs and gutters saved the developer $60,000. Installing narrower streets eliminated impervious area and reduced paving costs by 17 percent. Excluding the stormwater ponds saved $200,000 in construction costs and added two developable lots, valued at $45,000 each. Other economic benefits to the developer include reduced costs of clearing land for development of $160,000, and adding 2.5 additional acres of open space, which reduced the developer's wetland-mitigation requirements.

Conservation subdivisions take a comprehensive approach to stormwater management by combining LID controls with a site design that takes advantage of existing drainage patterns. Narrow streets and clustered building lots make maximum use of natural stormwater controls, thus reducing construction costs (Center for Watershed Protection 2001). A study of ten subdivisions found that conservation subdivisions that emphasized LID and protected natural drainage patterns cost, on average, thirty-six percent less than subdivisions that relied on conventional stormwater controls (Conservation Research Institute 2005).

Researchers note that some conservation subdivisions have an additional benefit in that there's greater demand for lots in these subdivisions compared with the demand for lots in conventional subdivisions. Greater demand for lots means the developer can charge more for the lot and lots may sell faster (Center for Watershed Protection 2001).

A case study of conservation and conventional subdivisions in South Kingstown, Rhode Island quantified the market benefits of conservation developments. The study compared the costs of developing the lots and the market value of the lots (Mohamed 2006). Results show that conservation lots cost less to develop and sell for a higher price. On average, conservation lots cost $7,400 less to produce than lots in conventional subdivisions, and sold for 12 to 16 percent more, per acre, than conventional lots. Lots in the conservation subdivision also sold in approximately half the time as lots in conventional subdivisions.

Another study of cluster developments in New England found that houses in these types of developments appreciate faster than houses in conventional developments (Lacy 1990). Lacy identified developments in Concord and Amherst, Massachusetts that were characterized by smaller individual lots surrounded by natural open space, limited lot clearing, and narrower streets. He compared these with nearby conventional developments. The Concord cluster development appreciated 26 percent more than conventional developments over an eight-year study period. The Amherst cluster development also yielded a higher rate of return on investment over a 21-year study period, compared to nearby conventional development.

In Tables 5-1 and 5-2 below we summarize the results of studies that compared construction costs using LID vs. conventional stormwater controls for residential and commercial developments (respectively). We included information in the tables if a study described the source of the cost difference, e.g., substituting a bioswale for curbs and gutters saved $Z. We excluded studies that reported a cost difference, but did not describe the details of the cost comparison. We found many studies in the literature that did not provide details of cost comparisons.

We distinguish between study results for built developments from results for proposed or modeled developments. In some cases the studies report total cost savings for a development but not savings per lot in the development. In these cases we calculated the per-lot cost savings. We recognize that the cost savings values reported below are in dollars from different years, and so comparisons of cost savings between examples may not be appropriate. We found insufficient data in most case studies to convert all values to the same-year dollars.

The large majority of studies listed in Tables 5-1 and 5-2 describe LID installed or proposed to be installed in new developments. We found very few studies that measured the economic outcomes of including LID stormwater controls in urban, redevelopment projects. We identified these studies as “retrofits” in the tables.

Table 5-1: Cost savings attributed to installing LID stormwater controls in residential developments.

Location	Description	LID Cost Savings[a]
Meadow on the Hylebos Residential Subdivision Pierce County, WA	9-acre development reduced street width, added swale drainage system, rain gardens, and a sloped bio-terrace to slowly release stormwater to a creek. Stormwater pond reduced by 2/3, compared to conventional plan. (Zickler 2004)	LID cost 9% less than conventional
Somerset Community Residential Subdivision Prince George's Co., MD	80-acre development included rain gardens on each lot and a swale drainage system. Eliminated a stormwater pond and gained six extra lots. (NAHB Research Center Inc. 2003)	$916,382 $4,604 per lot
Pembroke Woods Residential Subdivision Frederick County, MD	43-acre, 70-lot development reduced street width, eliminated sidewalks, curb and gutter, and 2 stormwater ponds, and added swale drainage system, natural buffers, and filter strips. (Clar 2004; Lehner et al. 2001)	$420,000 $6,000 per lot[b]
Madera Community Residential Subdivision Gainesville, FL	44-acre, 80-lot development used natural drainage depressions in forested areas for infiltration instead of new stormwater ponds. (PATH 2005)	$40,000 $500 per lot[b]
Prairie Crossing Residential Subdivision Grayslake, IL	667-acre, 362-lot development clustered houses reducing infrastructure needs, and eliminated the need for a conventional stormwater system by building a natural drainage system using swales, constructed wetlands, and a central lake. (Lehner et al. 2001; Conservation Research Institute 2005)	$1,375,000- $2,700,000 $3,798-$7,458 per lot[b]
SEA Street Retrofit Residential street retrofit Seattle, WA	1-block retrofit narrowed street width, installed swales and rain gardens. (Tilley 2003)	$40,000
Gap Creek Residential Subdivision Sherwood, AK	130-acre, 72-lot development reduced street width, and preserved natural topography and drainage networks. (U.S. EPA 2005; Lehner et al. 2001; NAHB Research Center Inc. 2003)	$200,021 $4,819 per lot
Poplar Street Apartments Residential complex Aberdeen, NC	270-unit apartment complex eliminated curb and gutter stormwater system, replacing it with bioretention areas and swales. (U.S. EPA 2005)	$175,000
Kensington Estates* Residential Subdivision Pierce County, WA	24-acre, 103-lot hypothetical development reduced street width, used porous pavement, vegetated depressions on each lot, reduced stormwater pond size. (CH2MHill 2001; U.S. EPA 2005)	$86,800 $843 per lot[b]
Garden Valley* Residential Subdivision Pierce County, WA	10-acre, 34-lot hypothetical development reduced street width, used porous paving techniques, added swales between lots, and a central infiltration depression. (CH2MHill 2001)	$60,000 $1,765 per lot[b]
Circle C Ranch Residential Subdivision Austin, TX	Development employed filter strips and bioretention strips to slow and filter runoff before it reached a natural stream. (EPA 2005)	$185,000 $1,250 per lot

Location	Description	LID Cost Savings[a]
Woodland Reserve* Residential Development Lexana, KS	Reduced land clearing, reduced impervious surfaces, and added native plantings. (Beezhold 2006)	$118,420
The Trails* Multi-Family Residential Lexana, KS	Reduced land clearing, reduced impervious surfaces, and added native plantings. (Beezhold 2006)	$89,043
Medium Density Residential* Stafford County, VA	45-acre, 108-lot clustered development, reduced curb and gutter, storm sewer, paving, and stormwater pond size. (Center for Watershed Protection 1998b)	$300,547 $2,783 per lot[b]
Low Density Residential* Wicomico County, MD	24-acre, 8-lot development eliminated curb and gutter, reduced paving, storm drain, and reforestation needs. Eliminated stormwater pond and replaced with bioretention and bioswales. (Center for Watershed Protection 1998b)	$17,123 $2,140 per lot[b]

Source: ECONorthwest, with data from listed sources.
Notes: * indicates hypothetical or modeled project, not actually constructed.
[a] Dollar amounts as reported at the time of study.
[b] Per-lot cost savings calculated by ECONorthwest.

Table 5-2: Cost savings attributed to installing LID stormwater controls in commercial developments.

Location	Description	LID Cost Savings[a]
Parking Lot Retrofit Largo, MD	One-half acre of impervious surface. Stormwater directed to central bioretention island. (U.S. EPA 2005)	$10,500-$15,000
Old Farm Shopping Center* Frederick, MD	9.3-acre site redesigned to reduce impervious surfaces, added bioretention islands, filter strips, and infiltration trenches. (Zielinski 2000)	$36,230 $3,986 per acre[b]
270 Corporate Office Park* Germantown, MD	12.8-acre site redesigned to eliminate pipe and pond stormwater system, reduce impervious surface, added bioretention islands, swales, and grid pavers. (Zielinski 2000)	$27,900 $2,180 per acre[b]
OMSI Parking Lot Portland, OR	6-acre parking lot incorporated bioswales into the design, and reduced piping and catch basin infrastructure. (Liptan and Brown 1996)	$78,000 $13,000 per acre[b]
Light Industrial Parking Lot* Portland, OR	2-acre site incorporated bioswales into the design, and reduced piping and catch basin infrastructure. (Liptan and Brown 1996)	$11,247 $5,623 per acre[b]
Point West Shopping Center* Lexana, KS	Reduced curb and gutter, reduced storm sewer and inlets, reduced grading, and reduced land cost used porous pavers, added bioretention cells, and native plantings. (Beezhold 2006)	$168,898
Office Warehouse* Lexana, KS	Reduced impervious surfaces, reduced storm sewer and catch basins, reduced land cost, added bioswales and native plantings. (Beezhold 2006)	$317,483
Retail Shopping Center*	9-acre shopping development reduced parking lot area, added porous pavers, clustered retail spaces, added infiltration trench, bioretention and a sand filter, reduced curb and gutter and stormwater system, and eliminated infiltration basin. (Center for Watershed Protection 1998b)	$36,182 $4,020 per acre[b]
Commercial Office Park*	13-acre development reduced impervious surfaces, reduced stormwater ponds and added bioretention and swales. (Center for Watershed Protection 1998b)	$160,468 $12,344 per acre[b]
Tellabs Corporate Campus Naperville, IL	55-acre site developed into office space minimized site grading and preserved natural topography, eliminated storm sewer pipe and added bioswales. (Conservation Research Institute 2005)	$564,473 $10,263 per acre[b]
Vancouver Island Technology Park Redevelopment Saanich, British Columbia	Constructed wetlands, grassy swales and open channels, rather than piping to control stormwater. Also used amended soils, native plantings, shallow stormwater ponds within forested areas, and permeable surfaces on parking lots. (Tilley 2003)	$530,000

Source: ECONorthwest, with data from listed sources.
Notes: * indicates hypothetical or modeled project, not actually constructed.
[a] Dollar amounts as reported at the time of study.
[b] Per-acre cost savings calculated by ECONorthwest.

VI. Directions for Future Research

Despite the increasing use of LID stormwater controls, and the growing number of economic studies of this technique, our literature review found areas for further research. These areas include:

- Additional research that quantifies the costs and benefits of stormwater management. This includes economic research on the lifetime O & M costs for LID and conventional controls, as well as, studies that quantify the economic benefits of LID methods.

- More detailed information on costs associated with LID. Specifically, information on the factors that contribute to cost savings or cost increases of LID relative to conventional controls.

- Economic studies of LID and conventional methods that control for the effectiveness of the techniques regarding managing stormwater volumes and improving water quality. Comparing LID techniques that cost more to install than conventional methods, but control larger amounts of stormwater, is an apples-to-oranges comparison.

- The large majority of economic studies of LID methods apply to new construction. More research is needed on the economic outcomes of including LID methods in urban redevelopment projects.

- Some preliminary evidence exists that LID can help control CSO volumes at a lower cost than conventional controls. Stormwater managers and public-policy decisionmakers would benefit from additional economic research on this topic.

- Economic studies that model theoretical LID and conventional controls, while informative, may be less convincing to some stormwater managers, decisionmakers and ratepayer stakeholders than retrospective studies of installed controls.

BIBLIOGRAPHY

American Forests. 2000-2006. *Urban Ecosystem Analysis*. Retrieved August 2, 2007, from http://www.americanforests.org/resources/urbanforests/analysis.php

Bachand, P.A.M. 2002. *Considerations of Costs and Benefits for Various Wetland Types on Treasure Island*. LSA Associates and the Treasure Islands Wetlands Project. April. Retrieved October 26, 2007, from http://www.lib.berkeley.edu/WRCA/bayfund/pdfs/01_17Considerations.pdf

Beezhold, M.T. and D.W. Baker. 2006. *Rain to Recreation: Making the Case for a Stormwater Capital Recovery Fee*. Presented at the WEFTEC.06 Conference in Dallas, TX. October 22. Retrieved October 26, 2007, from http://www.environmental-expert.com/resultEachArticlePDF.aspx?cid=5306&idmainpage=70&level=2&codi=11741

Bisco Werner, J.E., J. Raser, T.J. Chandler, and M. O'Gorman. 2001. *Trees Mean Business: A Study of the Economic Impacts of Trees and Forests in the Commercial Districts of New York City and New Jersey*. New York, NY: Trees New York and Trees New Jersey. September. Retrieved October 26, 2007, from http://www.treesny.com/eisreport.pdf

Boardman, A.E., D.H. Greenberg, A.R. Vining, and D.L. Weimer. 2001. *Cost-Benefit Analysis: Concepts and Practice,* 2nd ed. Upper Saddle River, NJ: Prentice Hall, Inc.

Booth, D.B., B. Visitacion, and A.C. Steinemann. 2006. *Damages and Costs of Stormwater Runoff in the Puget Sound Region*. Summary Report. Puget Sound Action Team and the University of Washington, The Water Center. August 30. Retrieved October 26, 2007, from http://www.psat.wa.gov/Programs/stormwater/SummaryReportPSATstormwaterFoundation_FINAL_08-30-06.pdf

Braden, J.B. and D.M. Johnston. 2004. "Downstream Economic Benefits from Storm-Water Management." *Journal of Water Resources Planning and Management* 130 (6): 498-505.

Brewer, K. and H. Fisher. 2004. *Successfully Developing a Low-Impact Design Ordinance*. Presented at the Low Impact Development 2004 Conference in College Park, Maryland. Prince George's County, MD and the Anacostia Watershed Toxics Alliance. September 21-23. Retrieved October 26, 2007, from http://www.mwcog.org/environment/LIDconference/downloads/Final LID Conference Program_091504.pdf

Brown, W. and T. Schueler. 1997. *The Economics of Stormwater BMPs in the Mid-Atlantic Region*. Final Report. Center for Watershed Protection and Chesapeake Research Consortium. August. Retrieved October 26, 2007, from http://www.cwp.org/Downloads/ELC_swbmp.pdf

California Department of Transportation, Division of Environmental Analysis, Office of Water Quality. 2005. *Water Quality News Flash.* Nos. 05-10 and 05-11. March 7 and March 14. Retrieved November 7, 2007, from http://www.dot.ca.gov/hq/env/stormwater/publicat/newsflash/3_07_05.pdf and http://www.dot.ca.gov/hq/env/stormwater/publicat/newsflash/3_14_05.pdf

Center for Watershed Protection. 1998. *Better Site Design: A Handbook for Changing Development Rules in Your Community*. Ellicott City, MD: Center for Watershed Protection. August.

Center for Watershed Protection. 1998b. *Nutrient Loading from Conventional and Innovative Site Development*. Chesapeake Research Consortium. July. Retrieved October 26, 2007, from http://cwp.org.master.com/texis/master/search/+/form/nutrient.html

Center for Watershed Protection. 2001. *The Economic Benefits of Protecting Virginia's Streams, Lakes, and Wetlands and The Economic Benefits of Better Site Design in Virginia*. Virginia Department of Conservation and Recreation. December. Retrieved October 26, 2007, from http://www.dcr.virginia.gov/soil_&_water/documents/swmecon.pdf

CH2MHill, Inc. 2001. *Pierce County Low Impact Development Study*. Final Report. Pierce County, Washington. April 11. Retrieved October 26, 2007, from http://piercecountywa.gov/xml/services/home/environ/water/CIP/LID/final-lid-report.pdf

Clar, M. 2004. *Pembroke Woods: Lessons Learned in the Design and Construction of an LID Subdivision*. Presented at the Low Impact Development 2004 Conference in College Park, MD. Prince George's County, MD and the Anacostia Watershed Toxics Alliance. September 21-23. Retrieved October 26, 2007, from http://www.mwcog.org/environment/LIDconference/downloads/Final LID Conference Program_091504.pdf

Coffman, L.S. 2002. "Low Impact Development: Smart Technology for Clean Water - Definitions, Issues, Roadblocks, and Next Steps." In E.W. Strecker and W.C. Huber, eds., *Urban Drainage 2002: Global Solutions for Urban Drainage, 9th International Conference on Urban Drainage*. American Society of Civil Engineers.

Conservation Research Institute. 2005. *Changing Cost Perceptions: An Analysis of Conservation Development*. Prepared for the Illinois Conservation Foundation and Chicago Wilderness. February. Retrieved October 26, 2007, from http://www.cdfinc.com/CDF_Resources/Cost Analysis - Part 1 - Report - with Exec Summary.pdf

Croote, T. 1999. *Cost-Benefit Analysis of EPA Regulations: An Overview*. CRS Report for Congress No. RL30326. September 16. Retrieved November 7, 2007, from http://www.cnie.org/nle/CRSreports/risk/rsk-42.cfm.

Devinny, J.S., S. Kamieniecki, and M. Stenstrom. 2005. *Alternative Approaches to Stormwater Quality Control*. University of Southern California, Center for Sustainable Cities and the Los Angeles Regional Water Quality Control Board. August. Retrieved October 26, 2007, from http://www.usc.edu/dept/geography/ESPE/documents/publication_stormwater.pdf

Doran, S. and D. Cannon. 2006. *Cost-Benefit Analysis of Urban Stormwater Retrofits and Stream Daylighting Using Low Impact Development Technologies*. Presented at the WEFTEC.06 Conference in Dallas, TX. October 22. Retrieved October 26, 2007, from http://www.environmental-expert.com/resultEachArticlePDF.aspx?cid=5306&idmainpage=0&level=0&codi=11743

England, G. 2002. "Low-Impact Development Revisited." *Stormwater* 3 (1). Retrieved October 26, 2007, from http://www.mswmanagement.com/sw_0201_low.html

Field, B.C. and M.K. Field. 2006. *Environmental Economics: An Introduction,* 4th ed. New York, NY: McGraw-Hill/Irwin.

Fine, J.D. 2002. *The Economic Benefits of Treasure Island Wetlands*. LSA Associates and the Treasure Islands Wetlands Project. April. Retrieved October 26, 2007, from http://www.lib.berkeley.edu/WRCA/bayfund/pdfs/01_17EconomicBenefits.pdf

Foss, A. 2005. "Low Impact Development: An Alternative Approach to Site Design." *PAS Memo*: May/June. Retrieved October 26, 2007, from http://www.pathnet.org/si.asp?id=1592

Freeman, A.M., III. 2003. *The Measurement of Environmental and Resource Values: Theory and Methods,* 2nd ed. Washington, D.C.: RFF Press.

Getter, K.L. and D.B. Rowe. 2006. "The Role of Extensive Green Roofs in Sustainable Development." *HortScience* 41(5): 1276-1285.

Gordon, P., J. Kuprenas, J.-J. Lee, J.E. Moore, H.W. Richardson, and C. Williamson. 2002. *An Economic Impact Evaluation of Proposed Storm Water Treatment for Los Angeles County*. University of Southern California, School of Engineering and School of Policy, Planning, and Development. November.

Gramlich, E.M. 1990. *A Guide to Benefit-Cost Analysis,* 2nd ed. Long Grove, IL: Waveland Press, Inc.

Harberger, A.C. and G.P. Jenkins, eds. 2002. *Cost-Benefit Analysis*. Vol. 152. The International Library of Critical Writings in Economics. Northampton, MA: Edward Elgar Publishing, Inc.

Horner, R.R., H. Lim, and S.J. Burges. 2004. *Hydrologic Monitoring of the Seattle Ultra-Urban Stormwater Management Projects: Summary of the 2000-2003 Water Years*. Water Resource Series. Technical Report No. 181. Seattle, WA: University of Washington, Department of Civil and Environmental Engineering. October. Retrieved October 26, 2007, from http://www.seattle.gov/util/stellent/groups/public/@spu/@esb/documents/webcontent/spu01_002597.pdf

Hume, G.C. and S.M. Comfort. 2004. *Low Impact Development Cost Comparison: Pierce County, Washington*. AHBL Inc. and Washington State University Cooperative Extension, Pierce County. June.

Johnston, D.M., J.B. Braden, and T.H. Price. 2006. "Downstream Economic Benefits of Conservation Development." *Journal of Water Resources Planning and Management* 132 (1): 35-43.

Kaufman, M.M. and M. Wurtz. 1997. "Hydraulic and Economic Benefits of Downspout Diversion." *Journal of the American Water Resources Association* 33 (2): 491-497.

Kloss, C. and C. Calarusse. 2006. *Rooftops to Rivers: Green Strategies for Controlling Stormwater and Combined Sewer Overflows*. Natural Resources Defense Council, Low Impact Development Center, and University of Maryland School of Public Policy. June. Retrieved October 26, 2007, from http://www.nrdc.org/water/pollution/rooftops/rooftops.pdf

Kolstad, C.D. 2000. *Environmental Economics*. New York, NY: Oxford University Press.

Lacy, J. 1990. *An Examination of Market Appreciation for Clustered Housing with Permanent Open Space*. University of Massachusetts, Amherst, Department of Landscape Architecture and Regional Planning. Retrieved October 26, 2007, from http://www.umass.edu/larp/crm/Lacy/LacyMarket.html

Lehner, P.H., G.P. Aponte Clark, D.M. Cameron, and A.G. Frank. 2001. *Stormwater Strategies: Community Responses to Runoff Pollution*. Natural Resources Defense Council. May. Retrieved October 26, 2007, from http://www.nrdc.org/water/pollution/storm/stoinx.asp

Lewis, K. 2006. *The Role of EPA Region 10 in Smart Growth and Low Impact Development Planning and Implementation in the Puget Sound Region*. Master's Thesis. University of Washington, Daniel J. Evans School of Public Affairs. June 8. Retrieved October 26, 2007, from http://evans.washington.edu/research/psclinic/pdf/05-06/Lewis_DP_final.pdf

Liptan, T. and C.K. Brown. 1996. *A Cost Comparison of Conventional and Water Quality-Based Stormwater Designs*. Portland, OR: City of Portland, Bureau of Environmental Services and Woodward-Clyde Consultants.

Mohamed, R. 2006. "The Economics of Conservation Subdivisions: Price Premiums, Improvement Costs and Absorption Rates." *Urban Affairs Review* 41 (3): 376-399.

Montalto, F. 2007. *LID Hydrologic Performance Modeling*. Letter to Basil B. Seggos, Chief Investigator, Riverkeeper, Inc. from Montalto, F., President, eDesign Dynamics. March 5. Retrieved May 4, 2007, from http://riverkeeper.org/document.php/552/eDesign_Source_.pdf

NAHB Research Center Inc. 2003. *The Practice of Low Impact Development*. U.S. Department of Housing and Urban Development, Office of Policy Development and Research. July. Retrieved May 4, 2007, from http://www.huduser.org/Publications/PDF/practLowImpctDevel.pdf

Otto, B., K. Ransel, J. Todd et al. 2002. *Paving Our Way to Water Shortages: How Sprawl Aggravates the Effects of Drought*. American Rivers, Natural Resources Defense Council, and Smart Growth America. August. Retrieved November 7, 2007, from http://www.americanrivers.org/site/PageServer?pagename=AMR_content_e926

Partnership for Advancing Technology in Housing (PATH). 2005. *Low-Impact Development in the Madera Community, Gainesville, Florida*. August. Retrieved August 23, 2007, from http://www.pathnet.org/si.asp?id=1627

Plumb, M. and B. Seggos. 2007. *Sustainable Raindrops: Cleaning New York Harbor by Greening the Urban Landscape*. Riverkeeper. Retrieved May 3, 2007, from http://riverkeeper.org/special/Sustainable_Raindrops_FINAL_2007-03-15.pdf

Powell, L.M., E.S. Rohr, M.E. Canes et al. 2005. *Low-Impact Development Strategies and Tools for Local Governments: Building a Business Case*. Report No. LID50T1. LMI Government Consulting. September.

Sample, D.J., J.P. Heaney, L.T. Wright et al. 2003. "Costs of Best Management Practices and Associated Land for Urban Stormwater Control." *Journal of Water Resources Planning and Management* 129 (1): 59-68.

Strassler, E., J. Pritts, and K. Strellec. 1999. *Chapter 6: Costs and Benefits of Storm Water BMPs*. Preliminary Data Summary of Urban Stormwater Best Management Practices. EPA Report No. EPA-821-R-99-012. Washington D.C.: U.S. Environmental Protection Agency, Office of Water. August. Retrieved May 10, 2007, from http://www.epa.gov/waterscience/guide/stormwater/files/usw_d.pdf

Thurston, H.W., H.C. Goddard, D. Sziag, and B. Lemberg. 2003. "Controlling Storm-Water Runoff with Tradable Allowances for Impervious Surfaces." *Journal of Water Resources Planning and Management* 129 (5): 409-418.

Tilley, S. 2003. *Natural Approaches to Stormwater Management: Low Impact Development in Puget Sound*. Puget Sound Action Team. March. Retrieved August 2, 2007, from http://www.psat.wa.gov/Publications/LID_studies/lid_natural_approaches.pdf

U.S. Department of Defense. 2004. *Unified Facilities Criteria - Design: Low Impact Development Manual*. Unified Facilities Criteria No. 3-210-10. U.S. Army Corps of Engineers, Naval Facilities Engineering Command, and Air Force Civil Engineering Support Agency. October 25. Retrieved May 4, 2007, from http://www.wbdg.org/ccb/DOD/UFC/ufc_3_210_10.pdf

U.S. Environmental Protection Agency. 2005. *Low-Impact Development Pays Off*. Nonpoint Source News-Notes. No. 75. May. Retrieved August 23, 2007, from http://www.epa.gov/NewsNotes/issue75/75issue.pdf

U.S. Environmental Protection Agency and Low-Impact Development Center. 2000. *Low Impact Development (LID): A Literature Review*. EPA Document No. EPA-841-B-00-005. October. Retrieved May 3, 2007, from http://www.epa.gov/owow/nps/lid/lid.pdf

U.S. Office of Management and Budget. 2000. *Guidelines to Standardize Measures of Costs and Benefits and the Format of Accounting Statements*. M-00-08. March 22. Retrieved September 14, 2007, from http://www.whitehouse.gov/omb/memoranda/m00-08.pdf

U.S. Office of Management and Budget. 1992. *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*. Circular No. A-94 Revised. Memorandum for Heads of Executive Departments and Establishments (Transmittal Memo No. 64). October 29. Retrieved November 7, 2007, from http://www.whitehouse.gov/omb/circulars/a094/a094.html.

Vesely, E.-T., J. Heijs, C. Stumbles, and D. Kettle. 2005. *The Economics of Low Impact Stormwater Management in Practice – Glencourt Place*. Presented at the 4th South Pacific Stormwater Conference on Stormwater and Aquatic Resource Protection in Auckland, New Zealand. NZ Water and Wastes Association. May 4-6, 2005. Retrieved May 3, 2007, from http://www.landcareresearch.co.nz/research/built/liudd/documents/Vesely_et_al_2005.pdf

Zickler, L. 2004. "Low-Impact Development Comes to Pierce County." *Seattle Daily Journal of Commerce* July 29. Retrieved August 2, 2007, from http://www.djc.com/news/en/11159535.html

Zielinski, J. 2000. "The Benefits of Better Site Design in Commercial Development." *Watershed Protection Techniques* 3 (2): 647-656.

APPENDIX: ADDITIONAL LOW-IMPACT DEVELOPMENT RESOURCES

Chesapeake Bay Program and Virginia Tech Institute for Innovative Governance. 2002. *Proceedings of Three Workshops on Impediments to Low Impact Development and Environmental Sensitive Design*. STAC Publication No. 02-003. December. Retrieved October 26, 2007, from http://www.chesapeake.org/stac/Pubs/ILIDFinalReport.pdf

Dreher, D.W. and T.H. Price. 1997. *Reducing the Impacts of Urban Runoff: The Advantages of Alternative Site Design Approaches*. Chicago, IL: Northeastern Illinois Planning Commission and the Illinois Environmental Protection Agency, Division of Water Pollution and Control. April.

Hager, M.C. 2003. "Low-Impact Development: Lot-level Approaches to Stormwater Management are Gaining Ground." *Stormwater* 4 (1): 15. Retrieved October 26, 2007, from http://www.forester.net/sw_0301_low.html

Horsley Witten Group. *Low-Impact Development Case Study: Pinehills, Plymouth, MA*. Massachusetts Executive Office of Environmental Affairs. Retrieved October 26, 2007, from http://www.mass.gov/envir/lid/pdf/smartgrowth_pinehills.pdf

Kollin, C. 2006. "How Green Infrastructure Measures Up to Structural Stormwater Services." *Stormwater* 7 (5). Retrieved October 26, 2007, from http://www.forester.net/sw_0607_how.html

Low Impact Development Center. No Date. *Low Impact Development (LID) Urban Design Tools*. Retrieved October 26, 2007, from http://www.lid-stormwater.net/intro/sitemap.htm

Low Impact Development Center. 2005. *Low Impact Development for Big Box Retailers*. U.S. Environmental Protection Agency, Office of Water. November. Retrieved October 26, 2007, from http://www.lowimpactdevelopment.org/bigbox/lid%20articles/bigbox_final_doc.pdf

Price George's County, Maryland, Department of Environmental Resources, Programs and Planning Division. 1999. *Low-Impact Development Design Strategies: An Integrated Approach.* June. Retrieved November 14, 2007, from http://www.epa.gov/OWOW/nps/lidnatl.pdf

Puget Sound Action Team. 2000. *Local Government Low Impact Development Ordinances and Regulations.* Retrieved November 14, 2007, from http://www.psat.wa.gov/Programs/LID/LID_ordinances.htm

Van Roon, M. 2005. "Emerging Approaches to Urban Ecosystem Management: The Potential of Low Impact Urban Design and Development Approaches." *Journal of Environmental Assessment Policy and Management* 7 (1): 125-148.

Weinstein, N. 2002. "Low Impact Development Retrofit Approach for Urban Areas." In *Proceedings of the Seventh Biennial Stormwater Research & Water Management Conference*. Brooksville, FL: Southwest Florida Water Management District. May. Pp. 98-104. Retrieved March 21, 2007, from http://www.swfwmd.state.fl.us/documents/publications/7thconference_proceedings.pdf

A Project report:

Las Virgenes Creek Restoration Project

Healing a Stream

By: Alex Farassati, Ph.D.
Calabasas Environmental Services Supervisor

Along Las Virgenes Creek in Calabasas, California, passer bys now have a better chance of spotting a deer or turtle rather than trash or graffiti along its banks. The artery within the Malibu Watershed was recently liberated from its concrete shell--installed over three decades ago as a flood control measure-and will once again serve as a habitat-friendly haven for wildlife in the middle of a bustling urban pocket.

Before **After**

Since the 1950s, the Los Angeles basin's natural waterways adjacent to developments have regularly been converted to cemented flood control channels to allow for rapid water removal (and the potential for fatal accidents when someone falls in during heavy rains). Urban planners are now realizing that this development practice greatly impacts a stream's natural duties.

In 1977, approximately 440 linear feet of Las Virgenes Creek between Highway 101 and the Agoura Road Bridge was lined with concrete, severely disrupting the wildlife corridor and removing all viable riparian habitats from this once thriving natural creek segment. Cemented-in flood channels have zero habitat value, no water cleansing and generate thermal pollution. The concrete channel removed vegetation and disturbed the creek's natural meander through the landscape.

The Malibu Creek Watershed provides habitats for the southern most documented continuous annual steelhead trout run of the West Coast. In addition to steelhead trout, the watershed provides habitat for arroyo chub, southwestern pond turtle, California slender salamander, California newt, Arroyo toad, Pacific tree frog, American goldfinches, black phoebes, warbling vireos, song sparrows, belted kingfishers, raccoons, ring tailed cats, wrentits, bushtits, California towhees, California thrashers, bobcats, western fence lizards, rattlesnakes, various raptors, coyotes and mountain lions.

This project was identified as a high priority project in the Calabasas Creeks Master Plan and Las Virgenes Gateway Master Plan. It had a regional impact on policy for urban stream restoration in the Santa Monica Mountains.

Concrete Channel built in 1977

The City of Calabasas was successful in securing $1.3 million from the California Coastal Commission California Water Resource Control Board, California Department of Water Resources and Office of Los Angeles County Supervisor for the design and construction of the project. This is the first reach of concrete channel to be targeted for removal in this creek, leading the way toward the future vision of restoring and/or stabilizing the entire length of the Las Virgenes Creek.

Project Objectives

Historically, the Los Angeles basin had many streams that were buried instead of being ecologically engineered into neighborhood design. Natural streams can be brought back and future development should preserve present ones. In 1985, California established an Urban Streams Restoration Program to assist communities with restoring these waterways back to environmental function as well as flood control. While northern California has been taking advantage of the program since its inception, southern California has been slow to participate. The City of Calabasas (located just north of City of Los Angeles) was first in Southern California to accomplish a restoration, which was 10 years in the planning. Since it was a new concept for all the parties involved, the City had no guidelines to follow and spent several years studying the project from every angle--the bioengineering, the ecology, the public safety, and the aesthetics.

As a result of the Creeks Master Plan, the City of Calabasas commissioned a feasibility study to consider alternatives to the existing concrete trapezoidal channel that would facilitate wildlife movement and provide native riparian habitat. The *Feasibility Study for Removal of Concrete Lining in Las Virgenes Creek near Agoura Road* completed in February 2000, concluded that either a gabion structure or concrete block revetment liner would be feasible alternatives to the existing concrete. The City felt this concept was not appropriate and commissioned a second study to re-evaluate the restoration potential. In 2003, Questa Engineering Corp. an Oakland based environmental engineering firm, completed a detailed *Feasibility Study* that under went a public and stakeholder review process, culminating in a City Council approved conceptual design.

The main objective of the restoration was to restore a native creek side habitat, enhance the biological environment, plant native vegetation, and display the importance of environmental stewardship to the community's youth through the addition of an educational gazebo. In addition to providing more native habitat in the region, this project was a high priority for watershed protection because it will help heal some habitat fragmentation in the area.

All objectives of this project are consistent with goals and direction of the Malibu Creek Watershed agencies, nonprofits, and environmentalist. If successful, other interested agencies will be encouraged to restore their own channelized creek segments. This shared vision and opportunity to work incrementally toward full stream restoration from ocean to headwaters will be realized throughout the watershed.

Extensive Feasibility Study

The potential design options were examined considering both technical and practical constraints. The technical analysis and discussion of the design considerations was presented in the report titled: *Preliminary Design and Feasibility Analysis for Restoration, Las Virgenes Creek, Calabasas, California* by Questa Engineering Corporation. This report examined existing geomorphic conditions, located existing utilities, identified right-of-constraints and thoroughly examined several potentially feasible options for concrete channel removal.

The *Feasibility Study* presented the results of Questa Engineering's investigation and analysis of the biologic, geomorphic, and hydraulic conditions within the Las Virgenes Creek Channel in the City of Calabasas, California. The purpose of this study was to gain an understanding of Las Virgenes Creek's channel processes and to determine what factors may lead to a successful restoration strategy.

The design process involved public workshops and design charrettes, City council presentations, and regulatory agency meetings to confirm project design direction and refine the project to achieve a balance between creating functional riparian habitat while still meeting the needs of the community, providing flood control, and ensuring the safety of public infrastructure. The Report provided valuable information and guidance as follows:

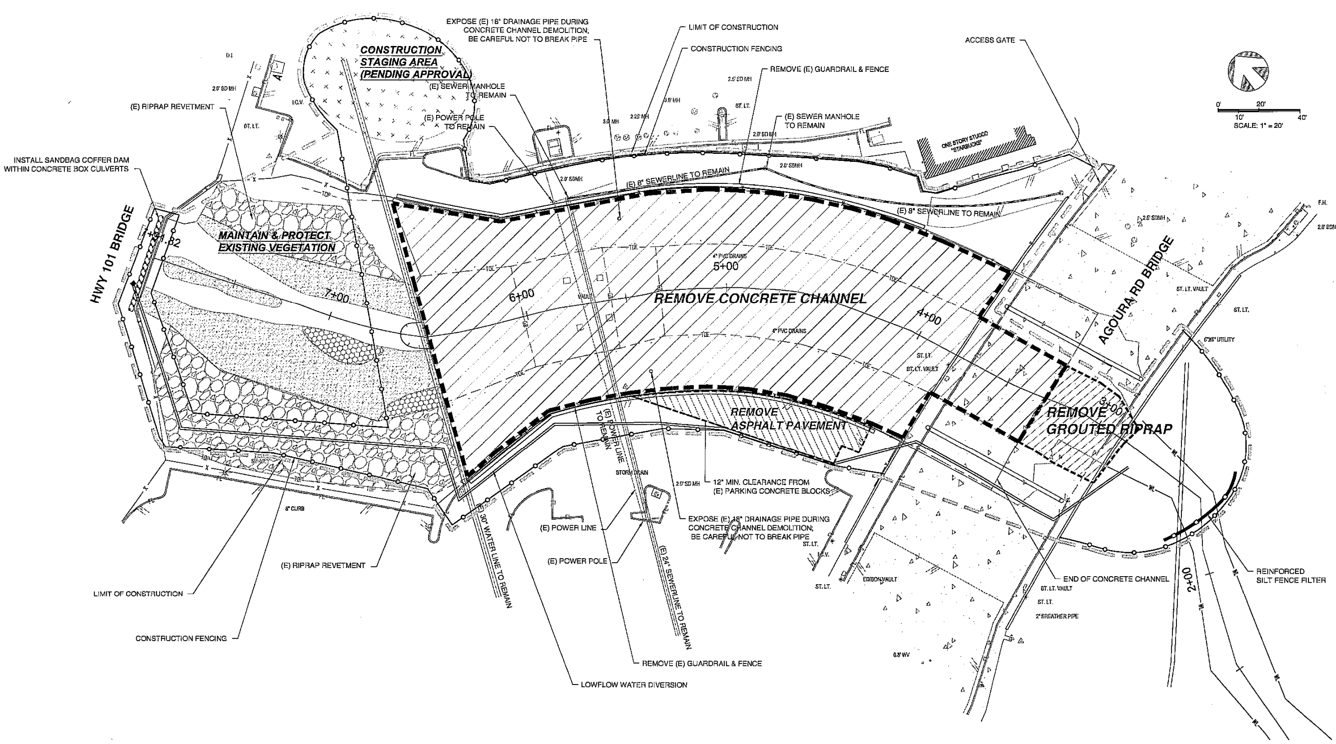
- It described the constraints and realities of urban stream restoration such as existing infrastructure and utility issues,
- A biological database search was conducted for any special status wildlife and plant species within the area,

- The geomorphic analysis examined the existing fluvial geomorphology and adjacent channel geometry parameters to determine appropriate restoration design strategies,
- A detailed topographic survey of the site was completed,
- Hydraulic computer models were developed to quantify existing flow conditions and test various project design alternatives,
- As built drawings of existing facilities, bridge abutments, and utility lines were attained and considered in the design,
- Fish passage conditions and design considerations were discussed and incorporated into analysis.

Additional follow up studies included geotechnical investigations to determine soil properties and detailed engineering design. Compiling all the baseline information and analysis, the report discussed the objectives of the restoration and the potential components of a restoration plan. Finally, the *Feasibility Study* outlined a preferred restoration strategy by combining individual project components to achieve project objectives.

Innovative and Harmonious Design

The final restoration design was based on the approved concept and provided an integrated resources approach that would provide useful riparian habitat while still meeting the flood control requirements through this creek segment. It was chosen from alternatives developed through hydraulic computer models that quantified existing flow conditions. The design of the habitat element of the project was supported through a biological database search for any special status wildlife and plant species within the area. Some important design elements were as follows:



a) Wildlife Protection

The Las Virgenes Creek once provided refuge and a safe passage for wildlife to travel between the Ventura County Open Space and the Malibu Creek State Park. This restoration would re-establish direct connectivity between these two existing riparian communities to the north and south of the concreted segment. The restoration would afford better cover for local wildlife and promotes increased movement of animals and aquatic wildlife up and down the stream course.

b) Public Outreach and Education

The restoration would be used to educate the public regarding urban watershed issues. The project includes a gazebo overlook that would be a public interface with story boards educating visitors about water resource issues and to increase awareness of watershed protection issues and water conservation practices designed to reduce local residential and commercial use of potable water. Messages regarding the importance of water conservation, information on local water use reduction programs and litter prevention was included on the educational panels.

c) Footpath and Trail Connection

The restoration design included a footpath to encourage pedestrian and bike access to the future creek-side park. The establishment of the proposed footpath is part of a larger Trails Master Plan envisioned by the Region and incorporated in the City's General Plan. Easements for the proposed footpath had already been obtained and became part of the Las Virgenes Creek trail that will run northward from Malibu Creek State Park along Las Virgenes Creek, intersecting and following for a short distance the Calabasas-Cold Creek Trail, then continuing north into Las Virgenes Canyon to the upper limits of the Creek in Ventura County.

d) Water Quality Enhancement

This project will restore the biological ecosystem of the Creek by integrating habitat restoration with water quality and public education. It will enhance the water quality of the creek by constructing a vegetated habitat with canopy to deflect the sunlight to reduce dissolved oxygen in the daytime, thereby drastically reducing algal blooms for which this segment has been listed under the Clean Water Act Section 303(d). The planting of native vegetation will partially restore the riparian habitat and tree canopy required for native habitat and ecosystems for wildlife to flourish and travel.

e) Environmentally Harmonious Channel

There are numerous locations throughout this region where flood control agencies have channelized natural stream courses. However, more than 3,600 square yards of concrete was removed from this segment of the creek while recreating the flood control facility in an environmentally harmonious fashion that will undo the wildlife corridor fragmentation, provide essential riparian habitat, protect fish passage, and still provide adequate flood control protection within the confines of the engineered channel that existed there. The success of Las Virgenes Creek Restoration will encourage other interested agencies to restore their own channelized creek segments as well.

Economic Benefits

Investment in public goods like environmental quality can generate very valuable returns, even if they are difficult to measure. Quality of life benefits enjoyed by residents from creek restoration are commonly called non-market goods, because there is no purchase price for them, but they do hold value. The importance of natural amenities and stewardship on homebuyers' location decisions and on young professionals' location decisions should not be underestimated. In fact, many studies have shown that natural and cultural quality of life amenities are increasingly important factors in firm location decisions, particularly for the knowledge-based industries of the New Economy *(Salvesen and Renski, 2002)*. The authors specifically address the unique opportunity for cities in semi-rural regions to attract firms by offering cultural amenities while retaining natural amenities such as clean air, environmental quality, recreation opportunities, and community attitude. As Calabasas works to attract businesses and retain educated young professionals, demonstrating interest in protecting its natural amenities will distinguish it from other cities. Local economic benefits from Las Virgenes Creek restoration can be estimated in three main categories:

A. Local Economic Benefits

They are generated when restoration costs are paid by State restoration funds that circulate as local wages and purchases. Combined with spending planned for the next few years, this project will generate economic benefits to local businesses and residents. Typically, a dollar spent in creek restoration circulates in the local economy approximately 1.28 times—this is called the *multiplier*. The size of multiplier varies depending on location and nature of the economic activity in question. Benefits estimated based on expenditures should be compared with potential benefits forgone from alternative expenditure options.

B. Property Value Boom

Many studies have examined the relationship between environmental restoration and increased property values. Riparian property owners could conservatively expect an immediate increase in property values, generating increased local tax revenues as well. People like to be near water and are willing to pay more to be near water--as "riverfront" real estate often demonstrate. Parks that are improved with naturalization projects also draw more people, which can benefit near-by businesses. Studies can predict how property values would improve after restoration based on similar housing markets near pristine streams or lakes. Research can also follow changes in property values throughout the restoration process, tracking actual improvements. Given experiences of urban stream restoration in other cities, the restored creek could become a property value boom.

C. Sustainable Neighborhood

Benefits accrue to the local economy and to government budgets from future damages that are avoided by restoring the creek. These benefits can include reduced health care costs, reduced infrastructure expansion costs, and sustainable neighborhood development patterns. Some of these benefits will accrue to community residents experiencing an improved quality of life from increased opportunities for passive enjoyment of a restored creek.

To more fully analyze this and all categories of benefits, Las Virgenes creek restoration and naturalization should be considered within a comprehensive and integrated analysis of relevant county and municipal growth and development. Inter-agency development planning can reduce future costs and conflict, advance public private partnerships, and leverage complementary funding sources. This restoration project resolved flood control issues and provided recreational opportunities to the Community.

Achieving the Goal with Limited Budget

Several environmental agencies supported creek restoration efforts, believing it will improve water quality and provide vital resources particularly in the Southern California's arid climate. The State Water Resource Control Board, California Coastal Conservancy, the Department of Water Resources and Office the Los Angeles County Supervisor assisted City of Calabasas with the funding from public bonds through voter-approved propositions directed at the enhancement of the state's diminishing natural areas.

The project design process involved extensive regulatory agency review. This project had been reviewed and permitted by the California Department of Fish and Game, California State Regional Water Quality Control Board, the US Fish and Wildlife Service, the US Army Corps of Engineers and County of Los Angeles Public Works Department and Los Angeles County Flood Control District.

After the design was completed, the cost estimates to implement the project was much more than what initially was assumed. City staff spent thousands of hours to solicit funding from various local and state agencies. Each successful funding commitment was used as match for another funding opportunity, until 90% of the project cost was secured. The other 10% was matched by city either as staff time and construction management. The Project was short listed as one of the 14 priority projects within the County of Los Angeles, as part of the Integrated Regional Water Management Plan (IRWMP).

It was once thought that concrete protected creeks and streams by sending flood water quickly downstream and away from homes and businesses. Now we understand that without trees and shrubs on the banks and stones and rocks in the streambed to slow it down, water flows through these concrete channels so quickly it can cause erosion downstream. And when a stream bank washes away, it takes with it soil and vegetation, which can cause land along to the bank to destabilize and eventually be lost. With this and other restoration projects, communities are starting to realize that these natural waterways should not be turned into sewers. They have multi-objective significance. The project achieved its primary goal: to heal and enhance this part of the natural landscape for ourselves and future generations to enjoy.

Mr. Chris Hooke, vice president of the Ventura Chapter of APWA presenting the Project of the Year Award to the Mayor of Calabasas during the grand opening dedication ceremony.

Construction Phase

1. Construction Management

The project began on July 27th, 2007 and was completed on schedule by December 18th, 2007. The construction management was critical during this project. Due to the sensitive nature of the project, there needed to be clear and open lines of communication between the City, the design engineer, and the contractor to ensure timely completion of the project, and to resolve field issues before they became costly contract change orders.

The design engineer, Syd Temple of Questa Engineering, worked closely with the contractor, Robert Valdez of Olivas Valdez Inc., during the construction to literally make sure that every rock was in the right place. The exact placement of the rock was critical to the long term stability of the channel. The intent of the design was to replace the concrete channel with a rock lattice. This consisted of a parallel trench dug on both side of the channel, filled with larger boulders, and 5 rock weirs that cut across the channel connecting to the parallel trenches. The rock locks together in a box like structure to keep soil erosion to a minimum. It was vital that the rock in the weir be placed at exact angles so that the force of the falling water would be focused in the center of the channel creating scour ponds. The force of the falling water would churn up the loose soil and thereby keep the ponds from filling up with sediment.

In addition, it was imperative that the coordination between the City Project Manager and the contractor was expedited due to the project starting later in the season. Any issue that might delay construction could have pushed the timeline of the project back and caused the contractor to be working in the channel during the rainy season, which would have created substantial permit issues with Army Corp of Engineers and Department of Fish and Game. City staff worked hard to review and approve all submittals in a timely manner to help the contractor to stay on schedule.

At the same time, City staff worked closely with the design engineer to respond quickly to any design changes that were required in the field. An example of this was a cut off wall that was to be installed under the bridge. The original design called for a cast in place concrete wall to protect the center bridge footing. However, the contractor encountered unforeseen poor soil conditions which made the existing design extremely difficult to construct. The result was a field design change that was implemented within a day. The solution called for grouted riprap to be used instead of the concrete wall. This field change maintained the original design concept and expedited construction.

2. Safety

The project is located next to a busy shopping center with a food court and several commercial office buildings. Based on this, there is a fair amount of both automotive and pedestrian traffic. The main entrance to the site is located just 20 ft from a heavily used driveway entrance, and maintaining normal traffic flow was crucial to the adjacent businesses. Public safety was a primary concern in the pre-construction stages of this project. The contractor performed a careful review of the traffic control plan and devised a system that when truck traffic was leaving the site, a flagman would be used to stop traffic and all pedestrian traffic would be escorted past the site entrance.

In addition to the safety measures, the contractor installed security fencing along the perimeter of the project to secure the site and protect the existing vegetation.

The contractor was very safety conscious. He required his workers to wear safety vests, hard hats and protective gear at all times. However, despite the most vigilant approach to safety, accidents do still occur. In order to remove debris from the channel, a 2 step process was utilized. The lower excavator would place debris in a pile that the upper excavator would then place in the dump truck. In an effort to access some debris, the veteran operator maneuvered too close the back of his platform, lost his stability and rolled the excavator. Fortunately, no one was injured except for some bruised pride.

3. Community Relations

Community relations were a very important element of this project. The project site was bracketed by a busy shopping center on one side, a densely packed office park, and several single family residences nearby, each with a unique concern about the project. City staff consulted with all the local businesses impacted by the project to gage their individual concerns and to create a direct line of communication with the City Project Manager.

On the shopping center side of the project the businesses were concerned that noise and dust from the demolition would create an unpleasant environment for customers. For example, a Starbuck's coffee shop is located just a few feet from the project, and has open terrace seating that overlooks one of the two project access points. The businesses at the other entrance to the job site had similar concerns as well as concerns regarding construction vehicles taking up space in an already crowded parking lot.

To mitigate this, the contractor approached the City with a proposal to do all the channel demolition work in the early morning hours. This was done to protect the workers due to the summer heat and to keep the disruption to the business to a minimum. However, due to the fact that several single family residences were located nearby, this idea was not feasible. This resulted in the contractor working normal construction hours. The parking lane on the bridge was closed to allow for construction parking, and water was used extensively to keep the dust to a minimum. Since the demolition was being performed at a lower elevation than the surrounding populated areas, channel noise was directed upward and was not a nuisance to the surrounding businesses.

On the other side of the channel adjacent to the office park, there was concern, as well. Their employee parking was already tight and the contractor would need access to the parking lot to construct a flood wall. This would involve taking up to 20 parking spaces to create a staging area for equipment. The contractor, City staff, and the property management company for the office park worked together to come to an agreement that would allow the contractor a limited amount of time in which he could access the property and construct the wall.

Despite some initial hesitation by some of the businesses, the strong coordination efforts by the City and the contractor with the businesses paid off, and the City did not receive a single complaint from the adjacent businesses or citizens.

Additional community outreach was implemented through the use of the City's television public access channel which covered the construction extensively and broadcast routine reports on the progress. A local newspaper, The Acorn, published series of articles on the project. City staff received several phone calls from various students requesting information on the project for their own project reports about the creek. Other cities have contacted City staff to inquire how a similar project could be done in their city.

4. Environmental Protection and Awareness

The long term goal of this project is to help restore the creek and generate awareness of the importance of protecting natural open space. A large sign was posted on the bridge crossing the project site and another facing the shopping center informing the public of the project and its purpose. This project also required some protective measures of its own. Netting was placed on the bridge to prevent swallows from nesting and eliminating a problem with the machinery disrupting the birds. The contractor made every effort to minimize the trampling of vegetation by placing security fencing and using established trails when venturing into the wooded creek areas.

Sediment control in the creek and leaving the job site was a very important issue. A water shed of 12 square miles creates flows in the channel all year long. In order for the channel to be demolished and reconstructed, the stream water needed to be captured and then pumped downstream. To achieve this, a settling pond and silt fences were constructed to allow any suspended particles to be deposited so as to not affect water quality downstream. In addition, the contractor would sweep the street after each truck that left the site, and took pride in the fact that he left the job site cleaner than they found it.

5. Unusual and adverse conditions

There were a few noteworthy events that occurred within the project site. The first is that despite the project only being 440 feet long, there are three utility lines that run through the project site. At the upstream end of the project there is a water and wastewater main located under the creek, and a power line runs over it. The water main is located just above the limits of the concrete channel. However, the wastewater main ran under a concrete portion of the channel. The contractor took special care not to damage the sewer when removing the concrete channel lining over the top of it.

After the concrete removal the sewer line was inspected and it suffered no damage. Fortunately, the power pole was located on the bank and due to its elevation was not at risk of being hit by the excavators that were working in the channel. However, one of the power poles did hamper debris removal because it forced the dump trucks to have to use the downstream entrance, which exited directly onto a busy road.

An additional construction challenge was that the contractor was faced with the constant presence of water. Due to the upcoming rainy season the contractor was required to be out of the channel bottom by October 15th. However, Mother Nature doesn't always follow a tight schedule. On Saturday September 22nd the Calabasas area receive a surprise rainstorm. The water shed area upstream is approximately 12 square miles, and the rain water quickly overwhelmed the diversion dam and spilled out on to the bare dirt channel. This resulted in construction being halted for three days while the construction area dried out.

Another source of water is the two drain outlets that feed into the channel. The outlet on the east side of the channel was connected to the parking lot of the shopping center. The shopping center would irrigate extensively at night and all the excess water would run into the channel. The contractor would arrive at the job site every morning to find a muddy mess. A solution was conceived to make use of all the excess water. The contractor used it as temporary irrigation water.

The design called for a five foot trench to be dug on both sides on the channel parallel to the sides for the entire length of the channel. This trench would be filled with large two to four ton boulders that would keep the channel from wandering due to stream bed erosion. Once the boulders were placed, willow stakes were placed around the boulders, followed by smaller rock and finally dirt in a process called “chinking”. In order for the willows to root they needed to be watered. The contractor blocked the outlet on the east side and placed a 4 inch diameter corrugated pipe in the outlet and channeled the water into the pipe. The contractor ran the pipe along the top of the slope above the willow stakes and then perforated the pipe at regular intervals which allowed the water too slowly leak into the trench and keep the willow stakes wet. Thus we managed to utilize all of the wasted water coming from the shopping center parking lot.

The water table was incredibly high on this project. In fact, the only thing keeping the water from surfacing was a two foot thick layer of gravel that was laid down during the initial construction of the channel. Any water that was not captured by the diversionary dam was using the gravel layer as a French drain to make its way downstream. Once the contractor had disturbed this gravel bed, the water surfaced, and created a serious problem at the downstream end of the construction site where it turned the soil conditions to mud. However, it created an opportunity to employ a little ingenuity and value engineering.

The design called for a concrete cut off wall to be constructed. Due the muddy conditions, this was proving to be very tough. As a result, City staff and the design engineer and came up with a quick and inexpensive design change. The cut off wall design was to be replaced with a grouted riprap. As it turned out the concrete apron under the bridge was not structural but rather ascetics. It was placed to continue the uniform look of the channel.

Design Engineer:	Sydney Temple, Questa Engineering Corp., Pt. Richmond, CA.
Project Manager:	Alex Farassati (City of Calabasas, CA)
Construction Managers:	Larry Edmonson, Todd Evans (City of Calabasas, CA)
Contractor:	Olivas Valdez, Inc. , Covina, CA.

Making Progress:
Restoration of the

Malibu Creek Watershed

Santa Monica Bay Restoration Project
Malibu Creek Watershed Executive Advisory Council

Final Report
January, 2001

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MALIBU CREEK WATERSHED

Introduction

The 109 mi^2 Malibu Creek watershed is the second largest subwatershed within the larger 414 mi^2 Santa Monica Bay watershed. It provides a wide variety of habitats for countless species (marine, animal and plant) and has long been a popular place for surfers, hikers and other outdoor enthusiasts. Surfrider Beach, famous for its surfing break and visited by 1.2 million people annually, is one of the most popular tourist destinations in the area. The watershed is also home to two federally listed endangered species – the tidewater goby and steelhead trout. As one of the few remaining coastal wetlands in Southern California, Malibu Lagoon is a critical stop-over for migrating birds along the Pacific flyway.

While open space predominates the region, residential and light commercial land uses, orchards, pastures, crops, natural areas and golf courses account for approximately 19% of the area. The watershed encompasses unincorporated portions of Ventura[1] and Los Angeles Counties, and seven cities -- Malibu, Calabasas, Agoura Hills, Thousand Oaks and Westlake Village and small portions of Simi Valley and Hidden Hills. Combined, these communities are home to more than 90,000 residents. Population growth within this region increased at a significant rate during the 1980s (10%), but slowed somewhat during the 1990s (2%). The current growth trend is expected to continue (see Figure 1).

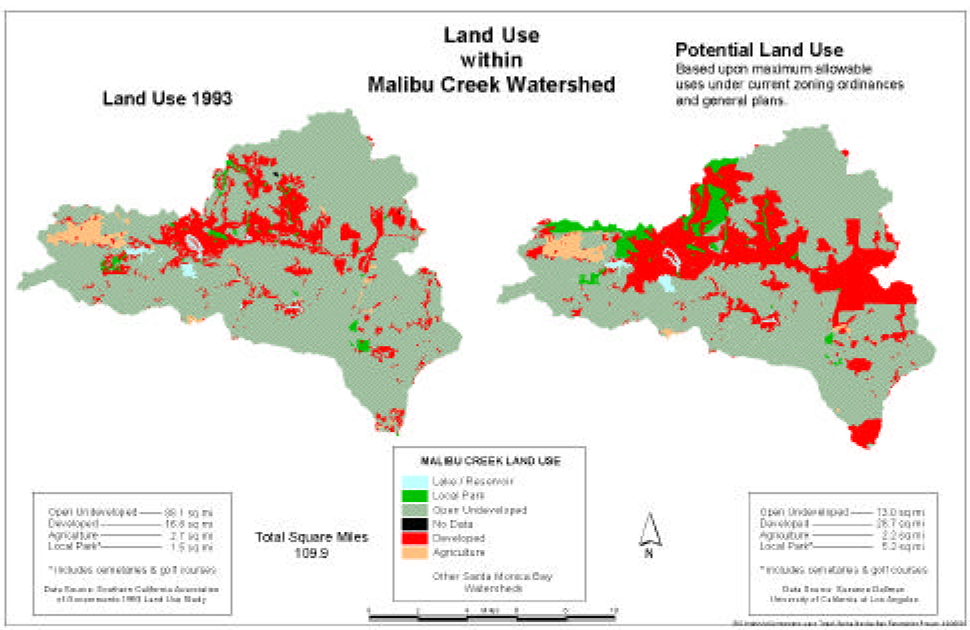

Figure 1. Past and projected land uses in the Malibu Creek Watershed.

[1] Ventura's unincorporated communities include Oak Park, Lake Sherwood and Hidden Valley.

In 1995, the Santa Monica Bay Restoration Project (SMBRP) completed the *Bay Restoration Plan* (BRP) which, among other elements, included a draft action plan for the Malibu Creek Watershed (MCW). The *Malibu Creek Watershed Natural Resource Plan*, released soon afterward by the Natural Resources Conservation Service, addressed watershed resources, water quality and quantity issues, and pollution reduction strategies. It also contained an appendix of 44 action items which paralleled the actions identified in the BRP.

A partial view of the Malibu Creek Watershed and the Pacific Ocean.

These 44 actions, consolidated down from an original list of 111 actions, were developed and agreed upon by watershed stakeholders through a consensus approach organized by the SMBRP. These 44 actions now provide the framework of guiding principles for restoration of the Malibu Creek watershed and comprise the Bay Restoration Plan's Malibu Creek Watershed Action Plan. They focus on six key areas of concern:

- Overall water quality and quantity
- Malibu Lagoon and surfzone
- Solid wastes and other wastes
- Land use
- Habitat protection and restoration
- Coordination and outreach

The entire process undertaken to guide restoration activities in the Malibu Creek watershed served as a subwatershed "pilot program" for Santa Monica Bay and could also serve as a model for other watersheds considering similar efforts. Key elements of this model include convening a stakeholder group, reaching consensus on the issues through stakeholder involvement, identifying the most significant pollutants of concern impacting the watershed's habitats and resources, developing restoration/protection management options, securing funding and ultimately, taking action.

The following report highlights the successes and challenges of this pilot program over the past six years, although some elements began before 1994. It contains four sections:

- ***Section One: Overview***, highlights the structure of stakeholder involvement in the watershed and provides brief summaries on: 1) sources of impairments to water quality, 2) other problematic issues, 3) human health risks and habitat degradation and 4) watershed studies and projects.

- ***Section Two: Action Plan Updat****e*, provides an in-depth update and assessment of the Natural Resource Plan's 44 action items (BRP actions).
- ***Section Three: Key Findings,*** summarizes the key findings of the data presented in Section Two.

- ***Section Four: Moving Forward - Watershed Restoration Priorities***, addresses future restoration priorities and objectives.

Implementation and Oversight Structure

The Malibu Creek Watershed Advisory Board, now called the Executive Advisory Council, was established in the early 1990s to address watershed pollution and restoration issues. Members of the Council include representatives of several local and state agencies, five municipalities, various other organizations and stakeholders, and the public at large (see Table 1.1). Throughout its tenure, the role of this Council has been to oversee, instigate and implement both upper and lower watershed restoration activities. More specifically, the group's role has been to:

- Call attention to watershed service opportunities (including grants, studies, pilot demonstration projects, partnerships, events, etc.);
- Promote/implement watershed protection and restoration projects;
- Help secure funding opportunities such as Proposition A bond funds and US EPA/State 205(j) grants and 319(h)[2]; and
- Oversee subcommittee activities (subcommittees identified below);
- Serve as an information sharing and clearinghouse outlet.

Malibu Creek Watershed Executive Advisory Council

Army Corp of Engineers
CA Coastal Commission
CA Department of Fish and Game
CA Department of Parks and Recreation
CA State Coastal Conservancy
CalTrout
City of Agoura Hills
City of Calabasas
City of Malibu
City of Thousand Oaks
City of Westlake Village
Heal the Bay
Las Virgenes Municipal Water District
Los Angeles County Department of Public Works
Los Angeles County Fire Department
Los Angeles County 3rd Supervisoral District
Los Angeles Regional Water Quality Control Board
Malibu Land Coastal Conservancy
Malibu Surfrider/Surfrider Foundation
National Parks Service/Santa Monica Mountains National Recreation Area
Natural Resources Defense Council
Resource Conservation District of the Santa Monica Mountains
Santa Monica Bay Restoration Project
Santa Monica Bay Audubon Society
Santa Monica Mountains Conservancy
Sierra Club
Triunfo Sanitation District
US Environmental Protection Agency
Ventura County
Watershed Community Residents/Stakeholders

* Active members, those organizations with consistent representation at stakeholder meetings, are bolded.

Table 1.1. Malibu Creek Watershed Executive Advisory Council.

The committee is also a Watershed Implementation Committee that advises the Bay Watershed Council on matters pertinent to this watershed.

To better focus on key watershed issues and to help carry out the mission of the Executive Advisory Council, eight subcommittees have been formed. These subcommittees report back to the Council about their activities/progress during the Council's regularly scheduled bi-monthly meetings.

1. Volunteer Water Quality Monitoring Task Force

The role of this subcommittee is to encourage volunteers to become involved in water quality and habitat monitoring activities. They meet every other month to discuss the latest methods and techniques for providing high quality, reliable data that can be used by stakeholders and decision-makers. The task

[2] US Environmental Protection Agency (EPA)/State grants are provided for water quality planning and implementation activities, respectively.

force has developed a volunteer monitoring program called "*The Stream Team,"* which is now coordinated by Heal the Bay (a local environmental organization), to assess the health of and impacts to stream reaches throughout the watershed**.** Currently, three volunteer groups are monitoring over 16 fixed locations throughout the watershed.

2. ***Steelhead Recovery Task Force***
   Originally called the "Rindge Dam" subcommittee, this group's focus has shifted from simply addressing the feasibility of removing Rindge Dam to now looking at all potential/existing barriers impeding steelhead migration to the upper reaches of Malibu, Topanga, Solstice and Arroyo Sequit creeks and their tributary streams.

3. ***Human Health***
   The role of this sub-committee is to identify and reduce health risks in the watershed, specifically those associated with recreational use of the creek, lagoon and surfzone. Most recently, they helped design a portion of the Coastal Conservancy/ UCLA study[3] which addressed pathogens.

   [This committee's membership overlaps with the *Monitoring and Modeling* and *Lower Malibu Creek and Lagoon Task Force* subcommittees and its activities have been scaled down somewhat as a result.]

4. ***Monitoring and Modeling Sub-committee***
   The role of this subcommittee is to design, coordinate and oversee monitoring efforts in the watershed. In April 1999, the subcommittee released the draft *Malibu Creek Watershed Monitoring Program* which has the primary objective of "collecting data and information on pollutants and other problems that impair the formally designated beneficial uses of Malibu Creek and its tributary streams." The report was reviewed by the SMBRP's Technical Advisory Committee and funds are now being sought to implement the plan.

5. ***Lower Malibu Creek and Lagoon Task Force***
   The role of the Lower Malibu Creek and Lagoon Task Force has been to: 1) oversee lagoon monitoring and restoration efforts, 2) address the impacts of high water levels, breaching and septic system influences to the lower creek and lagoon and 3) serve as the review committee for the long-awaited Coastal Conservancy/UCLA study. Following the release of the report, the committee has started the process of selecting which creek/lagoon management options to pursue and implement.

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[3] *Lower Malibu Creek and Barrier Lagoon System Resource Enhancement and Management.* Draft Final Report. California State Coastal Conservancy and UCLA, February 1999.

6. ***Invasive Species Task Force***
The Invasive Species Task Force was established in the later part of 1999 and its mission is to identify, assess and initiate removal of invasive plant and animal species in the watershed. Because many exotics are discovered through the efforts of other task forces, members of this task force work closely with them. The group has prioritized two actions: 1) to consult with the Los Angeles County Agriculture Commissioner about making Los Angeles County a “weed management zone” to become eligible for funding, and 2) to contact the Los Angeles County Department of Public Works about eliminating weeds in soil stockpile areas.

7. ***Flow Reduction Task Force***
The Flow Reduction Task Force was formed during the Winter 1999/00. Initial meetings have addressed developing a mission statement and set of goals. The focus of the task force will be on reducing stream flows into impacted streams within the watershed and on reducing residential/community demands for imported water through conservation.

8. ***Education Task Force***
This Task Force was formed in January 2000. At their first scheduled meeting, members began development of a mission statement, goals and a future plan of action. The primary focus of the Task Force will be on educating local residents and stakeholders about the restoration and preservation activities occurring in the Malibu Creek Watershed.

Watershed Impairments and Problematic Issues

The 1994 Water Quality Control Plan (i.e., the Basin Plan) developed by the Los Angeles Regional Water Quality Control Board (LARWQCB or Regional Board) identifies the entire Malibu coastline and Malibu Canyon and Lagoon as “Significant Ecological Areas” (SEAs), and documents 19 existing, intermittent and potential “Beneficial Uses” within the Malibu Creek watershed. However, various causes of impairments (Table 1.2) to this watershed threaten both its SEAs and beneficial uses. Some of the causes are well documented in several publications, including: 1) the Soil Conservation Service’s *1995 Malibu Creek Watershed Natural Resources Plan*, 2) the Regional Board’s *1997 Santa Monica Bay: State of the Watershed* report and *1994 Water Quality Control Plan*, and 3) the Coastal Conservancy’s *1999 Lower Malibu Creek and Barrier Lagoon System Resource Enhancement and Management* report.

Watershed Impairments
Urbanization and Development
Sedimentation and Erosion
Invasive Species
Nutrients
Pathogens and Bacteria
Excess Flows
Problematic Issues
Land Acquisition
Shortfalls in Funding
Inspections and Enforcement

Table 1.2. Watershed impairments and other problematic issues.

Watershed impairments, such as urban runoff, excess nutrients, pathogens and bacteria, sedimentation and erosion, invasive species, and excess freshwater flows adversely affect habitats, endangered species and human health. A quick summary of these impairments and the issues associated with them are provided here.

Urbanization and Development

As mentioned in the introduction, Malibu Creek watershed's population is growing at a significant rate (as much as 2 percent/year). This rapid growth is concurrent with development activities which contribute pollutant loads (heavy metals, nutrients, bacteria, trash and other inorganic compounds) through contaminated urban runoff, household waste, animal waste, on-site sewage disposal system discharges, illegal dumping and pesticide use. It also leads to greater demand for imported water, resulting in increased subsurface and creek flows and elevated groundwater tables, and ultimately impacting Malibu Lagoon and surfzone.

Sedimentation and Erosion

Much of the Malibu Creek watershed's soils are considered highly erodible. Increased dry weather flows, unstable streambanks, fires, construction sites not properly maintained and poorly-graded hillsides all contribute to the watershed's existing sedimentation and erosion problems. Brush clearing practices and roadside maintenance activities where dirt and debris are left on the side of the road and/or up-slope of creeks also increase sediment loads to receiving waters. These sources eventually reach the lower creek and lagoon and can adversely impact species and spawning grounds sensitive to high turbidity. Sediments also transport particle-binding pollutants, which in turn can affect many of the watersheds habitats and organisms. During seasonal high flow conditions (primarily during the rainy season), the impacts of sedimentation and erosion are especially pronounced.

Invasive Species

Both non-native plant and animal species in the Malibu Creek watershed have the potential to severely disrupt the natural ecosystem. The presence of non-native species can also be indicators of poor ecosystem health and represent competition for natural resources with native species.

The most significant non-native plant species include the giant reed, castor bean and wild tree tobacco (see Table 2.4 on page 67 for a more complete list of exotic plant species). The most significant non-native aquatic species include the western mosquito fish, yellowfin goby, oriental shrimp and polychaete worms.[4] Bullfrogs, crayfish and large-mouthed bass are also problematic and can be detrimental to southwestern pond turtles, California newts (both considered

[4] *Lower Malibu Creek and Barrier Lagoon System Resource Enhancement and Management*. Draft Final Report. California State Coastal Conservancy/UCLA, February 1999.

special species of concern in California) and Arroyo Chub.

Nutrients

Nutrient entering Malibu Creek watershed's lakes, creeks and streams stem from a variety of point and nonpoint sources including animal waste, surface and groundwater flows, storm drain discharges, septic systems and Tapia Treatment Plant discharges.   An overabundance of nutrients from these sources contributes to eutrophication problems in the watershed. Although evidence of eutrophication, specifically low dissolved oxygen and algal mats, is observed in some areas of Malibu Lagoon (Ambrose, et.al., 1999), the Las Virgenes Municipal Water District's (LVMWD or the District) monthly water quality data suggest a significant downward trend in the amount of nutrients present in the watershed's creeks and streams over the past ten years. Although little data has been collected on the watershed's upstream lakes and some reaches of Medea Creek, they also show signs nuisance algae and have been listed on the Regional Board's list of impaired waterbodies.

Pathogens and Bacteria

The presence of pathogens and bacteria in the watershed's creeks, lagoon and surfzone is a significant human health concern. These pollutants come from sources such as:

- Septic systems:[5] Systems not properly maintained and leach fields without adequate filter materials and distance are potential contributors of bacteria and pathogens to groundwater, creeks and the lagoon and surfzone.

- The Tapia Water Reclamation Facility: This facility, jointly owned by the Las Virgenes Municipal Water District and Triunfo Sanitation District, is located adjacent to Malibu Creek approximately 4.5 miles upstream from Malibu Lagoon. This facility treats municipal wastewater primarily from the cities and unincorporated areas of the upper watershed. Tapia has a processing capacity of 16 million gallons per day (mgd), but currently operates at 9 mgd. The tertiary-treated wastewater generated from this facility is either recycled or discharged into the creek, depending on the time of year, demand and/or other circumstances. Concerns have been raised for many years about both the quality and quantity of Tapia's effluent and its impact on the Malibu Creek, Lagoon and surfzone.

- Animal waste: Livestock manure and domestic pet waste not properly disposed of can mix with storm water and/or urban runoff and eventually find its way to the watershed's waterbodies.

[5] The total contribution of pathogens and nutrients from lower watershed septic systems to nearby receiving waters has not been conclusively determined. However, studies are in progress to assess the impacts, if any, septics have on Lower Malibu Creek and Lagoon.

Excess Flows

About 18,000 acre-feet of water is imported into the Malibu Creek watershed each year. Ultimately, this imported water contributes to higher groundwater tables, increased creek flows, more frequent lagoon breaching events and greater volumes of polluted urban runoff entering storm drains and local waterbodies.

Land Acquisition

Much of the undeveloped land (other than parklands) in the Malibu Creek watershed is privately owned and has the potential to be developed. Acquisition of such properties could increase existing wetlands, protect riparian corridors, preserve open space and provide for greater protection of the watershed's sensitive species.

Shortfalls in Funding

Achieving long term restoration, protection and management goals depends, to a large extent, on the availability of funds to carry out these activities. While a significant amount of funding has been secured for watershed activities (Table 1.3, starting on Page 12), much more is needed to accomplish the goals outlined in the Malibu Creek Watershed Plan.

Inspections and Enforcement

Historically, inspections and enforcement activities have not been a priority among key agencies. However, there are a whole host of enforcement activities that, if aggressively conducted, could improve water quality in the watershed. Examples include: 1) routinely monitoring construction sites to ensure that pollution prevention BMPs are properly implemented; 2) periodically inspecting/monitoring septic systems to ensure that they function properly; 3) identifying and prohibiting illicit connections to the storm drain system; and 4) enforcing local ordinances. Enforcement agencies having local authority include the CA Department of Fish and Game, CA Regional Water Quality Control Board, Los Angeles County Department of Health Services and all watershed municipalities.

Effects on Human Health and Habitats

Human Health Impacts

Pathogens and viruses from septic systems, animal waste and polluted runoff all contribute to exceedances of water quality standards and affect the health of swimmers and surfers in Malibu Lagoon and the adjacent surfzone. This area consistently receive bad grades due poor water quality, and signs are posted much of the year warning swimmers about the health risks associated with recreating in these polluted waters.

Habitat Impacts

The pollutants and other causes of impairments listed above impact the Malibu Creek watershed's habitats and resources in a variety of ways. Non-native plant species displace and/or out-compete native species. Imported water demands disrupt the natural ecosystem, ultimately causing high lagoon water levels and contributing to unnatural lagoon breaches (although the long-term effect of this is not fully known[6]). Construction barriers impede native aquatic species abilities to reach upstream habitats and spawning grounds. And, increased pollutant loadings degrade water quality by lowering dissolved oxygen levels, contaminating sediments with heavy metals and other toxins, and increasing turbidity and nuisance algae.

Watershed Studies and Projects

Table 1.3, starting on page 12, highlights key projects, stakeholder groups and partnerships (e.g., the Executive Advisory Council and its sub-committees) who have been instrumental in applying for and securing grant funds for restoration activities throughout the watershed. Specifically, the table highlights 17 Malibu Creek watershed projects that have been successfully implemented, conducted or started over the past eight years. It also showcases: 1) the partnerships vital to successful implementation of restoration activities, 2) the funds that were leveraged or secured ($4+ million), and 3) the variety and types of projects undertaken in both the upper and lower watershed. For example: alternative wastewater discharge options have been studied; streambanks and other sensitive habitats have been restored and/or constructed; endangered species have been reintroduced; pathogen sources have been evaluated; livestock BMPs have been developed/promoted; and water conservation is being addressed.

Additionally, **Section Four: Moving Forward with Restoration Priorities** identifies the *Top 10 Restoration Priorities in the Watershed* as well as a complete list of recommended projects that are considered high priorities for implementation, but in which little or no progress has been made to date. While some actions lack the necessary funds and/or data to be successfully carried out, others are just now becoming priorities in the watershed. In the coming years, they will no doubt become the focus of the Executive Advisory Council's restoration and preservation efforts.

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[6] Two independent studies conducted six years apart actually show a slight increase in the biodiversity in Malibu Lagoon despite several dozen intervening breaching events. These studies include 1) *Malibu Lagoon: A Baseline Ecological Survey*. Resource Conservation District of the Santa Monica Mountains, 1989 and 2) *Enhanced Environmental Monitoring Program at Malibu Lagoon and Malibu Creek*, UCLA, 1995.

Table 1.3. Key watershed projects, studies, stakeholders and partnerships in the Malibu Creek watershed.

Malibu Creek Watershed Restoration Projects/Studies	Funding Source & Amount	
STUDIES AND ASSESSMENTS		
Malibu Creek Discharge Avoidance Study **Timeline:** November, 1997 –January, 2000 **Lead**: LVMWD **Summary**: Assessment of all possible options for disposing of the tertiary-treated wastewater generated by the Tapia treatment plant.	LVMWD	$850,000
Lower Malibu Creek and Barrier Lagoon System Resource Enhancement and Management **Timeline:** August, 1997 - March, 1999 **Lead:** CSCC/MCW Lagoon Task Force (study conducted by UCLA.) **Summary**: Assessment of the lower Malibu Creek watershed and lagoon, and compilation of management alternatives for implementing restoration, protection and management activities.	CSCC EPA LVMWD SMBRP/F	$100,000 $100,000 $46,000 $30,000
Effects of Sand Breaching the Sand Barrier on Biota at Malibu Lagoon **Timeline:** November, 1996 - Current **Lead**: RCDSMM **Summary**: Survey of birds and fish, and monitoring of water quality parameters (ammonia, nitrates, phosphates, DO, turbidity, water temperature, pH, salinity and lagoon water levels).	CalTrans	$47,000
Septic Tracer Study (The "Dye" Study) **Timeline:** August, 1998 - February, 1999 **Lead**: City of Malibu **Summary**: Phase I: Evaluation of the fate transport of pathogens from septic system effluent at one test site (Cross Creek Shopping Center) to groundwater and Malibu Creek and Lagoon. Phase II: Investigation of the potential for septic contamination from residential and commercial properties in the Malibu Civic Center area, near the creek, lagoon and surfzone.	EPA 319(h) Malibu	$60,000 Contribution not calculated
Evaluation of Rindge Dam For Removal **Timeline:** 1999 - Current **Lead**: Steelhead Recovery Task Force, Army Corps of Engineers, State Parks **Summary:** The Army Corp of Engineers conducted a reconnaissance study to determine the level of support among watershed stakeholders in removing Rindge Dam. Based on their findings, they have made plans to conduct a feasibility study on the various alternatives for removing the dam. Currently, they are looking for a funding source to start the study.	Army Corp of Engineers	Staff Time

Table 1.3. Cont'd.

Water Conservation Study **Timeline:** 1997-98 **Lead:** LVMWD and American Water Works Association Research Foundation **Summary:** Implementation of the North American Residential End Use Study, which installed data loggers in 100 homes to gather detailed information on water use. Data is being used to set national standards on appliance efficiency and conservation program planning. The study confirmed toilet flushing as the largest indoor use and provided data on incidence of leaks.	LVMWD AWWARF	$15,000 $421,000
Septic Systems in Malibu **Timeline:** June 1998 **-** January, 1999 **Lead:** Heal the Bay **Summary:** Estimation of the number of multi-family and commercial septic systems located in the Lower Malibu Creek watershed. Heal the Bay estimates that there are 390 multi-family and commercial septic systems in this area, many of which have not been permitted by the Regional Board. A summary of recommended actions is included in the accompanying report.	Heal the Bay	Staff Time Interns
Framework for Monitoring Enhancement and Action for the Malibu Creek Watershed **Timeline:** January – June, 1998 **Lead:** Heal the Bay, CA State Coastal Conservancy and the Graduate Dept. of Landscape Architecture (CSU Pomona) **Summary:** Watershed assessment and design of a citizen volunteer monitoring program (Stream Team) that collects useable high-quality data that addresses specific issues in the Malibu Creek Watershed and fills data gaps for regional stakeholders. A 150-page easy-to-understand, step-by-step field guide was produced and is used by volunteers to conduct water chemistry and stream walk monitoring activities. The guide also contains educational information about natural processes, issues of concern and the history of urban development in the Malibu Creek watershed.	CSCC	$37,000
3 Endangered Species Protection Studies (Steelhead Trout) **Timeline:** See summaries **Lead:** LVMWD **1) Summary:** April 1998 – June 1999. Recording of temperature data at multiple stations in Malibu Creek for a period of one year and compilation of steelhead trout temperature requirements. The final report (which was submitted to the LARWQCB) found that temperature ranges, while slightly higher than optimal below Rindge Dam, are sufficient to support all states of steelhead trout. **2) Summary:** December, 1997. Compilation of data on the steelhead in Malibu Creek, including original research on steelhead genetics and the recommending of listing steelhead trout as a unique and endangered population. **3) Summary:** November, 1998. Water audit of riparian vegetation in Malibu Creek to determine the minimum flows necessary to sustain steelhead trout while minimizing inflows to the lagoon.	 LVMWD LVMWD LVMWD	 $10,000 $10,000 Staff time

Table 1.3. Cont'd.

HABITAT/SPECIES RESTORATION PROJECTS		
Tidewater Goby Reintroduction to Malibu Lagoon **Timeline:** April, 1991 **Lead**: RCDSMM; partnership with Heal the Bay **Summary**: Successful re-introduction of 54 tidewater gobies, a federally listed endangered species, into Malibu Lagoon. As many as 1500 gobies were counted in 1998.	State Parks	$23,000
Restoration of Malibu Lagoon Bird Peninsula and Mud Flats **Timeline:** Fall, 1995 - Spring, 1996 **Lead**: RCDSMM **Summary**: In partnership with CA Parks and Recreation, excavation of over 2,200 cubic yards of old fill material within the Lagoon; restoration of aquatic habitat, mud-flat habitat, and high storm flow refuge for the tidewater goby. Post project monitoring of fishes, water quality and invertebrates.	EPA Near Coastal Waters Program Grant CalTrans	$131,695 $30,000 (in-kind services)
Sediment Reduction and Streambank Stabilization – Las Virgenes Creek **Timeline:** 1996 - 1998 **Lead**: RCDSMM **Summary**: Stream bank restoration along 200-foot portion of Las Virgenes Creek to reduce sedimentation; 17,000 cubic yards excavated and new mild slope created along the north bank. Native species planted to prevent future erosion.	EPA 319(h) County of LA (Prop A)	$607,000 (including in-kind services)
DEMONSTRATION PROJECTS AND WATERSHED POLLUTION CONTROL PROGRAMS		
Constructed Wetlands **Timeline:** March, 1998 – Ongoing **Lead:** LVMWD **Summary:** Rehabilitation of an existing percolation pond (on State Parks property) as a constructed wetland to treat Tapia's effluent and to treat urban runoff from the upper watershed.	Prop A funds LVMWD	$260,000 $50,000

Table 1.3. Cont'd.

Livestock Waste Management Pilot Project **Timeline:** 1996 - 1999 **Lead**: RCDSMM **Summary**: The RCDSMM: 1) conducted an extensive research effort to identify all horse owners and corrals in the Malibu Creek watershed; 2) conducted a watershed-wide survey of horse owners to better understand their current management practices and needs 3) hosted a horse manure compost demonstration site; 4) created a video entitled "Horse Management Program." and 5) developed a Stable and Horse Management BMP manual to help reduce point and nonpoint source pollution from livestock waste.	EPA 319(h)	$84,000
Malibu Lagoon Water Level Management Project **Timeline:** September, 1999 - Current **Lead:** CA Department of Parks and Recreation **Summary:** Management of the water level in Malibu Lagoon and disinfection of the water prior to its release to the ocean. As planned, this project should ensure that the lagoon's sandbar remains closed during the dry season (May – October). A Request for Proposals was released by State Parks in September, 1999 seeking a consultant to design a method for water level management of the lagoon. The project should be completed by Summer, 2001.	Prop A funds	$1.2 Million
Urban Runoff Treatment Facilities at Malibu Lagoon **Timeline:** Completed June, 2000 **Lead**: City of Malibu **Summary**: The City of Malibu was awarded Prop A funds to install a Storm-ceptor **J** for the 24-inch Malibu Road Drain (commonly referred to as the Mystery Drain) which discharges directly into Malibu Lagoon. The storm ceptor is designed to remove grease, oil, trash and sediment. The City has also added a disinfection system (as a pilot project) to work in concert with the Storm-ceptor **J** to remove pathogens from the discharge.	Prop A funds Purizer Corp. City of Malibu	$60,000 $600,000 $70,000
Watershed-wide Monitoring Program **Timeline:** April 1999, ongoing **Lead:** Monitoring and Modeling Subcommittee **Summary:** Completion of a draft plan which calls for coordination of existing monitoring programs and addition of supplementary monitoring to create a comprehensive survey of the state of the Malibu Creek watershed.	LVMWD City of LA LAC-DPW Ventura Co EPA 205(j)	$18,000 Beach bacti stations Stream gage Stream gage Application

EPA 319(h) – Environmental Protection Agency Nonpoint Source Implementation grant program
EPA 205(j) - Water Quality Planning grant program
Proposition A funds - Los Angeles County grant funds for storm water control capital projects

SECTION II: ACTION PLAN UPDATE

In order to implement Malibu Creek watershed restoration activities in a more comprehensive and focused manner, in 1994 forty-four action item goals were developed by consensus through a one-year series of facilitated meetings with watershed stakeholders[7]; the process also included identifying implementors responsible for each of the 44 actions. Although no timelines were provided for these restoration activities, there has been and continues to be determination among watershed stakeholders to implement them as soon as technically feasible or financially possible.

This section of the Malibu Creek Watershed report provides complete status updates and assessments for implementation of the 44 actions. They have grouped by topic according to the Action Plan. (see Appendix One for a complete table of these actions).

Overall Water Quality and Quantity Goals

1. ***Protect Beneficial Uses*. Develop and set water quality objectives to prevent point and nonpoint pollutant sources and pathogens from adversely affecting the beneficial uses of the watershed and nearshore environments.**

   The Los Angeles Regional Water Quality Control Board (LARWQCB or Regional Board) is responsible for establishing water quality standards for all Los Angeles and Ventura County waterbodies, including those in the Malibu Creek watershed. The updated *Water Quality Control Plan* (or Basin Plan), prepared by the LARWQCB in 1994, is the guidance document that includes the beneficial use designations within the watershed. Specifically, the Plan:

   - Designates beneficial uses for surface and ground waters;
   - Sets narrative and numerical objectives that must be attained or maintained to protect the designated beneficial uses of and conform to the state's antidegredation policy;
   - Describes implementation programs to protect all waters in the Region; and
   - Incorporates (by reference) all applicable State and Regional Board plans and policies and other pertinent water quality policies and regulations.

[7] A complete summary of the mediation efforts that lead to the development of the Executive Advisory Council and the 44 Action Items can be found in the document, *Comprehensive Malibu Creek Watershed Mediation Effort, Final Report*. May, 1994.

The Basin Plan[8] identifies 19 existing, potential and/or intermittent beneficial use categories for waterbodies in the Malibu Creek watershed (see the 1994 Basin Plan for a complete list). The Plan also sets specific watershed water quality objectives for total dissolved solids (TDS), sulfate, chloride, boron and nitrogen, in addition to general county-wide water quality objectives (ammonia, bacteria, coliform, biochemical oxygen demand (BOD), chemical constituents, chlorine, nitrogen, oil and grease, etc.). The mechanisms used to achieve these water quality objectives include:

- Issuing permits (NPDES, WDRs)[9] with contaminant discharge limits to point source dischargers;
- Requiring cities to prevent/control polluted discharges through implementation of comprehensive urban runoff control programs and best management practices (BMPs) as called for in the 1996 Municipal Storm Water NPDES permit issued by the Los Angeles Regional Water Quality Control Board;
- Requiring cities to adopt local ordinances for the control of nonpoint sources of pollution within their jurisdictions;
- Adopting regional waste discharge requirements for residential septic systems;
- Conducting public education programs to prevent residential sources of pollution (this task is not carried out directly by the Regional Board but is required under the Municipal Storm Water permit).
- Enforcing the California Porter-Cologne Act and the Federal Clean Water Act by conducting routine inspections, issuing fines and/or "Cease and Desist" orders to offenders and requiring cleanup of contaminated sites.
- Initiation of Total Maximum Daily Loads (TMDLs) for pathogens and nutrients for Malibu Creek and Lagoon.
- Following eco-regional (site specific) nutrient criteria development as part of the US Presidential Clean Water Action Plan (http://www.cleanwater.gov/). Under this plan, EPA must develop criteria by 2001 and begin initiation of compliance by 2003.

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[8] The Basin Plan's legal authority is provided under the California Porter-Cologne Act.
[9] National Pollutant Discharge Elimination System (NPDES), Waste Discharge Requirements (WDRs)

2. ***Protect Recreation.*** **Ensure swimming, surfing and fishing without adverse health effects posed by poor water quality. Protect appropriate recreational opportunities such as surfing, swimming, sportfishing, sailing and hiking in the creek, lagoon and surf system as long as it doesn't impact other beneficial uses.**

This action is a goal rather than an actual action and its success is directly linked to the successful implementation of virtually every other action listed herein.

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3. ***Protect Ecosystem/Endangered Species.***

- **Enhance and protect lagoon, creek, beach and intertidal habitats for threatened and endangered species, native biodiversity and riparian habitat.**
- **Attain and maintain water and sediments of sufficient quality to support a healthy creek, lagoon and surfzone, taking into account interactive impacts.**
- **Prevent any increased input of substances in toxic concentrations into the watershed and surfzone.**
- **Reduce habitat degradation caused by road/bridge building encroachments and dumping of road materials, and adopt ordinances and watershed-wide joint powers agreements to do so.**

Many of the activities that must occur to accomplish the goals of this action are incorporated into the goals of other actions, in particular Eliminate or Reduce Sources (#4), Biological Standards (#5), Reduce Accelerated Sedimentation (#10), Temperature (#12), Restore/Enhance Malibu Lagoon and Surfzone (#20), Malibu Lagoon Bridge (#26), Runoff Reduction (#31), Habitat Protection (#33-38) and Coordinate on a Watershed Basis (#39).

Believed to have vanished from the area some time ago, the federally endangered red-legged frog was recently discovered on the Ahmanson Ranch development site in the northern portion of the Malibu Creek watershed. On that same property, a large patch of 40,000 San Fernando spine flowers was also discovered. Formerly, the flower was believed to be extinct since the 1920s. The fate of these two species is ultimately tied to how the development project proceeds, which, as of the date of this report, has not been determined.

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4. ***Eliminate or Reduce Sources.*** **Eliminate or reduce, by sub-watershed area, sources of harmful pathogens, toxic chemicals, sediments and nutrients.**

Pathogens, toxic chemicals, sediments and nutrients are transported to local waterbodies through groundwater, storm water and urban runoff flows. To help minimize the impacts of these pollutants, the County of Los Angeles and its 85 cities are required under the 1996 Municipal Storm Water NPDES permit[10] to control polluted runoff discharges within their jurisdictions. Since approval of this permit, all four Los Angeles County cities in the Malibu Creek Watershed have adopted local ordinances which clearly identify and prohibit activities specifically known to contribute pathogens, toxic chemicals, sedimentation and nutrients to local waterbodies. Such ordinances also give cities the legal authority to immediately enforce these prohibitions. Table 2.1 highlights the measures covered addressed in the local ordinances recently adopted by Malibu, Calabasas, Agoura Hills, Westlake Village and Thousand Oaks.

Storm Water Ordinance Measures
Illicit Connections and Discharges Prohibition against using, maintaining, or continuing any illicit connections to the municipal sewer system.
Littering Prohibition against littering of garbage, refuse, etc. (pollution) on streets, alleys, sidewalks, storm drains, public and private lands, lakes, streams, etc. within the city.
Storm Drain Discharge Prohibitions
• Landscape Debris
• Untreated wash water from gas stations, auto repair facilities, etc.
• Untreated wastewater from mobile car wash, carpet cleaning, steam cleaning, or other mobile service providers
• Wastewater from repair of machinery and equipment which are visibly leaking oil, fluids or antifreeze [to the maximum extent practicable (MEP)]
• Untreated runoff from storage areas containing oil grease and other hazardous materials
• Commercial/municipal swimming pool filter backwash
• Untreated runoff from washing toxic materials from paved or unpaved areas (some exclusions)
• Untreated runoff from washing impervious surfaces in industrial/commercial areas (MEP, some exclusions)
• Wastewater from concrete truck washing
• Runoff containing banned pesticides, fungicides or herbicides
• Disposal of hazardous waste into containers which causes or threatens to cause discharge to the storm drain
Good Housekeeping Provisions
• Prevent chemicals or septic waste from mixing with rain water which may enter city streets or storm drains
• Minimize runoff generated from irrigation
• Prevent machinery/equipment leaks, spills, etc. from mixing with storm runoff
• Regularly sweep parking lots with 25+ spaces to remove pollutants and debris (can consider other effective means)
• Do not discharge food waste to the storm drain system
• Implement BMPs to MEP for fuel and chemical waste, animal waste, garbage, batteries, etc.
Compliance with Industrial, Commercial and Construction NPDES

The County of Ventura and its Malibu Creek watershed communities have taken a similar approach those listed for Los Angeles County to eliminate sources of pollutants. These include: 1) adoption of local ordinances and the legal authority to enforce them; 2) implementation of public education programs; 3) inspections for all auto repair and food/restaurant facilities to ensure compliance; and 4) establishing guidelines for all new developments to incorporate permanent BMPs as part of their design. Calabasas has also installed a continuous

Because many of the storm water ordinance provisions were only recently adopted by these watershed cities, it will take several years

[10] The Municipal Storm Water NPDES Permit was issued by the Regional Water Quality Control Board in July, 1996.

before the water quality testing data collected can show trends in pollution reduction. Clearly, a comprehensive monitoring program is key to determining whether these measures are working.

Watershed cities also conduct public education programs to reduce point and nonpoint sources of pollution, which are addressed in Public Education (#42). And lastly, watershed efforts to reduce pathogens and nutrients are specifically addressed in Reduce Pathogens (#7), Reduce Nutrients (#9) and Septic Systems (#23).

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5. ***Biological Standards*. Establish viable minimum habitat standards to support native species of locality.**

A whole variety of fish, bird and plant species, some of which are state and/or federally listed as endangered or threatened, depend on healthy watershed resources for their survival. However, these species may have different or even competing needs to survive. For example, fluctuations in the lagoon's water level and regular tidal flushing are needed for birds to be able to access the mud flats, a situation which is achieved by routine breaching of the lagoon's sand berm. The tidewater goby, on the other hand, can be adversely affected by fluctuations in salinity resulting from a breach. Reconciling these needs makes establishing minimum habitat standards a difficult task.

The Coastal Conservancy/UCLA study, *Lower Malibu Creek and Barrier-Lagoon System Resource Enhancement and Management,*[11] evaluated minimum habitat standards in the lower creek and lagoon to better establish biological water quality objectives for several indicator species. The final draft of this report provided information about the physical tolerances of target species for parameters such as temperature, ammonia, pH, dissolved oxygen, nitrate, nitrite, sulfide chlorine and chloride. Two significant conclusions were drawn from Coastal Conservancy/UCLA's research: 1) different species, even desirable species, have quite different tolerances; and 2) while there is much water quality data available, there is little information available about the tolerances of most of the target species to the physical condition of concern.

Separately, the Las Virgenes Municipal Water District (LVMWD)

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[11] *Lower Malibu Creek and Barrier-Lagoon System Resource Enhancement and Management*. Draft Final Report. California State Coastal Conservancy/UCLA, February 1999.

conducted a water audit of riparian vegetation in Malibu Creek to determine the minimum flows necessary to sustain steelhead trout in the creek while at the same time minimizing inflows to the lagoon. It was determined that a minimum of 2-4 cubic feet per second (cfs) would be required at the County gauge station[12] to sustain the steelhead below Rindge Dam. This information was submitted to the National Marine Fisheries Service (NMFS) in 1998 for review. Historical evidence of drought years and groundwater flows and their effect on steelhead will also be considered by NMFS in its final determination of the minimum flow necessary to support steelhead trout.

The County of Los Angeles, Department of Public Works (LAC-DPW) and several other storm water dischargers have organized a regional storm water monitoring coalition whose goal is to establish a monitoring research agenda. Issues being discussed and considered for future research include the use of biological indicators to assess the health of inland and coastal waters in Southern California, and the feasibility of developing bio-criteria. (The coalition only *defines* areas of future research that might be undertaken by interested parties but does not actually conduct research itself.)

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6. ***Monitor Pathogens*. Use appropriate testing techniques to determine the presence of pathogens and test for compliance with established standards. Pathogen testing should be implemented when and where bacteria counts are high.**

Rather than testing directly for pathogens, local agencies routinely test for the presence of pathogens using bacterial indicators such as coliform. Their efforts are highlighted below. Testing for pathogens directly is difficult because there is no rapid method to reliably quantify their presence in water samples. However, direct pathogen testing using one of the methods available has occurred twice in Malibu Creek. These tests were conducted under two studies – the *Enhanced Environmental Monitoring Program at Malibu Lagoon and Malibu Creek* study conducted in 1993-94 by UCLA and the *Lower Malibu Creek and Barrier Lagoon System Resource Enhancement and Management* study conducted by the Coastal Conservancy and UCLA in 1998. It is foreseeable that pathogen testing will occur on a routine basis once methods to detect pathogens directly are improved.

[12] The County gauge station records stream flow velocities and collects samples for a variety of constituents in Malibu Creek just below the Tapia outfall and Piuma Road.

- During rain events, LAC-DPW samples for bacteria in storm water runoff near Piuma Road (as required under the 1996 Storm Water NPDES permit). The samples collected show that the amount of bacteria present in wet-weather flows are three to four magnitudes greater than the amount present in dry-weather flows. Since the sampling sites are in areas where there is no public contact, notifications are not made to the public. The monitoring results are, however, reported to the Los Angeles Regional Water Quality Control Board annually and available for public review.

- Since bacteria and pathogens represent a human health concern, the Los Angeles County Department of Health Services (DHS) conducts monitoring activities in unincorporated areas of the County and for any city that does not have its own health department. Where high bacteria counts are observed, DHS takes additional samples to identify the source(s) and closes beaches impacted by the discharge. If a source is identified, then enforcement action is taken by DHS or referred to the appropriate agency with legal jurisdiction (e.g., storm drain entry).

- In 1998, the City of Malibu initiated a septic system tracer study (the "dye" study) adjacent to lower Malibu Creek to determine to what extent, if any, septic systems may contribute pathogens to local receiving waters. In conjunction with the LARWQCB, Malibu then conducted an extensive water quality monitoring program within the creek, lagoon and beach area during the later half of 1999 to identify where septic systems may contribute pathogens and/or nutrients to the lagoon and surfzone. A more detailed update on these activities is provided under Septic Systems (#23).

- The City of Calabasas, through its Volunteer Water Quality Monitoring program, started monthly monitoring for total and fecal coliform in 1999 at six sites in Las Virgenes Creek. Although not currently publicized, the City does submit the monitoring information to the Regional Board and plans to make it available on their city website in the near future.

- Both the City of Los Angeles and the Las Virgenes Municipal Water District have considerable data (from weekly monitoring) on bacteria levels in Malibu Creek and the adjacent surfzone. In addition, LVMWD has funded several special studies which use advanced testing methods to detect the presence of pathogens and has pursued research into new detection methods through their industry research contacts. The District's efforts have resulted in initiation of new studies on available detection methods by the American Water Works Association Research Foundation and the Water Environment Federation.

- Since the Tapia plant began discharging its effluent into Malibu Creek, there have been concerns about its contribution to the presence of pathogens and viruses found in the lower creek and lagoon. LVMWD has monitored Tapia's effluent for more than 15 years and has funded and/or co-funded four independent studies on the quality of its effluent. These studies concluded that there is no significant risk of illness directly associated with Tapia's effluent.

- Several years ago, the SMBRP assisted the Los Angeles County Department of Public Works in testing a new sanitary survey tool to identify the presence of human fecal matter in storm water flows. The goal of the method was to determine whether there was evidence of human waste by extracting coprostanol[13] from storm water runoff samples through a separation process. The expected advantages to this approach were that: 1) identification of human fecal matter could be conducted in the field rather than the lab, and 2) the results would be available in hours rather than days.

  While preliminary lab tests supported the feasibility of this method, field testing proved more difficult. Results of the study showed that field samples did not correlate well to controlled lab samples. Additional drawbacks to this method are: 1) coprostanol testing is considered very expensive (as much as 10x more) when compared to standard bacterial testing, and 2) there is little understanding of the role or impact of other storm water pollutants on the coprostanol extraction process. A significant amount of additional testing will have to be conducted and the cost of conducting field testing will have to decrease considerably before this particular sanitary survey tool will be considered for use in the field.

Although not occurring in this watershed, another sanitary survey method is undergoing preliminary testing in San Diego using DNA identification of human fecal matter to detect pathogen presence. This approach could potentially be considered for use in the Malibu Creek Watershed if results are encouraging.

[13] Coprostanol is a type of sterol found in animal waste in unique ratios, depending on the animal (i.e., human ratios are distinct).

7. ***Reduce Pathogens*. Reduce human pathogen inputs into the watershed.**

Reducing pathogen loads is one of the premiere goals of the Malibu Creek Watershed Plan and it can be accomplished in two ways: 1) by preventing pathogens from reaching Malibu Creek and Lagoon by eliminating them at the source and/or 2) installing treatment controls (i.e., end-of-pipe solutions). Given the potential sources of pathogens (e.g., septic systems, tertiary-treated effluent, polluted urban runoff and illicit connections), they must all be addressed in a comprehensive manner to effectively reduce pathogen inputs into the watershed. To help further this action, the Regional Board will be looking at these sources and establishing a total maximum daily load (TMDL) for pathogens in the Malibu Creek Watershed by March, 2002 (see Watershed Assessment, #44).

Using Proposition A funds, the City of Malibu installed a Storm-ceptor **J** facility with a disinfection device at the end of a 24-inch pipe that drains into Malibu Creek and Lagoon (commonly referred to as the Mystery Drain). Among other constituents, the system will reduce and/or remove pathogens from Mystery Drain discharges. The City is also considering treatment/disinfection devices for the remaining two storm drains discharging into Malibu Lagoon.

Additional efforts to control pathogen inputs from area septic systems are described in Septic Systems (#23). Also, Las Virgenes Municipal Water District's efforts to find alternative uses and/or disposal options for Tapia's effluent (rather than discharging it into Malibu Creek) are described under Water Imports and Discharge (#28).

8. ***Study Nutrients.* Determine and establish achievable nutrient standards to maintain natural populations.**

Several nutrient-based studies and data collection efforts have occurred throughout the watershed for many years, which include:

- Extensive sampling of nutrients was part of the Resource Conservation District of the Santa Monica Mountain's (RCDSMM) *Effects of Breaching on the Biota* study. Water quality parameters such as Ammonia (as nitrogen), nitrates (as nitrogen), and phosphates were sampled in Malibu Lagoon from 1996-98. This data will soon

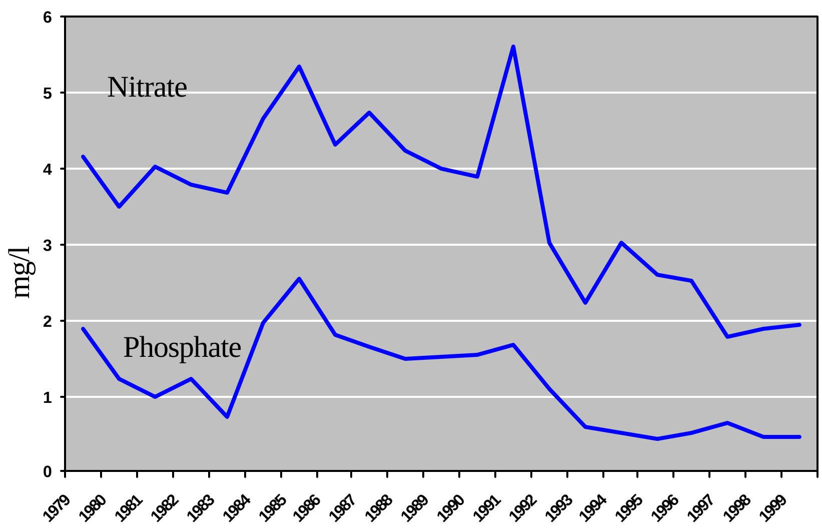

Figure 2. Annual nitrate and phosphate averages at 8-10 stations.

be compiled and available for use to the general public.

- The Las Virgenes Municipal Water District has collected nutrient and phosphate data for more than 20 years at 8-10 stations from the 101 Freeway to Malibu Lagoon. This data, which was also submitted to the LARWQCB suggests decreasing trends in both constituents over the past 20 years. (See Figure 2.)

- In 1979, Dr. David Chapman conducted a study on nutrients. Every month for a period of one year he surveyed algae throughout Malibu Creek and identified algal blooms to the lowest taxonomical level possible (typical species). Using the data collected, Dr. Chapman concluded that: 1) algal mats in Malibu Creek were dominated by *Cladophora*, distributed through the creek where flows were stagnant and shade was lacking, and 2) algal mats were scoured during winter storm events, thus creek algal biomass began afresh each year (i.e., there is no biomass carry over from year to year). His research suggests that the presence of nutrients alone does not govern the amount of or the extent to which algal blooms develop, but rather a collection of factors governs this. A study conducted by LVMWD in 1978 found that algal mats were prevalent in pools and stagnant waters without riparian canopy or shading throughout the watershed. This study supports Chapman's conclusions.

- The Regional Board has established a TMDL unit to set discharge limits for pollutants throughout Los Angeles County. In the Malibu Creek watershed, they will be focusing specifically on nutrient loads, pathogens and coliform. The Regional Board expects to complete the TMDL process for these pollutants by March, 2002.

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9. ***Reduce Nutrients.*** **Reduce nutrient loads into the watershed. Reduce nutrient levels to natural background levels. Encourage the Tapia Treatment Plant to employ state-of-the-art technology to remove nutrients from their discharges.**

Constituent (mg/l)	Creek Background Levels	Tapia Discharge Levels
Nitrates	6-8 mg/l winter 1-4 mg/l summer	15 mg/l, 1999 Annual Average
Phosphorus	Usually no detect or less than 1 mg/l	2.62 mg/l , 1999 Annual Average

Table 2.2. Nitrate and phosphate levels found in Malibu Creek and Tapia discharges. (Data provided by the Regional Water Quality Control Board.)

Tapia's discharges to Malibu Creek contain nitrate and phosphate levels which are higher than typical creek background levels (see Table 2.2). These levels have been identified as possible contributors to the algal blooms that cause lower dissolved oxygen levels in Malibu Creek, although various monitoring results show adequate dissolved oxygen (DO) levels in the creek below Tapia. The Las Virgenes Municipal Water District began voluntary biological nutrient reduction at its Tapia facility in 1992 by decreasing airflow to its aeration basins to reduce nitrate levels, and recently installed mixers to reduce nitrate levels even farther. Overall, the amount of nutrients discharged directly by Tapia has decreased about 35% since 1993.

Additionally, Tapia's wastewater discharge permit, which was re-issued by the Regional Water Quality Control Board in 1997, requires significantly lower nitrate and phosphorus levels than the plant's previous permit required. Specifically, it calls for nitrates to be reduced from 13 milligrams/liter (mg/l) to 10 mg/l and phos-phorus from 6 mg/l to 3 mg/l. To meet these provisions, the Las Virgenes Municipal Water District is studying the effectiveness of percolation beds in removing nutrients from Tapia's effluent. Prior to the permit provisions, however, LVMWD voluntarily imple-mented process changes at the Tapia facility to improve average nitrate and phosphorus removal efficiencies by 25-35%. As men-tioned previously, the permit also prohibits Tapia from releasing its effluent into Malibu Creek from April 15th to November 15th, thereby significantly reducing the amount of nutrients discharged.

As part of its review on the nitrate and phosphorus limits established in Tapia's current permit, the Regional Board is currently analyzing background nutrient levels in Malibu Creek subwatersheds and correlating their effects on biological factors (DO, temperature, pH, etc.). Based on results of the Regional Board's assessment, Tapia may need to further reduce nitrate and phosphorus discharges associated with urban runoff.

The County of Ventura addresses nutrient problems through several programs, including public education targeting pet waste and residential use of fertilizers, education of municipal staff in charge of landscape maintenance, confined animal waste management and storm water discharge prohibitions.

Septic systems also discharge nutrients to the watershed. Septic leach fields which are not sufficiently separated from groundwater, and hydraulic gradients which "pull" septic discharges to local creeks can contribute to the nutrient loadings observed in Malibu Creek and Lagoon. Although the Regional Board is required to issue Waste Discharge Requirements (WDRs) to multi-family and commercial complexes using septic systems, their efforts have lagged in actually identifying and permitting these facilities (see Septics, #23).

Several other programs in the watershed promote nutrient reduction through education, implementation of appropriate BMPs and capital projects. Please see Confined Animals (#18), Septic Systems (#16), Composting, Recycling and Conservation (#29) and Public Education (#42) for related nutrient reduction activities.

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10. ***Reduce Accelerated Sedimentation*. Historical seasonal sediment flow to beaches should be allowed. Human-augmented sediment discharges into the watershed should be reduced by:**

- **Enforcing erosion control regulations on a subwatershed basis.**
- **Encouraging all cities and the County to adopt ordinances of no net increase in sediment from any development into the watershed.**
- **Adopting watershed-wide ordinances to reduce sediment runoff from private property.**
- **Minimizing the loss of topsoil in developing areas through implementation and enforcement of BMPs.**
- **Eliminating dumping of dirt on road shoulders.**
- **Eliminating massive grading within the watershed.**

All construction activities/developments in Los Angeles County over five acres are required to obtain a Construction NPDES permit from the Regional Board by filing a Notice of Intent (NOI) and identifying appropriate/site-specific BMPs that will be implemented. The BMPs selected must be effective in prohibiting contaminated discharges from leaving a site under construction. The requirements will soon apply to construction and development projects greater than one acre.

Under the 1996 Municipal Storm Water NPDES permit, cities are required to adopt local ordinances which include sediment control/reduction strategies (see Table 2.1 under Eliminate Sources, #4 on 20). Sediment control/reduction strategies implemented within the watershed include the following:

- The City of Calabasas conducts annual reviews of erosion control plans for developers that have open construction sites (exposed soil, no stabilization), open City projects and any project starting during the rainy season. City inspectors also ensure that erosion control measures, which must be identified as a condition for receiving a development permit, are correctly installed and maintained (e.g., sandbags, berms).

- The Cities of Agoura Hills and Westlake Village require developers and new construction projects to implement wet weather control plans during the rainy season (October - April) and enforces them as warranted. State permitted construction sites (those 5 acres or greater) are checked at least once during each rainy season by City inspectors.

- The City of Thousand Oaks requires that: 1) all development projects (except single family residences) disturbing one acre of soil or more prepare a storm water pollution control plan (SWPCP) before receiving a grading permit, 2) new developments incorporate permanent BMPs into their site designs, and 3) erosion control plans be developed for all active projects before the start of the rainy season. Construction inspectors routinely check construction sites for proper implementation of SWPCPs and BMPs.

Additionally, in 1997 the RCDSMM (using Proposition A and US EPA 319(h) grant funds) implemented a sediment reduction and stream bank stabilization project along a 200-ft section of Las Virgenes creek adjacent to Lost Hills Road. Initially, the RCDSMM excavated approximately 17,000 cubic yards of old fill material which had been dumped in the streambed by a previous development project. A new mild streambank slope was then reconfigured using bio-engineering techniques (erosion blankets, geo-grid system, and native re-vegetation). The fill material removed from the site was accepted without charge by the County Sanitation District for cover at the Calabasas landfill. This in-kind contribution, estimated at $500,000 was the single biggest factor in allowing the project to proceed, as funds had not been secured to cover the disposal cost of the fill material. Since its completion in 1998**,** the restored streambank has successfully withstood several storms, become stabilized and is now considered fully restored. Based on the RCDSMM's routine inspection of the stream bank, some components will be modified to increase its long-term stability.

11. ***Fire Regulation-Erosion Control*. Modify fire regulation practices and weed abatement programs to reduce erosion. One method is to require mowing rather than discing of weed setback zones.**

Since public safety is the primary objective in preventing wild fires, particularly in the Malibu Creek watershed, native habitats located near commercial establishments and residential homes have historically been removed or degraded. However, per the Los Angeles Fire code, the Fire Department has set in motion a progressive, preventative approach to fire safety while promoting native vegetation retention called the *Fuel Modification Program*. Implemented in 1996, this program requires landowners of any new construction or addition of 50% or more square footage to develop a fuel modification plan showing:

- Specific plant pallets
- Plant spacing and arrangement
- An irrigation plan
- Legal documentation of a comprehensive long-term vegetation maintenance program for the property.

Existing and future landowners are required to adhere to the plan's components. Landowners are also required to comply with existing standards for brush clearance to reduce the threat of fire. The standards do, however, recognize the need for erosion control and watershed protection, and therefore allow up to three inches of grass to remain on relatively flat lands and up to 18 inches on slopes otherwise prone to significant erosion.

Cities in the watershed have also adopted policies promoting mowing rather than discing areas likely to erode and promote the use of drought-tolerant plants where possible.

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12. ***Temperature*. Establish water temperature policies for fisheries.**

The RCDSMM has routinely sampled and accumulated lagoon water temperature data since 1989 as part of all of its Malibu Lagoon projects. Although this relatively long-term data has not yet been used to formulate water temperature policies (no lead agency identified), it is available for use upon request. The Las Virgenes Municipal water district also recorded temperature data continuously for one year at multiple stations in Malibu Creek and compiled temperature requirements for steelhead trout. The RCDSMM's data, along with LVMWD's data and the habitat/species information and assessments contained in the Coastal

Conservancy/UCLA report, could help guide the development of a temperature policy for Malibu Creek and Lagoon.

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13. ***Storm Drains*. Employ appropriate BMPs for storm drains throughout the watershed. Stencil all catch basin inlets (storm drains).**

In 1995 as part of its Gutter Patrol Program, Heal the Bay started stenciling catch basin inlets in the City of Malibu with the message **"NO DUMPING - This Drains to Ocean."** Once the program was completed, they provided city personnel stencils and paint to ensure the longevity of this effort as stencils faded or as new storm drains were installed. Malibu's local residents were also reached with the "No Dumping" message by Heal the Bay through educational door hangers (in the shape of fish), local community events and local newspapers. The same "No Dumping" stencils were provided to other cities in the Malibu Creek Watershed, thus promoting a consistent region-wide message discouraging illegal dumping of materials into storm drains. Storm drain stenciling is now required by all cities under 1996 Municipal Storm Water NPDES permit.

In May 1993, LAC-DPW developed a program to stencil a significant number of catch basins county-wide with the same phrase and logo **"NO DUMPING - This Drains to Ocean.**" Their initial effort included stenciling approximately 72,000 sites. The County then established a periodic re-stenciling schedule whereby three of the nine County areas would be re-stenciled each year (resulting in overall storm drain stenciling maintenance every three years). As part of this program, participating cities in the Malibu Creek watershed are scheduled to be re-stenciled sometime in 1999 (the County only provides stenciling service to those cities who contract with them for catch basin cleaning or who specifically request stenciling services). Cities who choose not to participate in the County's program are required to conduct their own cleaning and stenciling programs and may or may not use the same logo and phrase. In the Malibu Creek watershed, Calabasas and Westlake Village contract with the County for these services. Agoura Hills cleans its own storm drains and removes debris annually prior to the start of the rainy season, but contracts with the County for stenciling of its catch basins. The City of Malibu conducts its own program entirely (as mentioned above).

These watershed cities also conduct regular street sweeping activities to help prevent storm drains from becoming clogged with trash and debris. The City of Calabasas, using Prop A funds, has even installed a state-of-the art continuous deflection system (CDS) unit into one of its storm drains. CDS units use reverse-angle screens to filter out trash and debris once they enter the device. Initial research has shown these units to be quite successful at removing virtually all trash and debris from the system, and they are reportedly easy to maintain.

As mentioned under Reduce Pathogens (#7), three storm drains, which discharge flows directly into Malibu Lagoon were targeted for treatment by the City of Malibu. Starting in the winter of 2000/01, flows from one of the storm drains will be treated using an oxidan gas disinfection facility to eliminate bacteria and viruses before they reach the lagoon. If the results of this treatment process are successful, the remaining two drains will also receive the same treatment. The demonstration project is being sponsored with Prop A funds and by the City of Malibu, Southern California Edison and Purizer Corp, who is contributing the disinfection facility for the project.

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14. ***Mobile Car Washes*. Regulate mobile car washes to prevent discharges from reaching the creek and lagoon.**

Under the 1996 Municipal Storm Water NPDES Permit, all four Los Angeles County watershed cities have adopted local ordinances prohibiting mobile car washes from discharging runoff to the municipal storm drain system. Enforcement of this provision is limited, and is conducted on an as-needed basis. See Enforcement – General (#40).

The County of Ventura and its watershed communities are not required under their Storm Water NPDES permit to regulate mobile car wash discharges. However, this concern is addressed somewhat through public education and outreach.

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15. ***Illegal Drains*. Eliminate known illegal storm drains entering the watershed.**

The County of Los Angeles Department of Public Works prepared maps and connection inventory reports for 1082 storm drain segments county-side, resulting in discovery of 1838 undocumented connections. Of these, 49 illicit connections were found in the Malibu Creek watershed; 21 of them have since been formally documented and the other 28 are in the process of being documented. Typically, the County investigates all reports of illicit connections and advises the owners of these connections to either document them or remove them.

Although no illicit discharges (including gray water and septic connections) have been identified to date, the City of Malibu relies on the legal authority provided under its storm water ordinance to eliminate them if and when they are discovered.

Heal the Bay, through its Malibu Creek Stream Team program, conducts extensive surveys along various creeks and streams throughout the watershed. Volunteers who walk segments of the creek document, among other things, discharge points or outfalls that lead directly to the creek/stream. This information can be compared to known discharge points and legal action can be taken when illegal discharge points are discovered.

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16. ***Septic Systems*. Implement dye study of the septic systems in the vicinity of the lagoon, creek and surfzone. Study all identified systems and replace all malfunctioning systems.**

Please see summary under Septic Systems (#23).

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17. ***Trash/Park Sanitation*. Maintain sanitary conditions in parklands. Link to education in English and Spanish to prevent trash from impacting local resources. Manage and eliminate the harmful impacts of day use, including campers, picnickers and transients on water quality.**

The California Department of Parks and Recreation (State Parks) has taken several measures to control the spread of trash and debris within its parkland boundaries, including: 1) installing gull/bird proof lids on trash cans, 2) utilizing bilingual employees to enhance educational efforts to Malibu Creek State Park day-use visitors, and 3) periodic removal of transient encampments. However, signs posted in the park are not in both Spanish and English, and their visibility is poor.

Heal the Bay records dump sites during its stream walk activities, which includes parklands. The information collected should be used in determining where to best place trash cans within State Parks boundaries.

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18. ***Confined Animals*. Develop BMPs for livestock waste management.**

- **Conduct a survey of existing locations and amounts of animal waste within the watershed.**
- **Prohibit dumping of horse manure along the creek. Enforce set-backs of horse corrals and horse manure storage.**
- **Set limits on the number of livestock per acre to protect resources from overuse by large domestic animals.**

As one component of its EPA 319(h) Nonpoint Source Reduction grant, the RCDSMM conducted an extensive research effort to identify all horse owners and corrals in the Malibu Creek watershed. Their efforts culminated in the development of a Stable and Horse Management BMP manual to help reduce point and nonpoint source pollution from livestock waste. The manual provides information on how to manage horse waste, site planning and design for corrals, drainage and erosion control, etc. The project also included: 1) conducting a watershed-wide survey of horse owners to better understand their current management practices and needs; 2) designing and building a horse manure compost demonstration site as an educational tool for the public; and 3) producing a video entitled “Horse Management Program.” These materials are available to the public upon request. However, there is some concern that the message is still not reaching horse owners, or that the owners are not motivated to change their stable locations or practices. For example, Heal the Bay’s Stream Team has identified several horse facilities near streams and riparian zones that have poor or non-existent manure management measures. These facilities adversely impact the watershed’s creeks and streams.

The County of Los Angeles, Department of Health Services maintains a horse stable monitoring program through biannual inspection of stables with four or more horses throughout the County. These inspections verify that applicable best management practices related to storm water regulations are being implemented and that horse waste is well contained and prevented from reaching the storm drain system. When violations are discovered, the

Department of Health Services takes action to remedy the situation by first working with horse owners. Fines and restrictions are then imposed if that avenue is not effective.

This City of Malibu plans to conduct a survey of horse corrals within the city and will be providing education for proper management of manure once this activity is completed. Additionally, new and re-development projects within the city will be required to provide measures to assure that runoff from corrals does not reach the storm drain system.

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19. ***Household Irrigation Runoff*. Survey households in upper Medea Creek development to determine reasons and solutions for extraordinary water runoff and report to advisory committee.**

Dry-weather urban runoff from households in the watershed primarily comes from activities such as yard and garden watering, car washing and hosing down driveways and sidewalks. The Metropolitan Water District (MWD) and the Las Virgenes Municipal Water District both offer water conservation education classes for residents addressing such issues as when to water the lawn, what plants are more drought resistant, how to properly install irrigation systems, etc. There are also a host of educational efforts encouraging residents to minimize excessive water use both indoors and outdoors.

However, no official study has been conducted nor report presented detailing reasons for and solutions to the volume of runoff coming from any residential community in the watershed.

20. ***Restore/Enhance Malibu Lagoon and Surfzone*. Restore and/or enhance Malibu Lagoon, including threatened and endangered species.**

Threatened Species
Snowy Plover (*Charadrius alexandrinus*)
Peregrine Falcon (*Falco peregrinus anatum*)

Endangered Species
Brown Pelican (*Pelicanus occidentalis*)
Clapper Rail (*Rallus longirostris obsoletus*) *
CA Least Tern (*Sterna artilarum browni*)
Willow Flycatcher (*Empidonax traillii extimus*)
Bells' Vireo (*Vireo bellii pusillus*) **
Steelhead Trout (*Onchorhyncus mykiss*)
Tidewater Goby (*Eucyclogobius newberryi*)

* Not observed since 1956
** Not recently observed but suspected former nester

Table 2.3. Threatened and endangered species found in the Malibu Creek watershed.

The 13-acre Malibu Lagoon and its surrounding coastal salt marsh, wetlands and surfzone are significant biological resources for both bird and aquatic species, some of which are threatened or endangered (see Table 2.3). The area also represents a vital resting and feeding "stop over" point for many migratory birds, which is especially important given Southern California's few remaining viable habitats along the Pacific flyway.

The avian species listed in Table 2.3 are impacted by a variety of problems in Malibu Creek Lagoon, including: 1) persistently high lagoon water levels which submerge valuable mudflat habitat, 2) human and pet disturbance, 3) poor lagoon water quality, and 4) non-native vegetation. Restoration efforts to improve overall water quality in the lagoon, increase available habitat and limit intrusions have only recently begun. Initial efforts include: 1) the mudflat island created in the lagoon by the RCDSMM through a State Parks grant in 1995, 2) data collection and assessment via several studies and long term projects [see Table 1.3 starting on page 12], and 3) the recent study conducted by the Coastal Conservancy and UCLA on Lower Malibu Creek and Lagoon biota, water quality, hydrology and sources/impacts.

Two primary endangered aquatic species found either currently or historically in the Malibu Creek and Lagoon include steelhead trout and the tidewater goby. The last account of steelhead trout in either Malibu Creek or Lagoon was in 1997, the same year that the species was added to the federal endangered species list. Loss of upstream habitat and spawning grounds are believed to have contributed to its decline and ultimate disappearance in Malibu Creek reaches. Under the guidance of the Santa Monica Mountains Steelhead Trout Recovery Task Force, restoration efforts are just getting underway for this species. The focus of the task force includes assessing the feasibility of removing of Rindge Dam and other creek barriers impeding steelhead migration to upper reaches of the creek.

The tidewater goby, which was added to the federally endangered species list in 1993, was extirpated in Malibu Lagoon in the late 1960's/early 1970's due to the incremental and cumulative effects of environmental stressors such as habitat reduction (resulting from development activities), channelization and destruction of spawning grounds. Prior to the listing, in 1991 restoration efforts had started to both reintroduce and sustain populations of the tidewater goby in Malibu Lagoon. With a grant from the California Department of Parks and Recreation, the Resource Conservation District of the Santa Monica Mountains and Heal the Bay re-introduced 52 tidewater gobies. Seven years later, RCDSMM fish surveyors recorded 1,632 tidewater gobies at four sampling stations in the lagoon. Although the species is nowhere near the point of recovery from a statewide perspective, this number represents a significant improvement for the tidewater goby in Malibu Lagoon. A full report documenting the project, which also includes substantial water quality analysis performed before, during and after the re-introduction, is available from the RCDSMM.

The RCDSMM conducted another lagoon restoration effort in partnership with State Parks and the California Department of Transportation (CalTrans) in 1995. Using *EPA Near Coastal Waters Program* grant funds, a significant portion of Malibu Lagoon was restored by excavating over 2,200 cubic yards of old fill material and creating additional aquatic, mud-flat and high storm flow refugia habitats for birds, tidewater gobies and other aquatic species. Post project monitoring of fishes, water quality, and invertebrates was also performed. This data is available from the RCDSMM.

Malibu Lagoon.

Heal the Bay, through its Stream Team volunteer program, has helped to reduce the volume of trash in the lower creek and lagoon. Since 1998, they have removed over 6 tons of trash. Heal the Bay also serves as the Los Angeles area coordinator for Coastal Cleanup Day, which includes beach clean-up activities at Malibu Lagoon and Surfrider Beach.

State Parks conducts periodic cleanup activities in the lagoon and surfzone area to remove trash and other unwanted materials. Their efforts are helping to preserve the initial restoration efforts conducted by the RCDSMM and others.

Future restoration and enhancement activities are being evaluated by the Lower Malibu Creek and Lagoon Task Force using the Coastal Conservancy/UCLA report recommendations (see Assess Sources/Characteristics, #21, below). A group facilitator is currently helping the task force establish selection criteria and guidelines for voting on the management alternatives outlined in the UCLA report.

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21. ***Assess Sources/Characteristics.***

- **Conduct a thorough and definitive study of lagoon water quality, identify all pollution sources, and develop a remediation plan strategy.**
- **Develop a comprehensive picture of the hydrology, circulation, biota of the lower creek and lagoon and surfzone for policy decision making.**
- **Perform quarterly toxic chemical tests in Malibu Lagoon and surfzone.**

In 1997, the California State Coastal Conservancy contracted with UCLA to conduct the *Lower Malibu Creek and Barrier-Lagoon System Resource Enhancement and Management Study*. The goal of this study was to provide the information and analyses needed for rational, scientifically-based decisions about the management and enhancement of Lower Malibu Creek and Lagoon. The three key objectives of the study were to: 1) compile and synthesize relevant existing information, 2) collect new information to fill critical data gaps, and 3) recommend management and enhancement strategies.

The draft report, which was completed in February 1999, provides information on the hydrology and morphodynamics, biological resources, water quality objectives, effects of eutrophication, management of pathogens and wetlands restoration alternatives for lower Malibu Creek and Lagoon. The report culminates with a list of management alternatives for policy makers to consider when undertaking or planning future restoration efforts. Comments on the draft report were submitted by various watershed stakeholders in May/June, 1999 and have been incorporated into the final report. Already, the Executive Advisory Council and Lower Malibu Creek and Lagoon Task Force members are using this and other data collected by the RCDSMM (see below) to proceed with developing a remediation strategy for the creek, lagoon and surfzone. As a preliminary step, a facilitator/mediator has been retained by the task force to promote consensus among stakeholders in selecting and implementing various management actions identified in the final report.

Additional data on Malibu Lagoon was collected by the RDCSMM over several years. They have more than ten years of water quality survey data available that includes information on: 1) fish species diversity, densities, seasonal and relative abundance; 2) bird species diversity, seasonal relative abundance and specific area usage; and 3) pre and post- sand barrier breaching abundance and usage (for fish and birds). Two reports in particular, *Malibu Lagoon: A Baseline Ecological Survey (1989)* and *The Tidewater Goby (Eucyclogobius newberryi), Reintroduction of a Geographically Isolated Fish Species into Malibu Lagoon (1993)*, provide a significant amount of water quality and biotic elements data. The RCDSMM also initiated a two-year study in November, 1996 entitled *Effects of Breaching the Sand Barrier on the Biota at Malibu Lagoon*. As part of this study, fishes and birds were surveyed, lagoon water levels were recorded and extensive water quality data was collected for ammonia (as nitrogen), nitrates (as nitrogen), phosphates, dissolved oxygen, turbidity, water temperature, pH and salinity. Data collection was completed in 1998 and is available for review from the RCDSMM.

Other Malibu Creek/Lagoon biota and water quality data have been collected over the past few years, primarily through projects requiring and/or conducting monitoring programs. These include:

- Construction of the new Pacific Coast Highway bridge (CalTrans);
- RCDSMM's *EPA Near Coastal Waters Grant*;
- *Enhanced Monitoring Program on Lower Malibu Creek and Lagoon*[14];
- Installation of groundwater monitoring wells in Malibu Lagoon State Beach (City of Malibu/State Parks); and
- The RCDSMM's ongoing Marine Sciences Environmental Education Programs at Malibu Lagoon.

Collectively, this relatively long-term data is useful in understanding the comprehensive picture of Malibu Lagoon's dynamic water quality

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[14] This study was conducted by Rich Ambrose, et.al. (UCLA) in 1995 and funded by the Las Virgenes Municipal Water District ($110,000).

changes as well as providing insight into the character of the lagoon's biota.

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22. *Illegal Drains*. **Eliminate known illegal storm drains entering the lagoon and particularly investigate sources emptying into the unclaimed storm drain.**

A number of drain pipes exist that discharge flow directly into Malibu Lagoon. The largest, a 24-inch pipe known as the Mystery Drain, carries runoff from the Malibu Road catch basins adjacent to Webb Way and from private catch basins in the Malibu Colony area (this drain is not considered "illegal" by the City of Malibu). As mentioned under Reduce Pathogens (#7), the City of Malibu was awarded Prop A funds to install a Storm-ceptor **J** near the end of the Mystery Drain to remove grease, oil, trash and sediment. The City has a long-term goal of eliminating "Mystery Drain" flows to Malibu Lagoon by redirecting the discharge through a new ocean outlet at the western end of the Malibu Colony. However, due to the complexities of permitting a new ocean outlet and private property issues, this project has not yet been scheduled.

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23. *Septic Systems*. **Implement dye study of the septic systems in the vicinity of the lagoon and surfzone. Study all identified septic systems and replace all malfunctioning septic systems.**

Septic systems in the lower watershed have long been suspected of contributing pathogens and nutrients to the Malibu Creek, lagoon and surfzone. However, identifying all sources and reducing pathogen/nutrient loading have proven to be among the most challenging issues facing watershed stakeholders.

There are an estimated 390 multi-family and commercial complexes using septic systems in the City of Malibu. Although these users are required to obtain discharge permits from the Regional Board, only 11 complexes had filed for and received discharge permits by 1999 to operate their septic systems.[15] Single family residential septic systems, estimated at 3,800, are not required to apply for a discharge permit from the Regional Board.

Many of Malibu's 4190 septic systems are suspected of contributing

[15] *Omission Accomplished: The Lack of a Regional Water Board Enforcement Program, 1992-1997*. Heal the Bay. January, 1998.

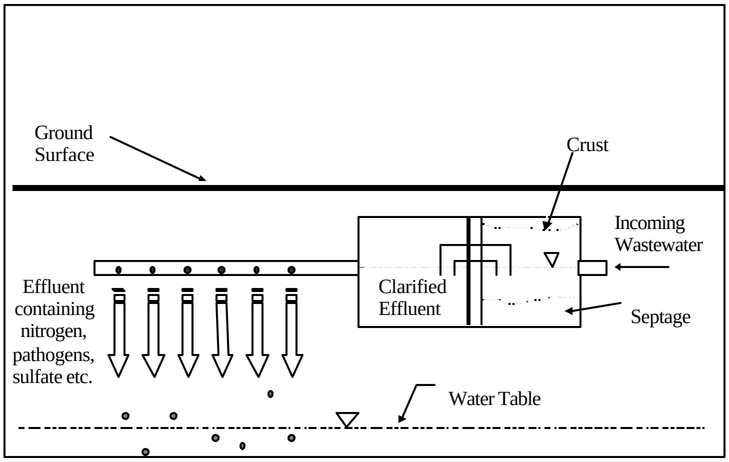

Figure 3. Septic system flow diagram.

pathogens and nutrients to the poor water quality conditions documented in Malibu Creek and Lagoon[16]. They are suspected contributors because septic effluent is released through subsurface discharge pipes into leach fields near the creek, lagoon and surfzone(see Figure 3). This effluent contains pathogens and nutrients which, under the right conditions, can be mobilized in groundwater. The City of Malibu and other enforcement agencies have historically lacked sufficient data to assess whether septic systems actually contribute pathogens and nutrients to nearby receiving waters, and monitoring of homeowner septic maintenance and/or replacement activities has not been conducted.

Several studies over the past few years have been carried out to determine the sources and amounts of pathogens/nutrients contributing to the lagoon and surfzone's degraded water quality. One such study, conducted by the Coastal Conservancy/UCLA, was completed in March 1999. While the report does suggest that nearby septic systems provide nutrients and pathogens to the lower Malibu Creek and Lagoon, how much is not clear. It recommends that more testing be conducted. (The study also included five different sampling events over a nine-month period to identify the presence of specific viruses in the lagoon and surfzone, but none were detected.)

Using consultants, the City of Malibu recently completed an extensive, two-phase study addressing the impacts of septic systems on Malibu Creek, lagoon and surfzone. In 1998 under Phase I, 11 groundwater monitoring wells were installed in strategic locations throughout the study area[17] to evaluate the potential of pathogens to be transported from septic effluent to groundwater and ultimately the creek, lagoon and surfzone. Biophage[18] tracers were used to determine this link. The results of the

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[16] Septic discharges occur underground in a leach field. The potential mobility of contaminants found the leach field are influenced by groundwater level and hydraulic gradient (direction and flow velocity).

[17] Two wells were installed between residential septic leach fields and the lagoon, one in the Malibu Lagoon parking lot, seven in the vicinity of the commercial leach field nearest to Malibu Creek and one on Cross Creek Road up-gradient from the other test sites.

[18] A biophage is a genetically synthesized virus that is physically identical to an enteric virus but is non-pathogenic.

first phase indicated two findings[19]:

- Under simulated breach conditions when the groundwater table was at least 2 feet below the leach field, the biophage tracer (PRD-1) did not appear in any samples taken from the monitoring wells. However, bromide (another tracer) did appear in groundwater samples directly below the septic leach field, indicating that there is a hydraulic connection.

- Groundwater that first intersected the leach field and then was subsequently drawn down (simulating breach conditions) showed that both the biophage (MS-2) and bromide were transported beyond the leach field boundary.

Based on these findings, two conclusions were drawn. First, if at least two feet of unsaturated soil can be maintained between the bottom of a leach field and the top of the groundwater table, then there is little concern regarding pathogen transport. However, if the groundwater intersects the bottom of the leach field, then there is cause for concern that pathogens will be transported in the direction of the creek, lagoon and surfzone.

In 1999, a follow-up study (Phase II) was conducted by Malibu in partnership with the Los Angeles Regional Water Quality Control Board to identify potential sources of pathogens in the study area. The City and Regional Board participated in both the design of the study parameters and sampling events. Groundwater, surface water, sediments and storm drain discharge samples were collected and analyzed for coliform (total, fecal, e-coli, enterrococcus), BOD, MBAS (a marker for detergent), nitrogen compounds (NO_3, NO_2, organic N) and phosphates. The samples were collected under different hydraulic conditions – during lagoon closure, breaching and open tidal action. Results of the study have been compiled and are available in the report, *Study of Water Quality in the Malibu Area, City of Malibu, California, Phase II.* Major findings of this report include:

- The discharges from three storm drains into Malibu Lagoon are contaminated with coliform bacteria, but the majority of coliform bacteria (99%) comes from Malibu Creek's upstream sources.
- The height of the groundwater table is influenced by the state of the

[19] *Study of Potential Water Quality Impacts on Malibu Creek and Lagoon From On-Site Septic Systems*. Prepared for the City of Malibu by URS Greiner Woodward Clyde. June, 1999.

lagoon (breached vs. bermed). Following a lagoon breach, concentrations of bacteria and nutrients found in the corresponding leach field area mobilize in the groundwater but attenuate over distance traveled.

- Samples taken from the wells located between the Colony and Malibu Lagoon suggest possible impacts from septic systems.

Also based on the monitoring results of the Phase II study, the Regional Board concluded in an August, 2000 report[20] that:

- Septic systems contribute to groundwater pollution in the Malibu Valley due primarily to insufficient separation between the groundwater table and septic leach fields.
- There is a hydraulic connection between groundwater in the Malibu Valley and local surface waters as evidenced by the correlation between groundwater movement and Malibu Creek and Lagoon water levels.
- The nutrients and pathogens/bacteria discharged by Malibu Valley septic systems adversely impact Surfrider Beach.

> The Phase II monitoring data confirmed, and study participants agree that if groundwater levels intersect the bottom of a septic leach field near Malibu Creek, then there is cause for concern that pathogens will be transported over longer distances, potentially reaching the Malibu Creek, Lagoon and surfzone.

There is disagreement over some of the conclusions drawn from the Phase I and II studies. Local regulatory agencies feel that additional factors must be considered before making any determination about the impact of septic effluent on Malibu Creek, lagoon and surfzone. Specifically, the geology of the site, direction of groundwater flow, time of day monitoring is conducted and the volume of effluent treated through the system must all be considered. At the time the *Making Progress: Restoration of the Malibu Creek Watershed* report was released, the project design, data collected and all conclusions drawn from the Phase II study had not been peer reviewed or evaluated by outside sources.

Although Malibu has not established an exact count of all private sewage disposal systems (PSDS) within its jurisdiction, the City has begun implementing programs, ordinances and other measures to assure the safe operation of on-site wastewater treatment systems. In 1999, the City adopted modifications to the Plumbing Code addressing or calling for

[20] *Preliminary Results of the Malibu Technical Investigation.* Los Angeles Regional Water Quality Control Board. August 18, 2000.

minimum tank sizes, appropriate flow rates, secondary treatment, filtering systems and more restrictive design criteria for new commercial and multi-family developments. The City has also seen problem septic systems in Malibu remedied through the use of advanced treatment systems. And, while no specific program requirements have been set, Malibu is also considering several strategies to further monitor and control septic system discharges. These include:

- Establishing a *Pumping Records Registration Program*;
- Developing an ordinance which would require mandatory retrofit to ultra low flow and low consumption fixtures/plumbing devices in all occupancy structures;
- Developing an ordinance requiring mandatory installation of grey water systems for all new construction;
- Adopting a contractor/plumber designed registration program; and
- Establishing an on-site, septic system inspection program.

In January 2000, the Santa Monica Bay Restoration Project convened a *Septics Management Task Force*[21] to develop a set of recommendations for how to better manage this potential nonpoint source of pollution. These recommendations, which include local permitting and inspection/monitoring of single family septic systems, were presented to various agencies and stakeholders during the fall of 2000 and will be adopted in the beginning of 2001 by the SMBRP's Bay Watershed Council. Once adopted, it will be the responsibility of the appropriate agencies to begin implementation of these measures.

The Ventura Regional Sanitation District, utilizing US EPA 319(h) grant funds, is planning a demonstration of off-the-shelf advanced individual disposal systems capable of treating household wastewater to less than 10 mg/l of total nitrogen. The results of this demonstration will certainly be useful to planners, agencies and septic system users in the Malibu Creek Watershed.

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24. ***Lagoon/Water Level Breaching***. **Evaluate options for regulating lagoon levels without artificial breaching of the lagoon. Prevent unnatural breaching of the creek/lagoon.**

[21] Participating agencies include the SMBRP, Heal the Bay, Supervisor Zev Yaroslavsky's office, City of Malibu, State Department of Health Services, Los Angeles Regional Water Quality Control Board, City of Los Angeles, and Los Angeles County Departments of Health Services, Regional Planning and Public Works.

Until 1997, State Parks was informally permitted the authority to institute breaching activities when Malibu Lagoon's waters reached a certain level. However, at the urging of local resource agencies who were concerned about the impacts of artificial breaches on the lagoon's sensitive aquatic species (i.e., tidewater gobies), the California Coastal Commission (CCC) and Army Corp of Engineers halted all breaching activities until a study could be conducted to assess the overall impact to the system. Exceptions were granted only when public health was threatened, (e.g., when lagoon waters reached levels that caused malfunctions/backups of nearby residential and commercial septic systems).

The RCDSMM conducted a study, *Effects of Breaching on the Biota*, which looked at how breaching affects many species found in the lagoon. They concluded that there is definitely a negative impact on these species when breaches occur.

There are, however, periodic artificial breaches spearheaded by the "shovel brigade," i.e., persons who feel that high water levels combined with poor lagoon water quality directly impact human health at a popular surf area. The shovel brigade takes it upon themselves to "control" where the breach occurs when the lagoon's water level is so high that a natural breach is imminent. This group digs a channel at the western-most edge of the lagoon to prevent the sand that is washed out from piling up at the first break point and adversely altering the shape of the waves for surfing.

In August 1999, State Parks issued a *Request for Proposals* for the design and construction of a system that will help manage the lagoon's water level during the dry season without adversely affecting fish and wildlife (e.g., tidewater gobies, steelhead trout). Until a system is approved and constructed, artificial breaching will not be permitted unless public health and safety are threatened.

25. ***Public Notices.***

- **Breaching / Public Health: Regular notices to inform the public and agencies about breaching times of lagoons.**

  As a standard practice, State Parks informs the public and other concerned parties each time a mechanical/artificial breach of the lagoon is to be performed. In addition to notifying key agencies such as the Coastal Commission, State Parks notifies local newspapers. The Los Angeles County Department of Health Services and LA County Lifeguards posts beach closure signs and warn beach-goers near the breach point.

- **Encourage Los Angeles newspapers to publish weekly monitoring bacteria results at beach entrances.**

  In 1990**,** Heal the Bay launched the first-ever *Beach Report Card*. **J** Using water quality data from samples collected by the Los Angeles County Department of Health Services, County Sanitation District of Los Angeles County (CSDLAC) and the City of Los Angeles Environmental Monitoring Division at Hyperion, Heal the Bay interpreted bacteria results and established a grading/reporting system (A-F) that the general public could easily understand. Initially, beach grades were published on a monthly basis for 61 beaches throughout Los Angeles. Grades are now provided for over 250 beaches in Los Angeles, Orange, Ventura and Santa Barbara Counties via local newspapers, marine shops surf and dive shops and on local weather stations. Grades are also posted on Heal the Bay's website, which has undergone improvements to better inform the public about how the beaches are monitored and the health risks associated with swimming in the Bay.

  Four of the 250 beaches graded are located in Malibu – 3 locations near Surfrider Beach and one at Malibu Pier. Whenever the lagoon is breached, Surfrider Beach receives an "F" grade (based on water quality data). However, the data showed excellent water quality during the four summer months of 1999 when the lagoon was not breached.

- **Implement public notification and education programs about potential health problems at beaches.**

  In 1995, the Santa Monica Bay Restoration Project conducted a comprehensive epidemiological study to assess the correlation between contaminated storm drain discharges and incidence of swimmer illness[22].

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[22] Other organizations and agencies providing funding and support for this study include the

Revised beach warning signs.

Results of this study showed, conclusively, that there is a significant increase in occurrence of illnesses among swimmers who swim within 100 feet of flowing, dry-weather storm drains. Immediately following the release of this study, new warning signs were created and permanently posted directly in front of flowing storm drains, calling attention to the dangers associated with swimming in urban-runoff contaminated waters. The results of the study also triggered revisions to the County's Beach Closure and Health Warning Protocol, which now requires posting the new warning signs and notifying the public of beach closures in a timely fashion and on a more regular basis. Four years later, the results of this study are still used as a guidance tool by the media, environmental organizations and others to inform the public of the risks associated with swimming in front of flowing storm drains.

Following the Epidemiological Study, Heal the Bay initiated, helped draft and advocated for passage of a bill that would require California's popular beaches (i.e., more than 50,000 visitors annually) which receive storm drain discharges to: 1) conduct routine water quality monitoring for three bacterial indicators, and 2) inform the public when established bacterial thresholds have been exceeded by posting warning signs or closing the beach. The bill (AB411), which was passed in October 1997, also requires local health agencies to set up a hotline to inform the public of all beaches currently closed, posted or otherwise restricted. Heal the Bay also utilizes volunteer speakers through its *Speaker's Bureau* program to help educate over 25,000 people every year about: 1) sources of sewage to the bay, 2) the potential health problems associated with swimming in contaminated waters, and 3) where and when to swim in Bay waters. The program targets schools, corporations and community groups.

State Water Resources Control Board, City of Los Angeles, Beach Cities Health District, City of Santa Monica, Los Angeles County Department of Public Works, Los Angeles Regional Water Quality Control Board, Chevron Companies, Las Virgenes Municipal Water District, Milken Family Foundation, Heal the Bay and the US Environmental Protection Agency.

26. ***Malibu Lagoon/Bridge*. CalTrans should set up a mitigation fund to cover the costs of any impacts to Malibu Lagoon and the surfzone resulting from the reconstruction of Malibu's Pacific Coast Highway Bridge.**

Within one year of completing the Pacific Coast Highway bridge across Malibu Creek and Lagoon, CalTrans provided State Parks approximately $110,000 for salt marsh restoration activities. State Parks used these funds to remove exotic plant species in the area just below the bridge and revegetated it using native plants. CalTrans also provided $98,830 to the Resource Conservation District of the Santa Monica Mountains over a five year period (1996-2000) for tidewater goby monitoring and restoration activities (including funds for the *Effects of Sand Breaching the Sand Barrier on Biota* study; see Lagoon/Water Level Breaching, #24).

27. ***Landfill***. **Expand the understanding of the impact of the Calabasas landfill on water quality and especially ensure that Calabasas landfill installs monitoring wells which they were directed to construct in 1990; report monitoring results of findings to the advisory committee.**

In cooperation with the County Sanitation Districts of Los Angeles County (CSDLAC), the National Park Service (NPS) prepared an environmental assessment (EA) on the issuance of a special use permit for continued operation of the landfill. The EAs preferred alternative included issuance of a permit with 13 conditions to mitigate the impacts of the landfill on park resources and visitor enjoyment. These conditions include: 1) off-site preservation of 100 acres of habitat along the US 101 freeway corridor, 2) $40,000/year wildlife fund for wildlife habitat research, 3) native plant restoration of landfill slopes, 4) alternative grading concept plans, and 5) development of an interpretive wayside exhibit addressing solid waste management and environmental issues. The five year permit was issued in November, 1998 and implementation of its 13 conditions began immediately afterward.

As part of the condition of approving the permit, CSDLAC purchased off-site land to permanently mitigate the loss of habitat. The 107-acre parcel purchased (referred to as the Albert Abrams property) is located on the south side of Agoura Road, west of Liberty Canyon Road and is a vital link to the wildlife corridor.

A groundwater study is also being conducted at the landfill to further define the extent of the landfill's effect on groundwater. In August and October 1999, eight piezometers were installed in the area to obtain geologic and hydrogeologic data. The information gathered will be used by the County Sanitation District to: 1) acquire those portions of the Lower Cheeseboro Canyon that contain surface or subsurface contamination and 2) design a water quality corrective action program. Routine post-rainfall surface water testing continues to show no adverse impact to surface water quality resulting from landfill operations.

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28. ***Water Imports and Discharge***. **Maximize environmentally acceptable use of reclaimed wastewater (household and treatment plant) and grey water, and reduce the importation of potable water. Encourage use of reclaimed water for irrigation of landscaping and community open space. Price reclaimed water more competitively.**

Harmoniously implement water conservation efforts and grey water ordinances between cities. Ultimate long-term goal of no-waste discharges into waters used for recreation and/or for sources of food.

The Las Virgenes Municipal Water District provides 65,000 residential customers, nearly 75% of the watershed's residents, with approximately 18,000 acre-ft of imported water each year. Several other water agencies also supply an additional 10,000 acre-ft of potable water to upper watershed customers; these agencies include Callegus Municipal Water District, Triunfo Sanitation District, Oak Park Water Co., California Water Services Company, Lake Sherwood Community Services District and Hidden Valley Mutual Water Company. The amount of water returned by these residents to the Tapia facility for tertiary treatment is about 11,200 acre-ft, of which 5,000 acre-ft is recycled and beneficially used for irrigation. The greatest demand for Tapia's recycled water is for irrigation purposes, usually from mid-June to mid-September, when temperatures are higher. Moderate, but highly variable demand is observed in the "shoulder" periods of May through mid-June and mid-September through October, with much lower demand for the remaining six months of the year. During peak demand, 100% of Tapia's daily volume of recycled water is distributed to users and potable water is often used to supplement the supply. To keep spring and fall surplus water out of Malibu Creek, each year the District installs and then dismantles (to allow mowing and discing) over 35 miles of temporary irrigation pipes for surplus disposal via off-site spray fields. The District has even expanded recycled water incentives, giving surplus water away for free to its existing customers. It is also seeking state and federal co-funding to connect new customers that are currently too far away to serve economically. Combined, these programs/approaches have enabled the District to keep Tapia's effluent out of the creek from mid-April through mid-November.

The Las Virgenes Municipal Water District has also passed ordinances requiring the use of recycled water anywhere state law allows and the distribution system can reach. Price incentives are used to encourage use of reclaimed water. The District also uses a tiered rate structure to discourage waste and runoff of potable water (i.e., the unit rate increases with excess use). Other water conservation efforts are highlighted under Composting, Recycling and Conservation (#29).

In November of 1997, the Regional Board renewed the Tapia Water Reclamation Facility's NPDES permit and included new effluent discharge prohibitions. The new permit prohibits Tapia from discharging its effluent into Malibu Creek from April 15th through November 15th. In 1998, during the first summer of prohibition, Tapia was unable to store or find alternative uses for its effluent and violated the permit several times during that period. Reasons for the violation include: 1) lower recycled water demands, and 2) the limited time period given for LVMWD to evaluate and implement creek discharge avoidance alternatives. However, LVMWD is seeking permanent alternatives to discharging into the creek. They hired consultants and engaged stakeholders to conduct a study which would identify and assess both short- and long-term options for using, storing and/or disposing of the effluent. The resulting report, entitled the *Malibu Creek Discharge Avoidance Study,* identified a whole range of discharge alternatives for LVMWD to consider. An Environmental Impact Report (EIR) was subsequently developed for four project alternatives and seven other potential project alternatives.[23] The results of this report were provided to the Regional Board in late 1999.

At the municipal level, several cities have also taken measures to promote and/or require recycled water use. For example:

- Calabasas' local city ordinance encourages use of reclaimed water for landscape irrigation purposes and planting of drought tolerant native species within its jurisdiction. The City's Landscape Manager also provides technical assistance to residents who want information on efficient water usage by reviewing "plant palettes" for individual homeowners. Commercial development projects within the city require significant water budget calculations and plan checks prior to plan approval. A similar water budget program was instituted for individual homeowners originally, but because of the significant costs associated with developing a water allocation and budget plan, that program has been significantly reduced and is now limited to the elements mentioned above. The City's Planning Department, in conjunction with the Environmental Commission, has developed an Environmental Connection Handbook which addresses many topics such as water conservation, native plants and xeriscape. This handbook is available to residents who request it.

- The Cities of Agoura and Westlake Village endorse water conservation and reuse, and utilizes reclaimed water in all city parks, along the freeway, on street medians and on parkways wherever

[23] The four project alternatives included: 1) Deliver raw sewage to the City of Los Angeles sewer system; 2) Discharge recycled water to the Los Angeles river drainage basin; 3) Expand recycled water system; and 4) Store excess recycled water in the Las Virgenes Valley Basin.

available. Projects are routinely conditioned to utilize reclaimed water, such as landscaping projects along Kanan Road, Agoura Hills Road and along the 101 Freeway in these cities.

- The City of Malibu produced the *Grey Water Handbook* to help eliminate illegal disposal of grey water by encouraging residents to use it for irrigation. The city also modified the Plumbing Code to allow disposal through the use of sub-surface irrigation.

- The Triunfo Sanitation District endorses water conservation and promotes reclaimed wastewater reuse to its customers. These customers, which include the communities of Oak Park, North Ranch, Lake Sherwood and Westlake Village, use reclaimed wastewater on road medians and park grounds, and at schools and homeowners association developments. The City of Thousand Oaks and the County of Ventura also routinely condition projects to use recycled wastewater.

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29. ***Composting, Recycling, Conservation*.** **Implement improved recycling efforts. Maximize treatment and reuse potential of all aspects of the watershed's waste disposal operations (septic, sewer, sludge farming, and landfill operations).**

- **Encourage composting and other forms of recycling for waste management.**
- **Encourage recycling and reuse efforts to reuse water, household hazardous waste, plastics, paper, glass, cardboard, tin and aluminum.**

Several different agencies, municipalities and organizations are both responsible for and committed to accomplishing the goals of this action. Together, these combined efforts aggressively promote recycling and conservation throughout the upper and lower watershed.

- LAC-DPW and Ventura County both conduct a variety of county-wide outreach programs on composting, recycling and conservation which target residents and businesses. Program components include:
  - Operating residential curbside recycling program for single and multiple family dwellings in most unincorporated areas. In addition to providing collection services, they provide educational brochures to residents to help increase their level of awareness about recycling issues.
  - Conducting Household Hazardous Waste Roundups in

partnership with cities throughout the County. In 1998, Agoura Hills, Malibu, Calabasas, Hidden Hills and Westlake Village participated in roundups that resulted in collection of 24,246 lbs. of waste.

- Producing and distributing of Public Service Announcements (PSAs) and educational advertisements/brochures.
- Hosting free workshops and events to educate residents about green waste recycling, composting and gardening techniques to reduce water use. This program also promotes the recycling of Christmas trees each year.
- Partnering with local agencies to provide household hazardous waste roundups for their residents on a regular basis.

LAC-DPW and Ventura County promote participation in recycling programs through radio PSAs, web sites, local newspapers, fliers, city hall offices, chambers of commerce and libraries. When roundups are scheduled in a particular city, a banner is often hung across a road in a prominent section of town advertising the event. Both Counties also offer semi-annual *Green Gardening* workshops for the general public which include non-toxic gardening suggestions and composting information/supplies.

- The Las Virgenes Municipal Water District promotes composting and conservation efforts through:

  - The *Rancho Composting Facility*, which recycles all of Tapia's biosolids into garden compost. The compost is then sold in nurseries instead of being sent to the Calabasas landfill. The District has also installed two advanced energy fuel cells at the composting facility to convert methane gas generated from wastewater processing into electricity. The cells are now fully operational and generate power for use and sale.
  - A pilot incentive program, which was launched during FY 1998/99 for customers willing to replace all of their toilets with ultra low flow toilets (ULFT). This program tripled the number of ULFT retrofits in one year from 300 to 900.
  - The District co-sponsored *North American Residential End Use Study*, which installed data loggers in 100 homes to gather detailed information on water use. The data is being used to set national standards on appliance efficiency and conservation program planning. The study confirmed that toilet flushing is the single largest indoor use and provided data on leak incidence. Other water conservation practices promoted by LVMWD are

addressed under Public Education: Conservation (#30).

- The City of Malibu, jointly with LAC-DPW, maintains a permanent used oil drop-off site at its City Hall. The City also hosts monthly "Household Hazardous Waste Roundups" for collection of water-based paint, batteries and oil/oil filters, and bi-annual roundups for other chemicals. Malibu promotes its recycling efforts through the City's quarterly newsletter and distributes oil recycling containers and literature through a partnership with a local automotive retailer. Using these collection avenues, local residents recycled approximately 1143 gallons of used motor oil during the fiscal year 1997/98.

- Calabasas recently began offering curbside recycling for green waste and mixed recyclables to local residents. The City also provides: 1) the Environmental Connection Handbook which promotes reducing/reusing/recycling, composting and correct disposal of household hazardous waste, and 2) monthly used oil, paint, batteries, and antifreeze recycling opportunities.

- The City of Agoura Hills offers residents several opportunities to recycle their waste and conserve water. They: 1) conduct a curbside recycling program for paper, metals, and glass (initiated in 1991); 2) conduct a Christmas Tree recycling program each year; 3) initiated yard waste and household hazardous waste collection programs in 1995, and 4) adopted a Water Efficient Landscape/Irrigation ordinance in 1992 to reduce the amount of water being used for landscape/irrigation purposes. The City also began using rubberized asphalt in all overlay programs. During fiscal year 1998/99, the City used over 15,000 recycled tires in the overlay program.

- The City of Thousand Oaks offers weekly curbside pickup of green waste for recycling and bi-weekly pickup for paper, glass and metals.

- State Parks ensures, through its waste hauler contracts, that recycling bins are provided for the public to use when visiting Malibu Creek State Park and Malibu Lagoon State Beach.

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30. ***Public Education - Conservation*. Develop individual support for conservation practices through education, training and workshops which would reduce sediment and storm water runoff from private property.**

Only the activities undertaken by the Las Virgenes Municipal Water District promoting water conservation are addressed here. Other implementor's conservation programs are part of ongoing, wide-scale and multi-issue public education programs and are addressed under Public Education (#42).

The Las Virgenes Municipal Water District conducts a variety of water conservation programs and outreach projects throughout the year, which include:

- Bilingual "Protector del Aqua" classes emphasizing water conservation for local landscape maintenance companies.
- Distribution of educational fliers promoting water conservation to service area residents (in partnership with the Triunfo Sanitation District).
- A comprehensive website (www.lvmwd.dst.ca.us) with easy-to-find water conservation tips and information.
- *The Current Flow*, a quarterly newsletter with periodic information about water conservation and recycling information.
- Participation in local events, such as fairs and farmers markets.
- Classroom presentations and facility tours.
- Water efficiency tours to help residents reduce the amount of water needed for landscape irrigation.

31. ***Runoff Reduction***. **Develop land use decision-making approaches (including land use zoning and ordinances) to reduce point and nonpoint sources of pollution. Specifically, new developments within the watershed should employ on-site reuse of reclaimed water so that there is no net increase of water into the watershed. Develop and implement: 1) guidelines for minimizing and mitigating ecological disturbances related to point and nonpoint water flows into "unimproved" coastal streams; and 2) watershed-wide ordinances which would reduce storm water runoff from private property.**

Riparian corridor in the Malibu Creek Watershed.

In January 2000, the Los Angeles Regional Water Quality Control Board approved strict discharge standards for new developments in all of Los Angeles County. The Regional Board's Executive Officer then issued the new requirements in March, 2000. Specifically, the policy states that all new development projects meeting certain criteria must retain and/or treat the first ¾-inch of rainfall from any storm on-site (i.e., it must not reach the storm drain system). The policy will have a greater impact on newly developing regions than on existing, high density regions. Several cities in the County have appealed this ruling to the State Water Resources Control Board.

The City of Calabasas requires that new developments maintain a certain percentage of pervious surface, depending on what type of construction project is designed. For example, parking lots are required to maintain 30% perviousness. However, in some areas of the City, soils are high in clay content and hence expansive so pervious requirements are challenging. Development projects are thus evaluated on a case-by-case basis. Mitigation measures are required for those sites that do not, or cannot incorporate the pervious surface element into their plans.

The Cities of Agoura Hills and Westlake Village adopted their storm water and urban pollution control ordinances in 1997. As mentioned under Eliminate or Reduce Sources (#4), this ordinance gives Agoura

Hills and Westlake Village legal authority to enforce BMP requirements to reduce point and nonpoint sources of pollution, including site-specific measures for construction projects to minimize ecological disturbances.

The City of Malibu primarily addresses the problem of increased urban runoff from new development through setting limits on impervious surfaces under its zoning ordinance. The criteria for commercial developments includes: 1) devoting 40% of the lot area to landscaping, 2) devoting an additional 25% of the lot area to open space, and 3) limiting the floor area ratio to 15%. The criteria for residential developments includes limiting the use of impermeable surfaces to 30-45% of the total site area. Where downstream flooding and/or erosion is a potential concern, the City also requires developments to provide on-site retention of runoff volumes equal to predevelopment rates.

Recently, the Las Virgenes Municipal Water District, with support from the Metropolitan Water District of Southern California and the US Bureau of Reclamation, installed computerized irrigation controllers on street medians to regulate the amount of water used for irrigation. These controllers were tested against other controllers in the City of Westlake Village. The District also installed advanced plant ETo **J** sensor stations with real-time telemetry which measure the amount of water used by local plants each day. This daily data is linked to the LVMWD website (http://lvmwd.dst.ca.us) and can be accessed by all residents who use irrigation controllers for outdoor irrigation to refine their irrigation schedules. The ultimate goal in providing this data is to reduce: 1) the amount of water needed for irrigation by end users and 2) runoff from street medians. Nearly all large water users such as golf courses, schools, and cities could benefit significantly from the information provided by the ETo **J** sensors. In the coming year, the District will begin to educate the top 20% of its largest users about the sensor data to help them understand its benefits, how to access the data and how to make corresponding changes in their irrigation practices.

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32. ***Recreational Use Impacts.*** **Reconcile demands for public access and resource protection regarding trails and roads.**

There is a need to protect watershed habitats and resources while at the same time allowing these lands to be used for recreational purposes. To better balance these needs, the City of Calabasas outlined a comprehensive Las Virgenes Canyon subwatershed study in 1999 which included: 1) developing a master plan for Las Virgenes creek and 2) outlining issues to be addressed, such as wildlife corridors, potential for recreation and public access, and engineering requirements for flood control. The information collected under this study will be used to develop a priority list of projects to accomplish riparian habitat improvements for both wildlife and residents. The City has submitted three major grant applications to secure enough funds to both initiate the study and to start working on some of the project's components. The SWRCB 205(j) Watershed Planning Grant application received funding to initiate this study; the Federal EPA EMPACT Grant application was initially denied but resubmitted with changes; and the Water and Watersheds Research Grant application was denied.

In addition to installing interpretive signs next to the parking lot at Malibu Creek State Beach, the RCDSMM incorporated a public access trail into its Malibu Lagoon restoration project (highlighted under Restore/Enhance Malibu Lagoon and Surfzone, #20). Visitors can now walk directly to the shores of the lagoon near Pacific Coast Highway via a walk bridge and get an up close look at the lagoon's mud flats, birds and aquatic habitat.

While State Parks provides public access to almost all of its natural resource areas, the agency does limit access in employee housing areas, areas that have been revegetated, nesting areas for sensitive/endangered species and any area considered unsafe.

33. ***Land Purchases***. **Purchase high priority watershed protection areas**.

There are several key parcels of land that, if acquired by a non-profit organization or a state or local government agency, would greatly benefit overall restoration and protection goals throughout the watershed. Although none have yet been purchased, State Parks has identified several of these parcels in an internal report.

One such prominent site in the lower watershed is the golf course area adjacent to Malibu Lagoon (on the north side) and the vacant parcel next to it. This land was once part of the lagoon and has the potential to be restored as additional habitat for native species and birds migrating along the Pacific flyway. Other identified parcels include 160 privately owned, undeveloped acres located just north of the Cold Canyon Road northern loop; the Cross Creek Plaza; Ahmanson Ranch; and land near Lake Sherwood in the Hidden Valley area.

The National Park Service, in partnership with local scientists, planners and resource management professionals developed a set of objective, scientifically credible conservation criteria as a basis for deciding which lands in the Santa Monica Mountains were the highest priority for acquisition and protection. Using geographical information system (GIS) tools, lands high in resource value were identified, gaps in knowledge were identified, and maps identifying significant natural, cultural and recreational areas were produced. Land management agencies are using this data to set priorities for land protection within the Santa Monica Mountains and surrounding areas.

The City of Malibu is investigating the possibility of land acquisition for a constructed wetland in the Civic Center. If acquired, the land would provide for wetland treatment of Malibu Creek's flows and a year-round source of water for the existing seasonal wetland located on the north side of the Civic Center Way (west of Stuart Ranch Rd).

The Malibu Coastal Conservancy, a community-based, non-profit organization whose mission is to facilitate acquisition and restoration of open space and environmentally sensitive lands, has also focused its attention on acquiring the open space considered part of the Malibu Wetlands.

34. ***Buffer Zones*. Develop and mandate site specific buffer zones for sensitive areas.**

Within its park boundaries, State parks has identified areas where buffer zones could be established or improved to protect sensitive areas. One such site is located in Tapia Park. Here, State Parks redesigned the road system to better protect the riparian forest adjacent to Malibu Creek.

The Las Virgenes Municipal Water District, the City of Calabasas and the Santa Monica Mountains Conservancy co-funded ($3,000,000) the purchase of approximately 700 acres of open space adjacent to the District's Rancho Composting facility as a buffer zone against urban encroachment. The City of Calabasas also instituted a development code requiring builders to ensure a 100-ft development setback (or other distance to be determined by a qualified biologist) from watercourses within their jurisdiction.

The City of Agoura Hills has established open space zones for its hillside areas and has adopted County designated "Significant Ecological Area" (SEAs) to help protect local natural resources.

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35. ***Habitat Fragmentation*. Develop and implement land use policy that will eliminate any additional habitat fragmentation. Support existing corridors between isolated open lands and establish alternatives where feasible.**

Together, the National Park Service and State Parks have encouraged and funded habitat linkage studies within Malibu Creek State Park. Through a grant from the National Park Foundation, Canon USA, the Southwest Parks and Monuments Association, California State Parks and the National Park Service, a cooperative research effort was launched in 1996 to address critical concerns associated with carnivores. Because carnivores play a critical role in ecosystem functions and are indicators of ecosystem health, this long-term research will try to determine how urban growth and encroachment impacts carnivore habitat. Components of the study include: 1) radio telemetry to evaluate home range requirements, habitat needs and movement patterns for bobcats, coyotes, badgers and gray foxes, and 2) remote camera surveys to evaluate overall carnivore distribution patterns and to assess population sizes of marked animals. Results of the project will be incorporated into park planning and resource management activities to promote wildlife conservation in the

Santa Monica Mountains. Data on animal movement and critical habitat areas will also be used to guide park planning actions, land protection strategies and habitat restoration efforts.

The City of Calabasas established Open Space Districts through a section of its development code. These districts are intended to prohibit or limit developments in areas: 1) with important environmental resources, 2) with potential hazards, and/or 3) to maintain open space for wildlife habitat.

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36. ***Fish Barriers*. Remove barriers to fish migration, especially Rindge Dam.**

Rindge Dam.

Rindge Dam, which was constructed in 1924, is a 100-ft dam located on Malibu Creek approximately 2.5 miles upstream of Malibu Lagoon. By the late 1950s, the dam had significantly filled with sediment and no longer functioned as intended. The Army Corps of Engineers estimates that 800,000 – 1,600,000 cubic yards of sediment are trapped behind the dam wall today.

Starting in the mid/late 1990s, interest in removing Rindge Dam gained momentum and has since resulted in the formation of the Steelhead Recovery Task Force under the Malibu Creek Watershed Executive Advisory Council. Since its inception, the focus of this task force has expanded from just assessing the feasibility of removing Rindge Dam to addressing all creek barriers prohibiting steelhead trout[24] from reaching valuable upstream spawning grounds. Heal the Bay, through its Stream Team activities, has surveyed 15 miles of Malibu Creek and mapped all barriers to fish passage in the watershed. While Malibu Creek remains the primary focus, several other creeks (Topanga, Solstice and Arroyo Sequit) are also being surveyed and documented for obstructions to steelhead migration.

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[24] Steelhead trout was added to the federal list of endangered species in August, 1998. See Restore/Enhance Malibu Lagoon and Surfzone (#20) for additional information.

Site Statistics	Rindge Dam is located approximately 2.5 miles upstream of Malibu Lagoon. The site selected for construction was the eastern end of a segment of the creek which runs west to east, where the canyon walls narrowed and the geology was most favorable for attaining structural strength and stability.		
Design and Construction	Rindge Dam was constructed in 1924 and the adjacent spillway was completed in 1926. The dam was constructed in a constant arc radius design using Belgian cement and steel railroad rails for reinforcement. Its original purpose was to provide water for irrigation of ranch lands in the Santa Monica Mountains.		
Capacity	The original reservoir capacity of the dam was 574 acre-ft (186 million gallons of water). By about 1956, the capacity had reduced to 50 acre-ft due to increased sediment deposits. By 1965, the reservoir was completely filled with sediment. It is estimated that Rindge Dam now holds approximately 10 million gallons of water within its sediment base.		
Customer Base (No. of Customers,	**Year**	**Commercial Users**	**Irrigation Users**

Steelhead Recovery Task Force efforts led directly to the Army Corps of Engineers (Corps) involvement in assessing the feasibility of the alternatives presented for removing Rindge Dam. In early 1999, the Corps concluded an initial reconnaissance study which determined that there was enough support among watershed stakeholders to move forward with a feasibility study. Among other things, the study also concluded that removal of Rindge Dam and other Malibu Creek barriers would allow steelhead to access an estimated 4630 ft^2 of spawning habitat and 2 linear miles of rearing habitat within the Malibu Creek watershed.

The Corps is now planning a full-scale feasibility study which will assess various removal/mitigation alternatives, associated costs, timelines and federal interest. Potential alternatives include: 1) dam removal, 2) installation of conduits through the dam and reservoir, and 3) construction of a fish ladder.

Despite these efforts, the feasibility of steelhead's survival in the upper watershed has been questioned by some who cite high temperatures, variable creek flows, contaminated discharges and other barriers as detrimental to the survival of the species. Although historical flow data indicates that Malibu Creek was an intermittent stream, several fish biologists looked at recent water quality/quantity data and found that current upper and lower creek conditions would not be detrimental to steelhead trout.

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37. ***Exotic Vegetation***. **Support control of the intrusion of exotic plants into the wilderness areas of the watershed.**

Controlling the spread of exotic vegetation in the watershed is, at best, a daunting task that requires endless effort and resources. More than 20 species have significantly impacted the Malibu Creek watershed and other coastal regions, and their impact is cumulative. Table 2.4 highlights the watershed's most significant non-native plant species. Some plants (grasses) have even changed the soil structure, making it nearly impossible for native species to grow.

Exotic Plant Species Found in the Malibu Creek Watershed

Common Name	Scientific Name
Black Mustard	*Brassica nigra*
Castor Bean	*Ricinus Communis*
Eucalyptus	*Eucalyptus sp.*
Euphorbia (false caper)	*Euphorbia terracina*
Giant Reed	*Arundo Donax*
Horehound	*Marubium vulgare*
Harding Grass	*Phalaris aquatica*
Ice Plant	*Carpobrotus edulis*
Italian Thistle	*Carduus pycnocephalus*
Mediterranean Mustard	*Hirschfeldia incana*
Milk Thistle	*Silybum marianum*
Myoporum	*Myoporum laetum*
Pepper Grass	*Lepidium latifolium*
Ripgut	*Bromus diandrus*
Smilo Grass	*Piptatherum miliaceum*
Star Thistle	*Centaurea melitensis*
Sweet Fennel	*Foeniculum vulgare*
Tree of Heaven	*Ailanthus altissima*
White Sweet Clover	*Melilotus albus*
Wild Tree Tobacco	*Nicotiana glauca*
Yellow Star Thistle	*Centaurea solstitialis*

Table 2.4. Exotic plant species found in the Malibu Creek watershed.

One of the most prolific exotic plant species found in lower and upper Malibu Creek Watershed is A*rundo donax* (also known as giant reed). This reed can grow as much as 2.5 inches per day and reach a maximum height of 27 feet. Its growth rate and rapid defense mechanism make it nearly impossibly to eradicate once an area has been invaded. The plant spreads primarily during floods when it is uprooted from upstream locations and transplanted further downstream. *Arundo donax* soaks up huge amounts of water, rapidly replaces native riparian habitats, obstructs wildlife access to waterways and is an extreme fire hazard. Data collected by Heal the Bay's Stream Team shows that there is an enormous amount of *Arundo donax* in Malibu Creek, just below Malibu Creek State Park. Efforts are currently underway to remove it from a 2.5-mile reach of Malibu Creek, between Rindge Dam and Malibu Lagoon. Once removed, native species will be planted as necessary to create a healthy riparian canopy in areas disturbed by this invasive plant.[25]

State Parks, Mountains Restoration Trust and Stream Team volunteers have identified and recorded non-natives throughout the watershed. Stream Team volunteers are even using global positioning system (GPS) devices and field guides which have plant identification keys to identify the

[25] This is a cooperative project between the National Park Service, Santa Monica Mountains National Recreation Area (NPS), California Department of Parks and Recreation, Malibu Creek State Park; and Mountains Restoration Trust.

exact locations of several non-native plants found in riparian zones.

With assistance from the Los Angeles County Fire Department, State Parks has initiated four prescribed burns since 1996 to help control proliferation of milk thistle, an exotic species found on the parklands. They also manually remove, on a regular basis, substantial stands of yellow star thistle, sweet fennel, Arundo, Euphorbia and other exotic plants on the parklands.

Weed Warriors, a volunteer group coordinated by the California Native Plant Society and recruited by word of mouth, has removed invasive exotic vegetation (e.g., castor bean, ice plant, Arundo) from public lands throughout the Santa Monica Mountains since the mid-1980s. Some of their restoration locations include Sycamore Canyon, Cold Creek, Malibu Creek State Park, Lower Malibu Creek and Lagoon, and Bluff Park. The number of volunteers and volunteer hours recruited for restoration activities varies from location to location, but usually ranges somewhere between 1000-2000 hours each year. The frequency of restoration activities ranges from monthly to yearly, depending on the site. However, Weed Warrior's efforts to remove non-native vegetation are significantly boosted immediately after a fire when re-sprouting, non-native plants are small and easy to remove. Heal the Bay has even begun to advertise Weed Warrior event dates in their monthly volunteer newsletter *Sea Stars*. Because Weed Warrior volunteers do not use heavy or powered equipment, they generally choose areas where a native remnant population still exists. This approach increases the success of their efforts because it improves the opportunity for native re-colonization once the exotics are removed.

The City of Malibu reviews all new development plans to ensure that invasive, non-native species are not planted. The City maintains and provides, upon request, a list of prohibited plants to applicants and landscape architects. City personnel also make recommendations on what types of native species to plant. However, the City does not require existing exotics to be removed unless it is required as mitigation for a project, or unless the plants are targeted by the County Fire Department as part of a fuel modification plan to reduce the threat of fire. The City's Environmental Review Board will consider measures to increase the public's awareness about exotic vegetation in their workplan to the City Council in February, 2000.

Most recently, a new sub-committee has been formed under Malibu Creek Executive Advisory Council – the *Invasive Species Task Force*.

Its mission is to identify, assess and initiate removal of invasive species in the watershed.

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38. ***Wetlands*. Maintain, restore, create and enhance wetlands (natural and created).**

The Southern California Coastal Wetlands Inventory, which was established as part of Governor Wilson's *1993 Wetlands Conservation Strategy*, identifies 39 coastal wetlands between the Point Conception and Mexican border. Malibu Lagoon is included in that inventory. The overall goal of the strategy has been to identify regional and statewide wetland restoration and enrichment opportunities. Information for each wetland in the inventory includes: 1) a map of the site's historic perimeter, 2) a map of the site's vegetative communities, and 3) a site profile documenting the wetland's physical and biological characteristics. A comprehensive summary of Malibu Lagoon's inventory information can be found on the internet at http://ceres.ca.gov/wetlands/geo_info/so_cal.html.

Locally, the City of Malibu completed a wetlands delineation for the Civic Center area. Only one site was identified as an existing wetland – a sump area approximately four acres in size which is located north of Civic Center Way and west of Stuart Ranch Road. The City is also considering plans for a constructed wetland/creek paralleling Civic Center Way. The wetland/creek would secure a connection between Malibu Creek and the existing wetland (pond) area to provide: 1) additional biological treatment for dry weather flows and 2) storm water detention in the event of flooding in the Civic Center area.

The Malibu Coastal Land Conservancy helped the City of Malibu secure a $150,000 grant from the Federal Emergency Management Act (FEMA) flood insurance plan to develop a city-wide flood mitigation plan. The plan will: 1) identify areas with repetitive flood damage claims, 2) develop appropriate mitigation measures, and 3) evaluate wetlands restoration as a potential flood mitigation measure in the Civic Center area.

In March 1998, the Las Virgenes Municipal Water District began rehabilitating a percolation pond as a constructed wetland. The pond, once rehabilitated, could be used to polish Tapia's effluent and to treat urban runoff flowing from the upper watershed. However, there is some debate about what the constructed wetland is to be used for during the

Tapia's summer discharge prohibition period each year.

39. ***Coordinate on a Watershed Basis.*** **Create and implement a regional and subwatershed approach to the coordination of land use and water quality decisions for ongoing implementation concerns and to reduce unnecessary overlaps of ordinances and streamline regulations.**

- **Develop guidelines to reconcile the attainment of water quality objectives and resource protection with other, possibly conflicting public service goals, such as fire protection, flood control, and geologic stability.**

  The Resource Conservation District of the Santa Monica Mountains and other members of the Malibu Creek Executive Advisory Council have coordinated with the Los Angeles County Department of Public Works to establish new flood control channel clearing guidelines – guidelines that would preserve the maximum amount of habitat possible while ensuring public safety. As a result, new protocols were established for evaluating the necessary BMPs for each channel clearance site in the Malibu Creek Watershed. The protocols are now being used by FLORA as a model to inventory channel habitats and to develop recommendations for channel clearing in the Los Angeles River watershed.

  LAC-DPW has also improved its BMP practices related to infrastructure construction, maintenance and repair of roads, culverts, bridges, etc. (as called for in the 1996 Municipal Storm Water NPDES permit). These measures help to minimize impacts on local habitats and reduce erosion and sedimentation problems common to these types of activities.

  Please also see responses to Fire Regulation-Erosion Control (#11) and Recreational Use Impacts (#32).

- **Build support for the implementation of the mediation recommendations (research studies, ordinances, joint agreements, etc.) among agency staff and non-agency stakeholders who are working on management plans which affect the watershed – RCD/SCS Natural Resource Plan, SMBRP Comprehensive Conservation Management Plan, LA County NPDES storm water permit, City of Malibu Wastewater Management Plan, General Plans of area cities and the LA County 101 Corridor/Cities Area Plan Update.**

  Several efforts which either build support for, encourage or mandate the implementation of management plan actions/recommendations have been highlighted throughout this report. In summary, these include:

- Formation of the Malibu Creek Executive Advisory Council and its subcommittees;
- The 1996 Municipal Storm Water NPDES permit requirements;
- Local municipal ordinances;
- Public education programs;
- Water quality improvement and habitat restoration pilot projects in the watershed; and
- The availability of Prop A bond funds.

■ **Establish mechanisms, including joint powers authorities (JPAs), watershed commissions, special districts or other cooperative efforts for the integration of efforts aimed at coordinating, planning, and/or implementation where multi, general-purpose jurisdictions exist.**

The Cities of Agoura Hills, Westlake Village, Malibu, Calabasas and Thousand Oaks formed a joint powers authority (JPA) called the Council of Governments (COG). The JPA's governing board consists of one representative from each city and one ex-officio member representing the County of Los Angeles. The governing board then established a technical advisory committee (TAC) to review and make recommendations to the board as necessary. The COG meets monthly to review the TACs recommendations and to set priorities for the watershed as a whole. The formation of the COG has had several beneficial results, including:

- Creation of an operating budget to leverage city funds.
- Increased representation on regional committees in organizations such as the Southern California Association of Governments (SCAG) and the Metropolitan Transportation Authority (MTA).
- Adoption of priorities for the sub-region (transportation, open space preservation, watershed management, pollution reduction and public education).
- Securing funds totaling over $150,000 to study and set regional priorities.
- Promoting legislation that would provide incentives for property owners to donate land for open space.

■ **Develop and field test interactive models to facilitate systems-based watershed planning and management decisions.**

This action has not occurred. The National Park Service has been identified as the oversight agency, but there is no formal lead.

■ **Identify and create appropriate financing options which work and are**

cost effective, including joint financing options so duplication is avoided.

Although no formal source of funding has been established or identified to coordinate watershed planning efforts, agency stakeholders have been quite successful in securing funds to conduct many of the actions called for in the various watershed plans. Table 1.3, starting on page 12 in **Section One: Overview**, summarizes many of the watershed's major restoration projects and studies.

The Joint Powers Authority mentioned above could also be a mechanism for joint financing of watershed projects.

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40. ***Enforcement - General*. Develop effective means to enforce pollutant reduction programs.**

Local ordinances, developed by watershed cities under the 1996 Municipal Storm Water NPDES permit, have proved to be a creative mechanism for establishing and enforcing local pollution prohibitions. For example, local ordinances now call for developers to implement appropriate, site specific BMPs regardless of the size of their construction site; restaurants must not allow food waste to reach the storm drain system, mobile car washers must comply with wastewater discharge restrictions. Cities are also required to conduct "educational site visits" for businesses regulated under the Storm Water NPDES permit program. Although these visits are not used to enforce pollution reduction programs, city personnel use the opportunity to help businesses understand the rules and regulations governing polluted discharges.

Enforcement of the cities' storm water ordinance prohibitions is primarily passive in nature. Most city personnel do not "patrol" the streets looking for violators, but rather rely on calls/complaints to 1-888-CLEAN LA or to the city directly, or through "seeing" the violation take place. Calabasas also uses the sheriff's department to identify violators, and Thousand Oaks routinely inspects restaurants, automotive repair facilities and constructions sites for compliance. Once violations are discovered, specific steps are taken to resolve them. The City of Westlake Village, for example, employs verbal, written and even prosecution measures to enforce pollution control measures. Enforcement activities do occur through city inspector programs for some industrial/commercial and construction sites, but this is not the case for every facility due to the educational site visits mentioned above.

The City of Malibu and the Los Angeles County Department of Health Services conduct enforcement activities relating to illicit connections and malfunctioning septic systems in the Malibu Creek watershed. However, they are unable to provide staff to conduct these activities on a regular basis and thus rely on tips and complaints from the public to help identify and respond to such problems. Malibu has implemented a 24-hour Emergency Response Program in partnership with the County Sheriff and Fire Departments for septic spills and overflows. The City and the County Sheriff, Fire, and Health Departments are also notified to respond to 911 calls made by the public reporting any spills. In the event of a spill, both the City and County Fire Department are equipped to prevent spills from entering storm drains and take further action as needed. Code enforcement actions follow where necessary.

The Los Angeles County Department of Health Services approves the design aspect of septic systems but does not inspect them or regulate their maintenance and upkeep. Septic system installation permits are issued by LAC-DPW's Building and Safety division as part of an overall building permit of a site. Once installed, the Heath Services department only addresses septic system problems where public health is threatened and, like the City of Malibu, relies on complaints and tips to take enforcement action against violators.

In its report, "*Omission Accomplished: The Lack of a Regional Water Board Enforcement Program, 1992-1997*," Heal the Bay strongly criticized the Regional Board's enforcement activities relating to: 1) sewage, oil and hazardous substance spills; 2) industrial storm water violations; 3) illicit connections and poorly maintained or failing septic systems; and 4) NPDES and WDR permit violations. Since the *Omission Accomplished* report was released in 1998, the Regional Board's enforcement activities have significantly increased as has its budget to conduct these activities. A complete summary of the LARWQCB's enforcement activities are documented in quarterly reports which are available to the public.

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41. ***Enforcement - Camping*. Enforce existing camping restrictions within the watershed.**

When necessary, State Parks removes transient encampments from state park property. They also patrol parklands for illegal campsites on a regular basis and take appropriate action when such sites are encountered.

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42. ***Public Education*. Emphasize and encourage ongoing public education.**

- **Create a nonpoint source pollution education program for watershed occupants.**
- **Develop a *Adopt-A-Watershed* program that is watershed-wide.**
- **Implement effective education programs about the need for urban and non-urban preservation of open space and buffer zones.**

Educational Websites

www.ci.thousand-oaks.ca.us
www.ci.calabasas.ca.us
www.ci.malibu.ca.us
www.ci.agoura-hills.ca.us
www.co.la.ca.us
www.healthebay.org
www.laaudubon.org
www.lvmwd.dst.ca.us
www.ocd.ucla.edu
www.smbay.org
www.surfrider/SFMalibu/

Several watershed-based public education programs were addressed under Composting/Recycling/Conservation (#29) and Public Education: Conservation (#30). In addition to those outreach activities, many more are highlighted here.

- For more than 14 years, the RCDSMM has conducted field-based, year-round Marine Science Programs for students at Malibu Lagoon and Malibu Creek State Park. These programs are active, hands-on and participatory, emphasizing estuarine ecology, water quality and watershed dynamics. The programs further stress the problems caused by urbanization on wildlands, and provide solutions and watershed protection activities that students can incorporate into their daily lives.

The RCDSMM also produced the *Stable and Horse Management BMP Manual* for use by local horse owners and commercial stables (discussed previously under #18, Confined Animals). Complimenting this particular effort, Quint Cities[26] worked with the RCDSMM to create a companion handout entitled *Best Management Practices for Stable and Horse Management*. Both are available to horse owners and commercial stable facilities in the Malibu Creek watershed.

- State Parks gives lectures to teachers in the Los Angeles Unified School District on the values of and need to preserve open space. They have also incorporated open space and watershed protection themes into State Park nature walks, school presentations and campfire programs.

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[26] Quint Cities is a consortium of Malibu Creek watershed cities which includes Malibu, Agoura Hills, Westlake Village, Thousand Oaks and Calabasas.

- The City of Agoura Hills has actively targeted local residents since 1993 with educational information on conservation, sediment reduction and nonpoint source pollution prevention. Their endeavors include: 1) sponsoring local advertising campaigns; 2) distributing fliers at community events and at City Hall; 3) sending mailers to local schools; 4) writing about conservation practices in the City newsletter (circulated to 8,000 residents); 5) contracting with the Department of Health Services to educate restaurant employees about BMPs; and 6) conducting educational industrial/commercial site visits. The City also created an Open Space Task Force in 1998 which subsequently developed the *Open Space Preservation Plan* (released Fall, 1999).

- The City of Calabasas has implemented several educational programs addressing open space and buffer zone preservation which are supported by City Council members and CTV (a local cable access channel which serves as a source of environmental information). The City promotes: 1) the availability of biking trails via regional biking fliers; 2) the use of the City's parks through quarterly distribution of recreation booklets; and 3) the use of native, low water use plants (providing technical assistance on plant selection).

  While the *Open Space/Buffer Zone Preservation* concept has City support, there are no specific guidelines for private property owners to follow and actual implementation of this concept is primarily left to the developer's discretion. However, the Transportation Department is in the process of developing a master plan for trails in the city which will require most large developments to dedicate portions of their property to open space, and the City does prohibit new development activities within 100 yards of creeks and streambanks.

  Although the process has been slow, Calabasas also initiated an *Adopt-A-Creek* program to raise awareness about local riparian habitats. As envisioned, the program will be structured to accommodate various levels of public interest, from people who just want to clean up trash to people who want to restore a creek bank on their property or who want to help monitor the health of stream habitats.

- The City of Malibu has plans to implement a pollution prevention advertising campaign using the City's local cable TV channel, starting in November, 1999. The 30-second public service announcements will address how to prevent pollutants from reaching and entering the storm drain system, ultimately polluting local streams and the ocean.

- The City of Thousand Oaks circulates a monthly newsletter, *On the City Scene*, to its residents which highlights a local recycling hotline number, composting and disposal opportunities, hazardous waste collection services, etc. Residents are also encouraged to visit the city's website for up-to-date information on city events.

- In 1995, the County of Los Angeles Department of Public Works initiated a Five-year Storm Water Urban Runoff educational program, targeting residents throughout the entire County. The campaign provided information about various types of nonpoint source pollution such as used motor oil, pet waste, pesticides and herbicides, etc. All cities in Los Angeles County have been invited to join this effort and nearly all have accepted that offer, including the four Los Angeles County cities in the Malibu Creek watershed. Complimenting this five year campaign and building on its own efforts, LAC-DPW also launched the *Storm Water Urban Runoff* campaign and the *Used Oil Recycling* media campaign in 1999.

- Several of the Las Virgenes Municipal Water District's Malibu Creek watershed education programs are highlighted under Composting, Recycling, Conservation (#29) and Public Education – Conservation (#30). Additionally, the District has conducted educational outreach about sensible irrigation practices and the values of landscaping with native species. For example:

  - *Demonstration Gardens* were planted at District Headquarters, along Las Virgenes Road and in Gates Canyon Park. The gardens demonstrate the use of both native and non-native low water use plants.

  - Soil moisture sensors were installed at Gates Canyon Park and Grape Arbor Park in the City of Calabasas.

  - Landscaping software was developed in 1995 and is now routinely distributed by the District. It was also provided to local cities for their building permit plan checks. The software advocates for the landscape ordinance by helping residents understand the water needs for various types of plants and encouraging them to use drought-resistant, native species when landscaping their property.

- Irrigation technical training is intermittently provided (in partnership with local cities) which addresses: 1) basic irrigation principles, 2) irrigation system adjustment, repair and trouble shooting, 3) basic and advanced controller programming and 4) irrigation scheduling.

- Heal the Bay has offered its *Speakers Bureau* program since 1989. This program, comprised of specially trained volunteers, educates local communities and businesses, school children, special interest groups and other interested parties about storm water pollution issues and how each person can make a difference. Heal the Bay's speakers are available upon request and reach out to 25,000 people in Southern California annually.

  In 1998, Heal the Bay launched the *Stream Team* program (mentioned several times throughout this report), which trains and educates volunteers about specific water quality and environmental health issues in the Malibu Creek watershed. Already, The program has trained over 75 volunteers to help measure water quality and to conduct surveys on pollution sources and degraded habitats throughout the watershed. Heal the Bay also participates in the Eco-Heros program. The program has educated over 360 students about the effects of nutrients, sediments, urban runoff, and other water quality impacts to Malibu Creek and its tributaries.

Businesses are also being targeted with educational outreach by a variety of agencies. For example:

- LAC-DPW visits industrial and commercial establishments to educate owners and employees about implementation of on-site best management practices.
- The Los Angeles County Department of Health Service conducts a mandatory training program for restaurants about implementation of storm water BMPs and making modifications to activities known to contaminate urban runoff.

- Through the SMBRP's Public Involvement and Education (PIE) Fund, Quint Cities produced five pollution prevention brochures targeting: 1) painting contractors, 2) landscape and pool maintenance personnel, 3) contractors and site supervisors, 4) horse owners and 5) residents and homeowners. These brochures are available at the permitting counters in each city.

43. ***Watershed Monitoring*. Develop and implement a coordinated and integrated watershed monitoring program.**

- **Create a centralized database of water quality and resource data accessible to all parties.**
- **Develop a coordinated GIS database network, including a detailed land use map with all septic systems and storm drains, which is accessible to all parties.**

Although no centralized database has yet been created to house water quality and resource data, data collected by various agencies and studies is made available to all interested parties upon request. Many of these watershed monitoring efforts undertaken by watershed stakeholders have been highlighted throughout this report, including:

- Table 1.3, Watershed Restoration Studies/Projects (pgs. 12-15);
- Biological Standards (#5);
- Monitor Pathogens (#6);
- Study Nutrients (#8);
- Temperature (#12);
- Assess Sources/Characteristics (#21);
- Septic Systems (#23); and
- Irrigation Runoff Reduction (#31).

Other specific efforts are summarized here.

- In April 1999, the Monitoring and Modeling sub-committee (formed under the Executive Advisory Council) completed a draft plan calling for a coordinated watershed-wide monitoring program. Its recommendations include adding supplemental monitoring efforts to better establish a comprehensive survey of the state of the Malibu Creek Watershed. Implementation of this action is dependent on the availability of funds to carry it out.

- Through an agreement with two non-profit groups, the Natural Resource Defense Council and Environment Now, the Las Virgenes Municipal Water District contracted with UCLA to conduct a study entitled "*Enhanced Environmental Monitoring Program at Malibu Lagoon and Malibu Creek*." During the study, monitoring was conducted over a two year period from 1993-1995 and the data was analyzed to assess the effects of Tapia's effluent on Malibu Creek and Lagoon. Coincidentally, the study occurred both during one of the biggest fires in history and during an extremely wet year.

The report, released in 1995 and containing more than 100 pages of data, found no conclusive evidence of direct impact of Tapia's effluent on Malibu Creek, Lagoon and local habitats.

- As mentioned under Public Education (#42), Heal the Bay launched a Malibu Creek watershed volunteer monitoring program called *Stream Team* and completed their first water quality training program September, 1998. Participants in the program now sample water at 7 fixed stations throughout the watershed on a monthly basis. Two of these sites, which are minimally impacted by upstream activities, have been designated "reference sites." Another two sites overlap with the RCDSMM/City of Calabasas monitoring sites to assure the quality of data being collected. The monitoring locations are recorded using GPS devices, and the data collected is then organized using GIS capabilities. Observations and data collected include: 1) location of discharge points and outfalls, 2) presence of unstable bank conditions, 3) evidence of artificial streambank modifications, 4) impacting land uses, 5) presence of exotic/invasive vegetation, 6) possible barriers to fish migration, and 7) evidence of illegal dumping. A 150-page illustrated field guide was also developed for Heal the Bay's Stream Team activities by graduate students from the Cal State Pomona Landscape Architecture program. The guide includes step-by-step procedures for water quality monitoring.

  Heal the Bay recently started Phase 2 of this volunteer program, which includes: 1) volunteer training to continue monitoring efforts for years to come, 2) professional assessment of benthic macroinvertebrates (conducted by the CA Department of Fish and Game), and 3) the addition of enterococcus to the list of water quality parameters currently measured. Heal the Bay plans to make Stream Team data available on their website.

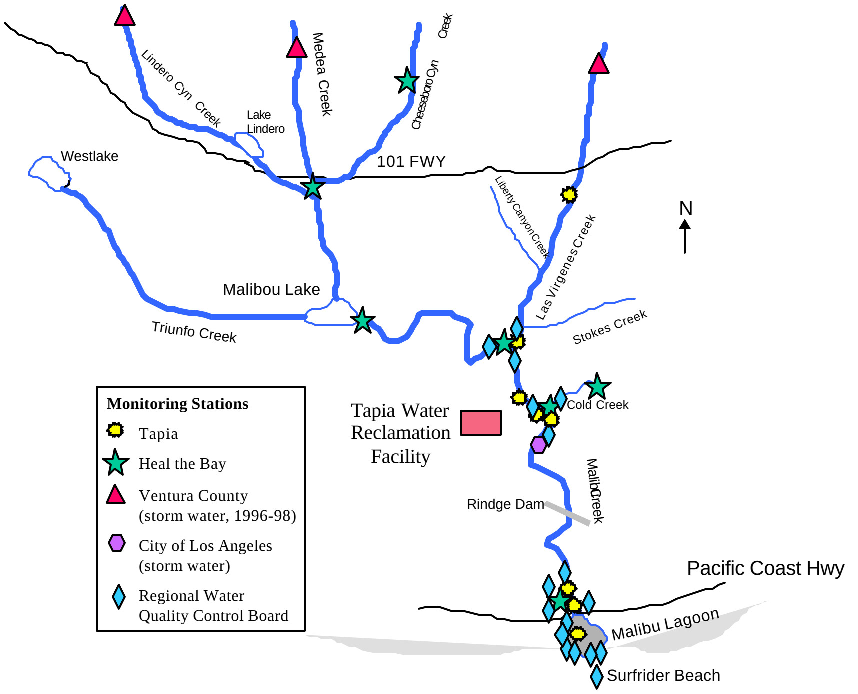

Figure 4. Current monitoring stations in the Malibu Creek watershed.

Heal the Bay has also started creation of a database for monitoring data taken in the Malibu Creek watershed (see Figure 4) and is using GPS to accurately locate other agency/monitoring group and rain gauge stations. To date, the monitoring sites for Calabasas, RCDSMM and the LVMWD have been logged. Ultimately, Heal the Bay plans to become a clearinghouse for all of the monitoring data collected.

Other monitoring data available to the public include: 1) water quality, biological monitoring and surveys of Malibu Lagoon, conducted by RCDSMM (see Assess Sources/Characteristics, #20); 2) volunteer monitoring in the upper watershed, sponsored by the City of Calabasas; and 3) coliform bacteria monitoring in the surf zone, conducted by the Malibu Chapter of Surfrider.

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44. ***Watershed Assessment*****.** **Identify, by subwatershed area, sources of harmful pathogens, toxic chemicals, sediments and nutrients.**

- **Expand an understanding of the hydrology of the watershed and nearshore bathymetry. Agree on needed research on what appropriate and attainable seasonable flows should be for Malibu Creek, Lagoon and nearshore areas.**

At the request of the National Marine Fisheries Service (NMFS), LVMWD conducted a study in 1998 to determine the minimum creek flow needed to sustain steelhead trout populations. Using their own outdoor water audit method and plant types/water needs information collected from the National Park Service and UCLA, the District concluded that a minimum flow (in dry years in late October) of 2-4 cubic feet per second (cfs) recorded at the County gauge station was necessary to ensure at least 1 cfs of flow below Rindge Dam (one cfs is the flow criteria established by NMFS to sustain steelhead trout).

- **Identify and apply suitable models to help target and prioritize pollution prevention, reduction and abatement measures.**

  This action, a fundamental component of several other actions, is summarized in Protect Beneficial Uses (#1), Assess Sources/Characteristics (#21), Runoff Reduction (#31), Habitat Fragmentation (#35), Coordinate on a Watershed Basis (#39) and Monitoring Efforts (#43).

- **Raise funding for and implement study on the health effects of urban runoff on surfers, incorporating Surfrider Beach into the design.**

  In 1995, the Santa Monica Bay Restoration Project conducted an epidemiological study ("Epi Study") to assess the health effects of those who swim directly in front of flowing storm drains. Malibu's Surfrider Beach was one of three locations used in this study. Results of the study showed, conclusively, that there is a significant increase of occurrence in illnesses among those swimming within 100 feet of flowing storm drains. A complete summary of this study is provided under Public Notices (#25).

  Some watershed stakeholders would like to see another epi study conducted that specifically assesses the health-related impacts of surfers using Surfrider Beach. However, the Human Health subcommittee reviewed this possibility with Dr. Charles Gerba (University of Arizona) and concluded that: 1) there were not enough users that could be interviewed in one season to give the study statistical validity, and 2) it's also not clear who would serve as the "control" group for such a study.

- **Establish a Total Maximum Daily Load (TMDL) model for all inputs to the watershed.**

  The Regional Board has been charged with determining how much of a pollutant can be assimilated into a water body without impairing its health and function, i.e., establishing a TMDL. This process, although required in the Clean Water Act for more than a decade, has only just begun. The Regional Board has established a TMDL unit to set discharge limits for pollutants throughout Los Angeles County. In the Malibu Creek watershed, TMDLs are to be developed for nutrients and pathogens/coliform by March, 2002.

- **Develop a research agenda to expand understanding about impacts of land use practices in the watershed.**

  The LVMWD hopes to coordinate its GIS use with data collected from Heal the Bay and others to better understand land use impacts in the watershed. One such application would be to overlay stream location data with district water use data and storm drain locations to better determine where runoff control and treatment efforts would have the greatest impact.

PROGRESS AT A GLANCE

Malibu Creek Watershed Action Plan

MINIMAL	MODERATE	SUBSTANTIAL
WATER QUALITY		**POLICY AND RESEARCH (B-/C+)** **IMPLEMENTATION (D)**
	POLICY AND RESEARCH	
	(1) Develop and set water quality objectives (5) Establish biological (habitat) standards* (8) Determine nutrient standards (21) Assess lagoon characteristics* (27) Landfill impacts on water quality (44) Watershed assessment	(6) Monitor pathogens
	IMPLEMENTATION	
(7) Reduce pathogens (9) Reduce nutrients (23) Manage septic system discharges (40) Enforce Pollution Reduction Programs	(4) Eliminate sources of pathogens, toxic chemicals, sediments and nutrients (10) Reduce accelerated sedimentation* (13) Storm drain stenciling and other BMPs (14) Regulate mobile car washes (15) Eliminate illegal drains (17) Control trash on parklands* (18) Implement confined animal BMPs*	
REDUCING EXCESS FLOWS (WATER QUANTITY)		**(D)**
(19) Household irrigation runoff survey (31) Runoff reduction measures	(28) Maximize use of reclaimed (recycled) water	
MANAGING SOLID WASTE		**(B-)**
	(17) Control trash on parklands* (18) Implement confined animal BMPs*	(29) Implement composting, recycling and conservation measures*
LAND USE		**(C-)**
(34) Create/maintain buffer zones for sensitive areas*	(10) Reduce accelerated sedimentation* (18) Implement confined animal BMPs* (32) Public access and resource protection* (35) Habitat fragmentation* (41) Enforce camping restrictions	(11) Fire regulation and erosion control*
HABITAT RESTORATION AND PROTECTION		**(D-)**
(5) Establish biological (habitat) standards* (12) Establish water temperature policies (24) Regulate lagoon water levels (32) Public access and resource protection* (33) Purchase high priority land areas (34) Buffer zones for sensitive areas* (36) Remove barriers to fish migration (37) Control exotic vegetation in wilderness (38) Maintain, restore and create wetlands	(10) Reduce accelerated sedimentation* (20) Restore Malibu Lagoon (21) Assess lagoon characteristics* (35) Habitat fragmentation*	(11) Fire regulation and erosion control* (26) Mitigate impacts of PCH Bridge reconstruction on Malibu Lagoon
COORDINATION AND OUTREACH		**(A-)**
	(18) Implement confined animal BMPs* (30) Promote water conservation (43) Develop and implement coordinated monitoring program	(25) Post public notices (29) Implement composting, recycling and conservation measures* (39) Coordination efforts (42) Public education programs

SECTON III: KEY FINDINGS

Over the past decade, an enormous amount of energy has been invested into making restoration of the Malibu Creek watershed a reality. These efforts have ranged from establishing an Executive Advisory Council and contributing countless hours for stakeholder meetings to creating a set of restoration priority actions and implementing them. And, while not all of the 44 actions identified in this report have been fully, or even partially implemented, there has been a measure of progress towards achieving their stated objectives. Table 3.1 highlights ten of the most significant accomplishments towards watershed restoration. This list represents the efforts of the entire stakeholder group through its partnerships, review committees, creative funding sources, technical support and hands-on restoration activities.

Section III summarizes the key findings of **Section II: Action Plan Update**. More specifically, it evaluates progress made to achieve the goals of the Malibu Creek Watershed Plan in relation to the key issues of concern in this watershed, i.e., water quality and quantity, solid waste, land use practices, habitats and coordination/outreach efforts. The preceding page provides a snapshot of the results of this assessment, i.e., how well the Plan's 44 actions have been implemented and whether they have made minimal, moderate or substantial progress.[27] Because some actions address multiple issues, they are assessed in each section of relevance. For example, implementing confined animal BMPs affects water quality, solid waste disposal and land use issues, hence a separate summary has been provided in each of these sections.

The reader should keep in mind that as this report is being written, new programs are beginning which

"TOP TEN"
Watershed Restoration Accomplishments

1. Formation and collaboration of the Malibu Creek Watershed Executive Advisory Council, and development of the Action Plan for Restoration.
2. Successful reintroduction of the tidewater goby, a federally listed endangered species, back into Malibu Lagoon.
3. Implementation of the Volunteer Water Quality Monitoring Program.
4. Implementation of the Santa Monica Bay Epidemiological Study linking swimmer illness with poor water quality near flowing storm drains.
5. Completion of the L*ower Malibu Creek and Barrier Lagoon System Resource Management* report addressing the hydrological dynamics of the lower watershed.
6. Restoration of aquatic habitat, mudflat habitat and high flow storm refuge for the tidewater goby in Malibu Lagoon which includes excavation of over 2,200 cubic yards of old fill material. Post-project monitoring of fishes, water quality and invertebrates.
7. Streambank restoration along a 200-foot section of Las Virgenes Creek using bio-technical erosion control techniques.
8. Installation of a storm drain disinfection facility to treat contaminated flows from the Mystery Drain into Malibu Lagoon.

Table 3.2. "Top Ten" watershed restoration accomplishments.

[27] Based on the information provided in Section Two: Action Plan Update, each action was evaluated by members of the Malibu Creek Executive Advisory Council on a scale of one to five according to how well it has met its intended goal(s). The scores submitted for each action were combined, the average taken and the results correlated to a rating of minimal, moderate or substantial progress (similar to a grade point average).

address some of the issues that have made no progress and/or have received very little attention before this time. For example: 1) the Santa Monica Bay Restoration Project has convened a Septics Management Task Force to develop recommendations for septic system placement, management, monitoring and replacement frequency and 2) the Lower Malibu Creek and Lagoon Task Force is addressing the feasibility of a constructed wetland in the Malibu Civic Center area. Although mentioned, these new efforts are not being evaluated in terms of their contribution towards successful implementation of the plan's 44 action items.

Note: For your reference, the numbers located next to each of the following summaries in this section correspond to the same actions discussed in **Section II: Action Plan Update**.

Goal: Improve Water Quality to Protect Beneficial Uses

Eighteen of the Malibu Creek Watershed Plan's actions address water quality issues, accounting for more than 40% of the Plan's total number of actions. Improving water quality key to the overall success of watershed restoration and protection efforts. For review purposes, these eighteen actions have been divided into two major categories – *Policy & Research* and *Implementation*. The actions in the first category, Policy & Research, have achieved moderate success over the last five years as many studies and coordinated assessment efforts have been conducted to improve our understanding of the state of water quality in the watershed. On the other hand, implementation efforts designed to improve water quality have lagged significantly since the Plan was adopted in 1994. Below is an in-depth assessment of both how much and how little has been done towards understanding and improving water quality in the Malibu Creek watershed.

WATER QUALITY:
POLICY and RESEARCH

Substantial Progress

Monitor Pathogens

Moderate Progress

Develop and Set Water Quality Objectives
Establish Minimum Biological Standards
Determine Nutrient Standards
Assess Lagoon Characteristics
Landfill Impacts on Water Quality
Watershed Assessment

Policy & Research Activities

Seven of this section's 18 actions address *Policy and Research* needs in the Malibu Creek watershed. Overall, they have achieved moderate success, with a one notable highlight. A summary of their relative success is provided here.

Substantial Progress

Monitor for Pathogens and Bacteria (#6)

The most significant progress made in addressing key water quality impairments in the Malibu Creek watershed has been in monitoring for bacteria and pathogens. Monitoring for indicator bacteria (i.e., total and fecal coliform) helps to determine whether human pathogens are present Malibu's local waterways and if the waters pose any health risks. Such monitoring has been conducted in the Malibu Creek watershed on a regular basis by several agencies and organizations for more than a decade, and includes data from samples taken during both the wet and dry seasons. Additionally, two separate studies have been conducted in the past seven years in Malibu Creek to directly test for pathogens. Because this type of testing is prohibitively expensive, it has not been conducted on a more regular basis.

Our understanding of the location and amount of bacteria and pathogens present in the watershed has significantly increased due to these studies and monitoring efforts. Collectively, the data gathered conclusively shows that bacteria (and mostly likely pathogens) have been and continue to be a significant water quality problem throughout the watershed. While the data is exhaustive in highlighting the extent of the bacteria/pathogen problem, unfortunately, it does not always pinpoint the source(s) of contamination and their relative contribution(s). The next step towards decreasing pathogen loads is to identify these sources and systematically prevent them from reaching local waterways.

Moderate Progress

Six actions under *Water Quality: Policy and Research* have been implemented with moderate success. These include:

- Develop and set water quality objectives to protect beneficial uses;
- Establish biological (habitat) standards for native species;
- Determine nutrient standards;
- Assess Malibu Lagoon's characteristics;
- Assess the impacts of landfill operations on water quality; and
- Conduct watershed assessment.

Develop and Set Water Quality Objectives to Protect Beneficial Uses (#1)

The Regional Board is charged with the task of developing and setting water quality objectives for waterbodies in the Malibu Creek Watershed, and they have experienced relative success in areas such as: 1) establishing discharge limits for point sources through the permitting process, 2) adopting the 1996 Storm Water Municipal NPDES Permit, and 3) creating a TMDL unit to begin establishing additional water quality objectives for impaired water bodies in the region. However, limits have not been established for non-point source discharges (storm drains, rainfall runoff, landscape irrigation, etc). To control pollutants generated from non-point sources, the Regional Board has created a TMDL unit which is currently in the process of establishing discharge limits for the watershed's primary pollutants of concern – pathogens and nutrients. However, this process is slow. Limits are not expected to be set for pathogens and nutrients until 2001 and not at all for other pollutants such as oil and grease, trash and debris, and heavy metals. Despite the significant limitations placed on Tapia treatment plant discharges, other sources of pathogens and nutrients still adversely impact the beneficial uses of the watershed's receiving waters.

Establish Minimum Biological (Habitat) Standards (#5)
Several habitat restoration activities, such as establishing mud flats in Malibu Lagoon, determining minimum flows to support steelhead populations, and removing exotic species, have resulted in some progress towards improving habitat to support native species. However, establishing water quality objectives based on biological standards has not been as successful. As the Coastal Conservancy/UCLA report states, "while there is much water quality data available, there is little information available about the tolerances of most of the target species to the physical condition of concern." Setting water quality standards is a difficult task without appropriate background information. To come up with sound water quality objectives which take into concern local species needs, their tolerances must be known. Then, where competing needs exist, they should be prioritized for protection, and a balance maintained that supports the most native species possible. More information is needed on the tolerances of native species before this action can be fully implemented.

Determine Nutrient Standards (#7)
Our understanding about the amount of and impacts resulting from nutrient loadings in the watershed is also quite comprehensive, due mostly to the long-term research data collected by several key agencies. Although monitoring efforts have provided a clear picture of the extent of the problem, there is much debate over how to control nutrient loadings, and what discharge limits would be most appropriate given various watershed dynamics such as canopy cover, stream velocity, still pools, water temperatures, etc.

Recently, the Regional Board's TMDL unit has begun to assess the nutrient data available and are in the process of establishing limits for nutrients in the Malibu Creek. Efforts to control/reduce nutrients are discussed under *Water Quality: Implementation*, below.

Assess Malibu Lagoon Characteristics (#21)
A portion of this action has been quite successfully accomplished but some additional steps need to be taken to complete the action as a whole. The Coastal Conservancy/ UCLA study, along with other long term monitoring efforts, provides a quite comprehensive picture of the hydrology, circulation, and biota of the lower creek and lagoon, as well as management recommendations on how to improve/protect the area. Next steps include identifying all the potential and existing sources of pollution/contamination and then developing a remediation strategy to improve the lagoon and surfzone's water quality based on these sources. The Lower Malibu Creek and Lagoon Task Force is currently in the process of ranking the UCLA study's management recommendations and will soon release an action plan of

priorities based on the report's recommendations. Completion of the CSCC/UCLA study represents a significant step towards assessing Malibu Lagoon's characteristics.

Assess Impacts of Landfill Operations on Water Quality (#27)

The County Sanitation District of Los Angeles County is the primary agency responsible for landfill operations. Measures to mitigate the impacts of landfill operations (e.g., research, land acquisition, native plant restoration) were approved and adopted in 1998 and are currently being implemented and/or planned for the near future (see page 51). For example, the results of an on-going groundwater monitoring study of the land directly below and surrounding the landfill will direct upcoming restoration and watershed protection efforts. While still too early to assess the benefits all of these measures will have on water quality, those already being implemented represent progress in the right direction.

Conduct Watershed Assessment (#44)

This action contains four subsets which address sources of pathogens, toxic chemicals, sediments and nutrients. As a group, they have been given a moderate rating, although individually some have been very successful, while others have not.

- The first sub-action, which calls for determining adequate seasonal flows for Malibu Creek, Lagoon and nearshore areas, has achieved minimal success. Only one study has been conducted to correlate minimum creek flow requirements with habitat needs (steelhead trout). Although Tapia no longer discharges flows during the dry season, discharge of imported water upstream and higher groundwater tables have permanently altered the creek's flow regime, which is now perennial rather than intermittent or seasonal. How best to address this issue is a daunting task because it requires the resolution of some related controversies (e.g., year-round diversion of Tapia effluent, diverting urban runoff, minimizing import water demands, retaining runoff on-site).

- The second sub-action calls for conducting a study on the health effects of urban runoff on surfers and swimmers. The SMBRP Epidemiological Study, conducted in 1995, did exactly this and was completed with great success. The results of the study showed conclusively the link between contaminated urban runoff and swimmer illness. Based on these results, several measures were taken to inform the public about health risks and to provide alternatives about where and when to swim in the Bay. The results of the study have also been referenced in developing bathing standards at both the state and federal levels.

- The third action, which calls for establishing TMDLs for all inputs into the watershed, has been only marginally implemented. Although the Regional Board has established a TMDL unit, limits for the watershed's pollutants of concern (nutrients and pathogens) will not be established until March of 2002. Furthermore, the Regional Board has no immediate plans to undertake additional TMDLs for the Malibu Creek Watershed for constituents such as heavy metals, trash and debris and other contaminants associated with urban runoff.

  Establishing TMDL limits for impaired water bodies is designed to help improve water quality over the long run, however, the effects of this process will not be immediately evident. Once TMDLs for nutrients and pathogens are established, it will take additional time to change and/or improve how permits are issued to implement appropriate control measures.

- The last action, which calls for developing a research agenda to expand understanding about the impacts of land use practices in the watershed, has made no significant progress. Several agencies have stated their desire to use GIS applications towards understanding land use impacts, but funds and staff time to implement this action have not been forthcoming. Watershed cities are addressing development issues through their municipal master plans, but these efforts are not comprehensive and do not consider the watershed as a whole. The formation of the regional Council of Governments may help bring the need for true watershed planning to the attention of those responsible for the development activities occurring in each city.

***Water Quality – Policy and Research Grade:* B-/C+**

Water Quality - Implementation

Eleven water quality actions are considered as "on-the-ground" implementation efforts. Collectively, their success has been somewhat limited, as the call-out box on the next page shows. It is interesting to note that no actions in this section have been rated as substantial. An assessment of their relative success is provided here.

Moderate Progress

Seven of this section's 11 actions have achieved moderate success. These include:

WATER QUALITY: IMPLEMENTATION

Moderate Progress

Eliminate Sources of Pathogens, Toxic Chemicals, Sediments & Nutrients
Reduce Accelerated Sedimentation
Stenciling and Other Storm Drain BMPs
Regulate Mobile Car Wash Discharges
Eliminate Illegal Drains
Control Trash on Parklands
Implement Confined Animal BMPs

Minimal Progress

Reduce Pathogens
Reduce Nutrients
Manage Septic System Discharges
Enforce Pollution Reduction Programs

- Eliminate or reducing sources of harmful pathogens, toxic chemicals, sediments and nutrients;
- Reduce accelerated sedimentation;
- Implement stenciling and other storm drain BMPs;
- Regulate mobile car wash discharges;
- Eliminate illegal drains;
- Control trash on parklands; and
- Implement confined animal BMPs.

Eliminate Sources of Harmful Pathogens, Toxic Chemicals, Sediments and Nutrients (#4)

Passage of the 1996 Municipal Storm Water NPDES permit is key to the progress achieved in implementing this action. It represents the first critical step in implementing this action successfully. The permit not only requires cities to address sources of contaminated runoff, it also requires that they secure the authority to enforce such control measures. Municipal ordinances have now been adopted by every city covered under the storm water permit which stipulate storm drain discharge prohibitions.

However, enforcement actions taken to control contaminated discharges have not been significant since the ordinances were adopted. Cities, lacking personnel and funding to effectively enforce discharge prohibitions, rely on citizen complaints, site visits and educational programs to carry out this action. And, while city personnel do conduct site visits, they lack the staff resources to make return visits on a regular basis. For example, a parcel of land being developed is visited, on average, only once during its construction phase. This is inadequate because the condition of a construction site change dramatically over the course of its development.

More specific information on reducing and/or eliminating pathogens, sedimentation and nutrients are addressed below.

Reduce Accelerated Sedimentation (#10)

Six components are listed under this action and, together, they provide a comprehensive plan for reducing human-induced sedimentation. The components include enforcing erosion control measures, preventing sediment runoff from development projects, adopting erosion control ordinances, implementing BMPs to minimize topsoil loss, preventing roadside dumping of dirt and eliminating massive grading practices.

Mechanisms, such as local ordinances, educational pamphlets and site visits, and construction NPDES permits do bring awareness about sedimentation issues to developers and residents. Cities also require and review erosion control plans for planned and active construction sites, and they require BMPs to be implemented to minimize sedimentation problems. These actions, while proactive and a good start, have not clearly reduced human induced sedimentation into the watershed. Due to limited resources, city personnel are unable to effectively ensure that the BMPs will be implemented over the entire duration of construction. Roadside dumping of dirt has proved virtually impossible to control, and topsoil losses from residential sites remains a concern in developing and newly developed residential neighborhoods.

Implement Stenciling and Other Storm Drain BMPs (#13)
Storm drain stenciling efforts have been well implemented throughout the watershed. Most watershed cities contract with the County of Los Angeles Department of Public Works to conduct this task approximately every three years (Malibu stencils its own storm drains). The stencils are one of the methods used to make residents aware of where storm drain flows eventually end up.

Unfortunately, it's still not uncommon to find catch basins clogged with urban-generated trash and debris, and contaminated discharges are still making their way into the storm drain system. Street sweeping and catch basin cleaning frequencies vary among cities, as do the storm drain cleaning techniques used. However, it's not clear that street sweeping frequency is related to need in the watershed cities. The fact that there is very little data available supporting the benefits of street sweeping has resulted in municipal reluctance to do more on this issue, and no studies have adequately linked land use activities with the volume of trash collected to better determine what frequency would be most cost effective.

Regulate Mobile Car Wash Discharges (#14)
Mobile car wash operators are required under municipal ordinances to ensure that their discharges do not reach local storm drains. Because mobile car wash operations have not been found to be a significant source of water quality impairments to the Malibu Creek watershed, they are not heavily monitored by municipal staff unless complaints are filed. Beyond adopting local ordinances, there is little effort given to address/prevent mobile car wash discharges.

Eliminate Illegal Drains (#15)
Of the 1,838 illicit connections found in Los Angeles County, only 49 were located in the Malibu Creek watershed. The County has already formally documented 21 of these illicit connections and is in the process of documenting the remaining 28. Although there is nothing remaining to accomplish under this action, it only received a moderate rating due to completing documentation of the remaining storm drains.

Control Trash on Parklands (#17)
Efforts to reduce or eliminate the amount of trash from parklands reaching Malibu Creek have been only moderately successful. While State Parks does provide trash receptacles on its property, some of them are either not properly placed to maximize use among visitors, or there simply aren't enough trash cans to hold all that is discarded on a typical weekend day by park visitors. More and better placement of trash cans and bilingual signs are needed to help decrease the amount of trash and debris making its way into Malibu Creek.

Implement Confined Animal BMPs (#18)
[This action primarily addresses horse owners in the Malibu Creek Watershed, most of which are located in the City of Malibu. There are not a significant amount of other types of livestock in this region.]

The Resource Conservation District has made a tremendous effort to monitor, educate and raise awareness among horse owners about the impacts of horse waste on water quality. Unfortunately, changes in manure management measures have not been widely observed since this outreach program began a few years ago. The region's larger stables do implement BMPs designed to control manure and keep it from reaching nearby streams. However, many private horse owners with corrals located near streams do not necessarily have the land or resources to reconstruct their corrals away from adjacent streams. Additionally, municipal ordinances and the Los Angeles County health code are either not adequate or are not being sufficiently enforced to prevent horse manure from contaminating runoff. Horse waste is still observed in and around stream banks and riparian corridors, and in many creek/stream reaches. More attention on enforcing local ordinances and public health codes is needed to ultimately correct this problem.

Minimal Progress

There has been only minimal progress for four *Water Quality:*

Implementation actions. These include:

- Reduce human pathogen inputs;
- Reduce nutrients;
- Manage septic system discharges; and
- Enforce pollution reduction programs.

Reduce Human Pathogen Inputs (#7)

Historically, efforts to implement this action focused on eliminating Tapia Treatment Plant discharges into Malibu Creek while other diffuse or nonpoint sources were not aggressively pursued. These efforts resulted in the Regional Board passing a revised discharge prohibition eliminating flows during the dry season. It was a significant step towards reducing public fear about adverse health effects associated with tertiary treated discharges into Malibu Lagoon. However, bacteria counts are still higher than health code standards allow and Surfrider beach still consistently receives "F" grades during breaching events. Identifying and preventing other sources of pathogen inputs has not been given significant attention until very recently. These potential sources include septic systems, storm drain discharges and livestock wastes. Because programs to address these sources are just getting underway, this action received a minimal rating. It is too early to assess whether all the various sources of pathogens can be effectively controlled.

Reduce Nutrients (#9)

Excess nutrients are a wide-spread concern throughout the watershed both above and below the Tapia treatment plant. Although many studies have documented the extent of nutrient problems watershed-wide, little has been done to determine the extent of all the possible sources contributing to the excess nutrients found in the watershed. And, despite the discharge prohibition of Tapia effluent during the dry season, the amount of nutrients found in the lower creek and lagoon are still too high and cannot be accounted for, making it nearly impossible to develop a plan of action for reducing nutrient inputs. Until all sources of nutrients have been identified, this action cannot be effectively implemented.

Manage Septic System Discharges (#23)

It is widely believed that septic system discharges contribute to the poor water quality observed in the lower creek and lagoon, but studies recently performed to ascertain the degree of pathogen contributions coming from septic systems are considered inconclusive, and funds to conduct extensive groundwater monitoring have been nearly impossible to secure.

How best to manage septic system discharges has proven to be quite controversial. Homeowners are leery of government intervention, fearing that any changes to current systems would cost them thousands of dollars. City leaders have been reluctant to impose additional restrictions on local homeowners or to suggest construction of a centralized sewer system in Malibu. The SMBRP's Septics Management Task Force is in the process of developing recommendations for how to manage septic discharges to better protect water quality in areas such as Malibu. These recommendations will require action by both state agencies and local municipalities.

Ultimately, very little progress has been made towards actually eliminating or reducing the impacts of septic system discharges on water quality. The actual number of installed septic systems in Malibu has not been determined or mapped, and only a small percentage of systems have been recently replaced

Enforce Pollution Reduction Programs (#40)

Enforcing pollution reduction programs is carried out at several levels of government – local, state and federal. Cities have been required to adopt ordinances, and the State Water Resources Control Board and the US Environmental Protection Agency have the ultimate responsibility to ensure that water quality is protected. Both the State and municipalities use enforcement as a means to achieve this goal. Although these mechanisms are in place, almost no enforcement programs have been effectively implemented. Cities, lacking personnel and other resources to conduct all the enforcement that would be necessary within their jurisdictions, have done so only passively. And, until recently the Los Angeles Regional Water Quality Control Board has had an extremely poor enforcement record regarding oil and other hazardous substance spills, sewage spills, and storm water and other NPDES permit violations. However, since 1998 enforcement actions have taken place within the Malibu Creek watershed.

Water Quality — Implementation Grade: D

Goal: Reduce Excess Flows into Malibu Creek

The goal of the following three actions is to reduce excess flows into Malibu Creek. These actions intent to: 1) reduce imported water demands and runoff volumes, and 2) maximize the use of recycled wastewater. Collectively, they have been poorly implemented, with moderate progress in only one instance.

REDUCING EXCESS FLOWS

Moderate Progress

Maximize Use of Reclaimed Water

Minimal Progress

Household Irrigated Runoff Survey
Runoff Reduction Measures

Moderate Progress

Maximize Use of Reclaimed (Recycled) Water (#28)

The Las Virgenes Municipal Water District, the lead agency responsible for promoting reclaimed water use in the watershed, has made significant strides in its efforts to recycle tertiary treated wastewater back to the communities that generate it. Efforts which include getting ordinances passed to require the use of recycled water where feasible and pricing recycled water more competitively have resulted in almost half (44%) of the total volume of wastewater generated by upstream communities being reused rather than discharged to Malibu Creek. Some of the alternatives proposed in the *Malibu Creek Discharge Avoidance Study* are also being implemented to maximize use of recycled water. For example, the District has: 1) increased the number of private end users during the prohibition, effectively doubling the non-creek disposal capacity of Tapia's tertiary treated effluent and 2) sought funding opportunities to help pay for the infrastructure needed to reach distant but potential end users.

Unfortunately, the demand for recycled water is not constant throughout the year and thus less wastewater is recycled in the fall, winter and spring months than during the summer and shoulder months. As a result, excess flows are still discharged to Malibu Creek during the rainy season (November 15th – April 15th). Implementing alternative disposal options during this time has proved more difficult to address and has thus been fairly slow. Still, the District's commitment to exploring several of the discharge alternatives identified in the report and to ultimately find a permanent alternative to discharging effluent into Malibu Creek is a positive step towards maximizing use of recycled water.

Watershed cities have also supported this action by passing ordinances requiring the use of recycled water for landscape irrigation along freeway corridors, in city parks, and other areas where feasible. Such requirements help solve two problems simultaneously – they reduce the amount of wastewater discharged into Malibu Creek during the rainy season and decrease demand for imported water.

Minimal Progress

Household Irrigation Runoff Survey (#19)

The intent of this action was to conduct a survey which would: 1) provide insight as to why such large volumes of runoff are coming from residential developments and 2) develop an awareness campaign based on the survey results to decrease these excess runoff volumes. Although there are several public education campaigns promoting water conservation at the residential level, no household survey has been conducted to determine why excess flows are coming from residential areas. Without the insights that such a survey could provide, it will be difficult to plan an educational awareness campaign specifically targeting those activities most likely to contribute to excessive household-generated runoff.

Runoff Reduction Measures (#31)

Measures designed to reduce the amount of runoff coming from residential and commercial properties have only recently been adopted by local and state agencies. For example: 1) in the last few years watershed cities have passed ordinances calling for more pervious surfaces in new developments; 2) in January 2000, the Regional Board adopted a measure requiring on-site storm water retention or treatment for the first ¾-inches of rain from each storm; and 3) the Las Virgenes Municipal Water District recently installed irrigation sensors to improve irrigation practices to minimize excess flow. Because these measures have been only recently adopted and implemented, whether or not their implementation will prevent increased runoff or actually lead to reductions in runoff remains to be shown. And, because two of the three efforts mentioned above only apply to new and substantial redevelopment projects, the effects of this measure will not be clear until new, isolated developments can be evaluated for runoff reduction. Finally, beyond the public education/outreach efforts implemented, other immediate efforts to reduce runoff in the Malibu Creek Watershed are not widely observed.

***Reducing Excess Flows Grade*: D**

Goal: Improve Management of Solid Waste

MANAGING SOLID WASTE

Substantial Progress

Composting, Recycling & Conservation

Moderate Progress

Control Trash on Parklands
Implement Confined Animal BMPs

The three actions addressing solid waste concerns in the Malibu Creek watershed have achieved relative success, overall rating at high end of moderate. The ultimate goal of these actions is to prevent trash and other forms of solid waste from reaching and adversely impacting watershed creeks, riparian corridors and habitats. A summary of how well these actions are being implemented is provided below.

Substantial Progress

Composting, Recycling and Conservation Measures (#29)

Combined, watershed agencies and municipalities have conducted an enormous amount of outreach promoting the values of composting, recycling and water conservation. They have also provided many opportunities for residents to participate in recycling and conservation efforts through programs like curbside recycling, household hazardous waste roundups, permanent used oil drop-off sites and workshops. While not necessarily cost-effective, these efforts have been successful in increasing public awareness of the need to recycle household waste and have led directly to the increased volumes of residential solid waste collected each year.

Moderate Progress

Two actions have made moderate progress in controlling specific types of waste found in the watershed. These include:

- Reducing the amount of trash found on local parklands; and
- Implementing confined animal BMPs for waste reduction.

Control Trash on Parklands (#17)

Local parks in the Santa Monica Mountains receive a large number of visitors every weekend, particularly to Malibu Creek State Park and Malibu State Beach and Lagoon. Much of the trash found in nearby creeks and the lagoon ultimately comes from park visitors. Whether it is left on the ground, placed in on-site receptacles but then raided by birds or blown out by the wind, too much trash is reaching the creek. State Parks has made moderate progress in its efforts to control the proliferation of trash on its properties through: 1) the installation of new and additional bird proof receptacles in areas of the park most frequented by the public, 2) posting bilingual signs encouraging visitors to use the receptacles provided and 3) utilizing Spanish-speaking employees to enhance its educational efforts. Although these approaches have been somewhat successful, they could be improved by installing even more bird-proof trash receptacles within State Parks boundaries and placing them in the most popular areas of the parks. State Parks' efforts could also be enhanced by improving the visibility and location of its bilingual signs.

Implement Confined Animal BMPs (#18)

While ensuring proper management and disposal of the solid waste generated by large domestic animals is a daunting task, some key steps towards accomplishing this goal have been taken. The *Horse and Stable Management BMP Manual* and a video created by the RCDSMM provides very specific information on how to manage horse waste. A horse manure composting demonstration site was also created to reinforce the benefits of managing horse manure through composting. These educational tools are very informative and are available to horse owners and the general public. However, as stated in the action summary, it is not clear that this information is in fact reaching enough horse owners. While large stable operations do implement good manure management measures, smaller stables where only a few horses are kept need more focused attention to help them properly manage animal waste.

***Managing Solid Waste Grade*: B-**

Goal: Improve Land Use Management in the Watershed

LAND USE MANAGEMENT

Substantial Progress

Fire Regulation & Erosion Control

Moderate Progress

Reduce Accelerated Sedimentation
Implement Confined Animal BMPs
Public Access & Resource Protection
Habitat Fragmentation
Enforce Camping Restrictions

Minimal Progress

Buffer Zones for Sensitive Areas

Seven actions address land use issues in the Malibu Creek Watershed. Of the five that fall within the range of moderate progress, several of them were actually rated "low moderate." The intent of these actions is to ensure that smart land use decisions are made to protect valuable habitats throughout the watershed. Such planning ranges from improving habitat fragmentation to controlling pollution caused by certain land use activities. In the Malibu Creek watershed, current conventional zoning requirements do not adequately protect riparian habitats, creeks and streams. Below is a detailed summary of how effectively these actions have been implemented.

Substantial Progress

Fire Regulation and Erosion Control (#11)
Only one action, Fire Regulation and Erosion Control, is considered to have made substantial progress in the Land Use category. Four years ago, the Los Angeles County Fire Department implemented a new program, called the *Fuel Modification Program*, to improve fire safety measures for residential and commercial developments. Recognizing the need to also control unnecessary erosion from residential properties, the Fire Department included in its new program standards which allow grass to remain on flat lands and slopes prone to erosion. Additionally, watershed cities now recognize the benefits of mowing, rather than discing, weed setback zones likely to erode and promote the use of drought-resistant, native plants in new landscape plans. These measures highlight the increased awareness among city and county agencies about the sources and importance of balancing erosion control with fire regulation needs.

Moderate Progress

Five actions under *Land Use* have realized moderate success although three of them are considered low-moderate. These five actions include:

- Reduce accelerated sedimentation caused by human activities;
- Implement confined animal BMPs (low-moderate);
- Balance public access and resource protection (low-moderate);
- Eliminate habitat fragmentation (low-moderate); and
- Enforce camping restrictions on parklands.

Reduce Human-based Accelerated Sedimentation (#10)

Efforts to reduce human-based accelerated sedimentation include: 1) passing local ordinances for development projects and enforcing these measures, 2) minimizing the loss of topsoil, 3) preventing roadside dumping of dirt, and 4) eliminating massive grading. Some of these actions have realized greater success than others. For example, in the past few years local ordinances addressing sedimentation control measures have been passed by all watershed cities, which is a milestone achievement. Furthermore, the Regional Board requires all development projects greater than five acres to obtain a Construction NPDES permit and to implement sedimentation control measures. However, enforcing these ordinances and BMP requirements has been relatively inadequate. With few exceptions, on average city inspectors are visiting construction sites required to implement sedimentation control BMPs only once during the rainy season, and the Regional Board lacks sufficient staff resources to conduct regular inspections of large development projects to ensure that pollution control BMPs are being implemented. The mechanisms to control and/or reduce accelerated sedimentation are in place, but enforcement of these measures is not readily occurring.

Implement Confined Animal BMPs (#18)

Among other things, this action calls for setting limits on the number of livestock per acre to protect resources from overuse by large animals, such as horses. Malibu has established limits based on the location of a parcel within the city. The County of Los Angeles Department of Health Services also inspects stables with four or more horses on a yearly basis to determine whether appropriate BMPs are being implemented and to ensure that horse waste is well contained and prevented from reaching creeks. Their surveys confirm that there is definitely a problem with manure waste management in the watershed. Although horse owners are required to ensure that no manure-contaminated runoff reaches adjacent streams and that no stalls are within 50 feet of a stream bank, enforcement of these measures is minimal due to DHS's limited staff resources. Some horse owners simply have not implemented adequate setback zones and pollution control BMPs, and their horse waste is still reaching and polluting adjacent streams in the Malibu Creek watershed.

Balance Public Access and Resource Protection (#32)
The steps needed to accomplish this action are not well defined, and thus what has been reported in Section II of this report is limited. Only a few plans have specifically addressed both resource protection and public access issues. These include the Resource Conservation District's restoration efforts in Malibu Lagoon and the upcoming Las Virgenes Canyon sub-watershed study. A more comprehensive plan focusing on how to minimize the impacts of residents, hikers, horseback riders and campers on the watershed's creeks, streams and sensitive habitats would be a good starting point towards balancing public access needs with resource protection goals.

Eliminate Habitat Fragmentation (#35)
Steps to improve and/or maintain continuous habitats for native species in the watershed have been somewhat limited in scope, and city master plans have focused on other regional impacts of population growth. However, the City of Calabasas' designation of *Open Space Districts* is a creative approach towards reducing habitat fragmentation, and other cities should be encouraged to designate similar districts within their own jurisdictions.

Also, the study initiated by the National Park Service and the California Department of Parks and Recreation four years ago has proved to be a key step in understanding the impacts that habitat fragmentation can have on native species. Over the next several years, the data gathered will be very useful in guiding park planning and habitat preservation efforts.

Enforce Camping Restrictions (#41)
Transient camping is not a significant problem in the Malibu Creek watershed, or on State Parks properties, and thus efforts to control it are minimal. As stated in Section II, State Parks personnel does patrol parklands and takes action as necessary.

Minimal Progress

Create/Maintain Buffer Zones for Sensitive Areas (#34)
While a few agencies have created buffer zones to protect sensitive habitats and prevent urban encroachment within their agency boundaries, the majority of the watershed's sensitive habitats are not well protected. Watershed cities have lagged in their efforts to protect sensitive habitats and setback requirements called for under municipal ordinances are inadequate to protect riparian habitats and stream corridors from development activities. Development projects located too close to stream and riparian corridors lead directly to increased sedimentation, spreading of invasive species and

increased trash and debris. Better efforts at the municipal level should be made towards creating adequate buffer zones in the watershed.

***Land Use Management Grade*: C-**

Goal: Restore and Protect the Watershed's Habitats

A total of 15 actions address the need for habitat protection and restoration in the Malibu Creek Watershed. These actions range from purchasing land containing sensitive habitats to preventing sedimentation and the proliferation of exotic species. As the chart to the left shows, collectively low-to-moderate success has been achieved towards restoring, enhancing and protecting the watershed's habitats and resources.

WATERSHED HABITATS

Substantial Progress

Fire Regulation & Erosion Control
Mitigate Impacts of PCH
Bridge Reconstruction

Moderate Progress

Reduce Accelerated Sedimentation
Restore Malibu Lagoon
Assess Lagoon Characteristics
Habitat Fragmentation

Minimal Progress

Establish Minimum Biological Standards
Establish Water Temperature Policies
Regulate Lagoon Water Levels
Public Access & Resource Protection
Purchase High Priority Land Areas
Buffer Zones for Sensitive Areas
Control Exotic Vegetation in Wilderness
Remove Barriers to Fish Migration
Maintain/Restore/Create Wetlands

Substantial Progress

Of the 15 actions in this section, only two have achieved substantial progress in protecting the watershed's habitats. They include:

- Fire regulation and erosion control; and
- Mitigate the impacts of Pacific Coast Highway bridge reconstruction on habitats.

Fire Regulation & Erosion Control (#11)
Development and implementation of the Fire Department's *Fuel Modification Program* was a significant achievement in reconciling public safety with resource and habitat protection. The program's grass height allowances, planting requirements and long-term vegetation maintenance plan help to minimize the erosion and sedimentation caused by excessive brush clearance and mowing practices. Combined, these measures are improving habitats located near developments and are helping to prevent the downstream impacts resulting from uncontrolled erosion and sedimentation.

Mitigate the Impacts of PCH Bridge Reconstruction (#26)
CalTrans established a mitigation fund to help improve various habitats around the Pacific Coast Highway bridge which crosses Lower Malibu Creek and Lagoon. Three very successful projects in the lower watershed were implemented as a result of this mitigation fund: 1) salt marsh restoration (State Parks); 2) five year monitoring of the tidewater goby (RCDSMM); and 3) the *Effects of Sand Breaching the Sand Barrier on Biota* study (RCDSMM). Because CalTrans has met its mitigation requirements, this action is considered fully and successfully completed. Additional lower creek and lagoon restoration efforts are addressed in several other actions throughout this report.

Moderate Progress

Four of this section's 15 actions have achieved moderate progress towards protecting the watershed's habitats. These include:

- Reduce accelerated sedimentation;
- Restore Malibu Lagoon;
- Assess lagoon characteristics; and
- Eliminate habitat fragmentation.

Reduce Human-based Accelerated Sedimentation (#10)
Efforts to control human-induced sedimentation from urbanized areas have been moderately successful, due primarily to: 1) increased public education efforts focused on developers and contractors, 2) adoption of local ordinances by watershed municipalities and 3) enforcement of construction-related BMPs. These efforts could also be improved through enhanced enforcement activities, mowing rather than discing areas likely to erode and educational outreach specifically targeting residential communities about the need for smart landscaping to protect the watershed's habitats from neighborhood-based sedimentation.

Restore Malibu Lagoon (#20)
The components essential to restoring Malibu Lagoon are numerous and complex. Already, a significant amount of attention has been given to the "need" to restore the lagoon, and many studies have been conducted over the years to help assess the extent of the problems associated with the area. This increased level of understanding about the impacts earned this action a moderate rather than minimal ranking. It is a critical first step towards any restoration plan. However, until now actual restoration efforts have been piecemeal, such as increasing the available habitat for migratory birds and the tidewater goby, restoring the salt marsh area, removing trash and debris, and construction of a storm water treatment and disinfection facility at the end of the mystery drain. A comprehensive plan must be developed detailing all of the steps needed for full restoration.

As mentioned in the body of the report, the Lower Malibu Creek and Lagoon Task Force is currently in the process of prioritizing the alternatives contained in the UCLA report and developing a restoration plan. Although not complete at the time of this report, their efforts are aggressively moving along. Once priorities are developed, the group will start seeking funds to implement those measures chosen.

Assess Malibu Lagoon Characteristics (#21)
The primary objectives in assessing Malibu Lagoon's characteristics are to evaluate and establish water quality criteria and habitat needs. The complement to this activity lies in determining how those characteristics actually affect/impact habitats. As

mentioned under both *Establishing Minimum Biological (habitat) Standards* and *Restore Malibu Lagoon* above, several studies have occurred to increase our understanding of the biological condition of the Lagoon, including the degree to which habitats are impaired. However, not all species have been considered in the characterization and there are still gaps in data which need to be filled — in particular, the physical tolerances of key species and the degree to which pollutants adversely affect these species. For this reason, the progress made under this action is considered moderate.

Eliminate Habitat Fragmentation (#35)
While the threat of habitat fragmentation does exist in the Malibu Creek Watershed, the fact that nearly 80% of the watershed is open space helps lessen that threat. The studies undertaken to evaluate the impacts of urban encroachment on habitats and to address critical concerns of carnivores are being used to direct and promote wildlife conservation efforts. Cities, recognizing the need for open space and habitat linkage preservation, are starting to incorporate these concepts into their master plans and to identify land parcels most desirable for acquisition to meet this goal. If acquired, the parcels identified by State Parks will also help reduce habitat fragmentation. And lastly, the on-going educational and awareness efforts targeting city planners and permitting departments should help guide habitat preservation efforts.

Minimal Progress

Nine actions, more than one-half of the total under *Habitats*, have made little or no implementation progress. These include:

- Establish minimum biological (habitat) standards;
- Establish water temperature policies for fisheries;
- Regulate lagoon water levels;
- Public access and resource protection;
- Purchase high priority lands for watershed protection;
- Develop buffer zones for sensitive areas;
- Control exotic vegetation in the wilderness;
- Remove barriers to fish migration; and
- Maintain, restore and create wetlands.

Establish Minimum Biological (habitat) Standards (#5)
Because of the monitoring efforts of many organizations, including the RCDSMM, Las Virgenes Municipal Water District and Coastal Conservancy/UCLA study, there is a greater understanding of the biological condition of the watershed's target and endangered species. However, no studies have been conducted to comprehensively assess the range of tolerances of these species. Although it may prove impossible to

actually optimize the habitat needs for each of the target species, particularly in the lower creek and lagoon area, establishing their minimum needs would provide a good starting point from which to set biological standards.

Establish Water Temperature Policies (#12)

Despite the Las Virgenes Municipal Water District's temperature data for steelhead trout and Resource Conservation District's decade-long Malibu Lagoon temperature data, no recommendations have been made about what the optimum water temperature should be for habitats and species in the Malibu Creek watershed. And, no studies have been conducted to determine the temperature tolerances of the watershed's local key/indicator species.

In its thermal plan, the State sets temperature limits for industrial and treatment plant discharges such as Tapia's effluent. However, such discharges into the Malibu Creek watershed are not a concern because they are well below the limits established by the State. Of greater importance to aquatic species such as steelhead trout is the overall quality of the water, its flow characteristics and whether there is sufficient habitat (e.g., deep pools, upstream spawning grounds) to support native populations.

Notwithstanding the lack of effort, it's not clear that establishing a water temperature policy is needed for Malibu Creek given its current state.

Regulate Lagoon Water Levels (#24)

Perhaps one of the most difficult issues facing the Lower Malibu Creek and Lagoon area has been how to regulate water levels in the lagoon. The unnaturally high water levels found in the lagoon during the dry season affect the hydraulic gradient in and around the lagoon, and this alteration causes many problems. Nearby septic systems become backed up, pollutants become more mobile in groundwater, bacteria counts increase, lagoon salinity decreases and mudflats (bird habitat) disappear. The need to regulate or control lagoon water levels is of critical concern for these and other reasons.

Prop A funds ($1,275,000) were awarded to State Parks and the City of Malibu in 1998 to develop a project to regulate lagoon water levels. Because Malibu is no longer participating in this effort, State Parks has taken on the leadership role in solving this problem. However, progress has been extremely slow. State Parks released a *Request for Proposals* in September, 1999 seeking a sound water level management plan/design and since that time several management alternatives have been discussed. However, a preferred alternative has not been selected and no project has been implemented as of yet. For this reason, this action has been given a minimal rating.

Public Access and Resource Protection (#32)

A balance must be maintained between allowing public access to open space while protecting sensitive habitats in the watershed. Unfortunately, this action has not received much attention until recently. Recognizing the need for balance, State Parks and a few watershed cities have begun to implement resource protection measures such as establishing access trails, erecting informative signs and outlining critical measures to be addressed (e.g., wildlife corridors and recreational needs) in city master plans. Still, local habitats are not adequately protected from community recreational activities. For example, allowing public access to the mud flats in Malibu Lagoon jeopardizes bird safety because some visitors bring their dogs and allow them to roam off-leash. Riparian habitats are trampled on by horses and hikers who may not realize that they are in sensitive areas. And, trash is left on the ground in parks which further impacts wildlife and aquatic habitats. Implementing measures that would *fully* protect sensitive habitats is not a popular idea as it would most likely require prohibiting public access completely. Therefore, a more attention must be given to this action and a plan developed that adequately balances public access with resource protection needs.

Purchase High Priority Land for Watershed Protection (#33)

This action has made little progress on three accounts. First, there has not been a comprehensive, publicly available assessment of which lands within the entire watershed would be the most desirable to acquire from a water quality/habitat prospective. Secondly, there has been little effort made to actually acquire key parcels, or to secure the funds to do so. And thirdly, there has not been an abundance of willing sellers. Obtaining some parcels which have long been sought after, such as the golf course adjacent to Malibu Lagoon, has proved impossible thus far. This action, in some sense, has found itself in a "catch 22" scenario. A seller isn't willing to open discussions about selling his/her land unless funds are available to purchase it, and government agencies will not allocate funds unless the landowner is a willing seller.

Additionally, the few parcels that have been identified as desirable for acquisition have not been selected as part of a greater watershed protection effort. Rather, they represent singular potential restoration opportunities. As an example, the City of Malibu is assessing the feasibility of acquiring land for a constructed wetland in the Civic Center area. While this is an important location, it has not been officially prioritized as the most important parcel for acquisition in Malibu. A comprehensive plan which prioritized parcels for acquisition and determines the likelihood of obtaining them would eliminate this problem.

Develop Buffer Zones for Sensitive Areas (#34)

With a few exceptions, little attention has been given to the importance of creating buffer zones and to identifying sensitive zones throughout the watershed which are in need of buffer areas for protection. And, local ordinances for buffer zone setbacks (up to 100 feet) are inadequate to protect streams and creeks within the watershed. A few buffer zone areas have been identified on State Parks property and land has been purchased near the Rancho composting facility, but this falls far short of protecting many of the sensitive areas throughout the 109 mi^2 watershed. Although the creation or designation of open space zones should help protect sensitive areas contained in these zones, its benefits will not be realized unless there is a real commitment from the watershed's cities to designate open space zones. Like the recommendation to prioritize land parcels for acquisition, a comprehensive survey of significant ecological areas should be conducted and a priority list developed which is specific to the habitat protection needs of the Malibu Creek watershed.

Remove Barriers to Fish Migration (#36)

Efforts to address this action started several years after adoption of the Bay Restoration Plan and the Natural Resources Plan, and began with the formation of the Steelhead Recovery Task Force. In Malibu Creek, there are two primary obstacles impeding steelhead's migration to upper reaches of the creek. These include the Arizona crossing at Cross Creek and Rindge Dam.

Arizona Crossing at Cross Creek

A few years ago, there were discussions about removing this particular obstacle to steelhead migration. However, plans have all but been dropped because funding was never secured to alter the crossing. Only recent passage of Prop 12 has sparked new interest regarding how the crossing could be changed to benefit steelhead trout migration upstream.

Rindge Dam

Although Rindge Dam has not been removed, the fact that the Army Corp of Engineers has conducted a reconnaissance study to confirm local support for the project was a very positive initial step. However, a feasibility study (which has yet to start) needs to be conducted to assess the various restoration alternatives. The Army Corps has appropriated $400,000 for this feasibility study and State Parks will be providing the necessary matching funds. Current cost estimates to remove Rindge Dam, based on several alternatives already proposed, range between $10-30 million. Still, it remains to be seen which restoration alternatives will actually be presented and whether enough funds will then be secured for the alternative ultimately selected.

Maintain, Restore and Create Wetlands (#38)

The majority of interest in maintaining, restoring and creating wetlands has been in the lower watershed, in areas including Malibu Lagoon and the Civic Center area. With the exception of the LVMWD's rehabilitation of a percolation pond as a constructed wetland and some restoration of Malibu Lagoon, no other wetland restoration efforts have been implemented. Part of the reason for this stems from a lack of funds to start such a project. Also, there is some controversy over just which areas are considered "historic wetlands" and can be rehabilitated, and which areas can even be restored given current development obstacles.

Control Exotic Vegetation in the Wilderness (#37)

As mentioned in the body of the report, controlling the spread of exotic vegetation in the watershed is an overwhelming and endless task, and the resources needed to conduct this activity successfully haven't been available. While there are certainly some vigilant efforts by State Parks, Weed Warriors and other volunteer groups, the problem is so great, and some species so prolific, that it seems that it will be all but impossible to permanently remove exotic species. Also, the success of removing one particular invasive species, Arundo donax, is reduced because the target areas for removal are downstream from other upstream patches of Arundo. Unfortunately, the funds made available for this activity limited the geographical area from which Arundo could be removed.

The newly formed Invasive Species Task Force plans to start addressing the need to identify, assess and initiate removal of many types of invasive species. Perhaps their efforts, along with the availability of Prop 12 bond funds will lead to more successful removal of exotics.

Restore and Protect Watershed Habitats Grade: D-

Goal: Improve Coordination & Outreach Among Watershed Stakeholders

COORDINATION and OUTREACH

Substantial Progress

Posting Public Notices
Composting, Recycling & Conservation
Coordination Efforts
Public Education Programs

Moderate Progress

Implement Confined Animal BMPs
Promote Water Conservation
Coordinated Monitoring Program

Overall, the 7 actions designed to improve ***Coordination and Outreach*** have been quite successfully implemented. The goals and objectives of these actions has been: 1) to improve communication and coordination efforts among stakeholders, public agencies and the general public, 2) to better educate the public about sources of pollution and what they can do to minimize the impacts of pollution on the watershed's resources, and 3) to combine monitoring resources to better understand watershed dynamics and impacts. Following is an assessment of progress achieved in meeting the goals of these actions.

Substantial Progress

Some of the more notable achievements have been in the areas of:

- Posting public notices regarding lagoon breaching, and publishing bacteria monitoring results and potential human health concerns;
- Promoting composting, conservation and recycling programs in the watershed through curbside recycling programs, household hazardous waste roundups, educational brochures, PSAs and workshops (just to name a few);
- Coordinating restoration and protection efforts on a watershed basis; and
- Implementing public education programs.

Post Public Notices (#25)

Public access to and understanding of information available on the quality of water in Malibu Creek and Lagoon has dramatically increased in the last five years. This is due to a number of factors, including: 1) regular and frequent posting of Heal the Bay's Beach Report Card through multiple venues, 2) improvements in bacterial monitoring, and 3) local newspaper coverage. The results of the Santa Monica Bay Restoration Project's *Epidemiological Study* also helped improve the protocol for advising the public of health risks associated with swimming in contaminated waters. While the public is made aware of the health risks associated with swimming in the ocean within three days after a rain event through the media, the study provided the information needed to scientifically back up the recommendations and led to revisions in the County's Beach Closure and Health Warning protocol. The study also led to passage of AB 411, which requires local health agencies to set up a hotline informing the public of closed, posted or restricted beaches. Together, these actions have effectively improved the public's awareness about the water quality and risks associated with swimming in shoreline waters adjacent to Malibu Creek and Lagoon.

Composting, Recycling and Conservation Programs (#29)

As mentioned under **Managing Solid Waste** (starting on page 99), an enormous amount of energy has gone into promoting composting, recycling and conservation awareness among watershed residents. All watershed cities offer some sort of recycling program, whether it be curb-side pickup, roundup events or permanent drop-off sites. Additionally, these recycling opportunities are promoted through city newsletters, public service announcements, local cable channels and city banners. The need for water conservation is also promoted through educational workshops, fliers, newsletters and bill inserts. Combined, these efforts have increased the public's awareness for the need to recycle and conserve.

Coordination Efforts (#39)

The formation of the Malibu Creek Watershed Council has led directly to many of the achievements highlighted in this report. The continued involvement of participating organizations listed in Table 1.1 on page 5 has also led to a better understanding of the dynamics of the watershed and has provided a reliable mechanism for restoring habitats, assessing water quality and protecting species in a constructive, cohesive manner. While implementation has been slow for many actions, it would have been virtually impossible to achieve the progress already made without the long-term commitment of council members working together.

The progress made to coordinate activities among different agencies with seemingly conflicting goals has also been a milestone achievement, which should serve as a model for other watersheds. In particular, reconciling brush clearing needs (fuel modification), flood control and roadside maintenance with preservation of habitats has led to revisions of past practices and establishment of new guidelines within the County Fire and Public Works Departments. The 1996 Municipal Storm Water NPDES permit has also proven to be another avenue for coordinating efforts between the County and cities in the Malibu Creek watershed. Although the activities called for in the permit are mandatory on an individual city basis, cities have realized and been motivated by the cost savings associated with forming partnerships. In particular, the formation of the Council of Governments (see Coordinate on a Watershed Basis, #39) reinforces the advantages of creating such partnerships.

Public Education Programs (#42)

Public education programs targeting watershed residents and businesses have been broad in both message and approach. Many new outreach avenues have become successful realities in recent years, including use of the internet, creation and circulation of city/utility newsletters, use of real-time data, increased numbers of roundups and collection events, and an ever-growing number of hands-on programs and activities (e.g., student field trips, residential gardening workshops, volunteer opportunities, commercial site visits, municipal training and workshop classes, etc.). Additionally, several public education programs have successfully targeted very specific user groups. Examples include: 1) the Resource Conservation District of the Santa Monica Mountains' *Stable and Horse Management BMP Manual*; 2) the Las Virgenes Municipal Water District's water conservation classes for landscape maintenance companies; and 3) State Parks' lectures for teachers on the values of and need to preserve open space.

Moderate Progress

Moderate progress has been achieved in areas such as:

- Implement confined animal BMPs;
- Promote water conservation practices; and
- Implement coordinated monitoring programs

Implement Confined Animal BMPs (#18)

The RCDSMM conducted an extensive survey to identify the horse owners and corrals in the Malibu Creek watershed. They then used the information to produce pollution prevention educational materials for this target group. While the outreach materials are very informative, it's not clear that they are effectively reaching horse owners and are leading directly to changes in habit among them. Many corrals are still placed too close to streams and creeks, management of horse waste is still not closely regulated and people are still riding their horses in adjacent creeks. More outreach using the tools now available is still needed.

Promote Water Conservation (#30)

Because virtually all of the water used by watershed residents is imported, conservation measures are vitally important to both protecting and sustaining natural habitats. The LVMWD has implemented several educational approaches to promote water conservation measures which would reduce the amount of water used by households, including: 1) installation of ultra low-flow toilets, 2) workshops promoting low water use plants and landscape, and 3) distribution of educational materials promoting water conservation. However, the watershed's population continues to increase and even more must be done to encourage households to install ultra low-flow toilets (the single largest indoor use of water), and to more closely monitor landscape irrigation needs and other activities which cause excessive runoff.

Coordinated Monitoring Programs (#43)
There is an enormous amount of recent and historic monitoring data available for waterbodies in the Malibu Creek watershed, and significant steps have been taken towards collectively integrating the watershed's monitoring activities. Independent studies and routine monitoring activities have also enhanced our understanding of the major pollution issues. However, this data has yet to become available through a centralized, user-friendly database, and it has never been analyzed as a whole. Heal the Bay has only recently received funding for and started to create a database of the monitoring activities of key agencies. And, although the Monitoring and Modeling Subcommittee released a plan detailing a coordinated, watershed-wide monitoring program, it has yet to be implemented. Its implementation depends on securing the funds needed to carry out each component of the plan. Future progress will require adequate resources to realize the goals of the coordinated monitoring plan developed.

***Coordination and Outreach Grade*: A-**

SECTON IV:
MOVING FORWARD WITH RESTORATION PRIORITIES

Significant achievements have been made over the past decade to restore the Malibu Creek watershed. Still, much remains to be done to improve its water quality, habitats and living resources.

This chapter provides a summary of priority watershed restoration and protection activities which will advance the Malibu Creek watershed Action Plan.

The 29 priorities listed (Table 4.2) are based on the assessment of progress contained in this report. From this list, the Malibu Creek Watershed Executive Advisory Council has identified a list of "Top Ten" priorities (Table 4.1). How well and how extensively these actions are implemented will depend on many things, including: 1) availability of funds to carry out programs, 2) policy changes and/or legislation, 3) availability of research data to move actions forward, 4) ability to acquire land, and most importantly, 5) ensuring stakeholder involvement.

This Top-Ten list is not intended to be static or even an exhaustive list of all the watershed's priorities. It is anticipated that priorities will change as actions are implemented and new issues arise.

"TOP TEN"
Watershed Restoration Priorities

1. Map all existing and potential sources of pollution in the watershed. Implement measures to pinpoint sources of pollution in both the upper and lower watershed.
2. Acquire key parcels of land for habitat protection.
3. Remove Arundo donax from the entire watershed.
4. Review general land use practices and past practices for each city and for unincorporated areas in the watershed to predict the impacts on public health, natural and aquatic resources, and recreational benefits.
5. Reduce sedimentation and erosion along stream banks, roadways and at construction sites.
6. Implement the coordinated watershed-wide monitoring plan developed by the Monitoring and Modeling sub-committee and develop a centralized database for the monitoring data.
7. Synthesize water quality data to establish minimum standards for native species of locality and identify where gaps in data still exist.
8. Develop/revise monitoring plan to address data gaps.
9. Develop a plan to identify, remove and prevent exotic plant and animal species from impacting the watershed.
10. Help/Encourage watershed cities to develop uniform development plans and ordinances which would:
    - Set slope minimums for hillside building and construction activities.
    - Establish native plant vegetation requirements
    - Prevent disturbances to natural drainage channels
    - Retain runoff on-site to the maximum extent practicable (including use of pervious surfaces)
    - Prevent sediment loadings to creeks/streams both

Table 4.1. "Top Ten" watershed restoration priorities.

MOVING FORWARD ON WATERSHED RESTORATION PRIORITIES **(Table 4.2)**	**Issues to be Addressed**					
	Improve Water Quality	Reduce Excess Flow	Reduce Health Risks	Improve Land Use Management	Habitat Restoration and Protection	Enforcement and Education
Policy and Planning						
1. Revise/modify/update the Malibu Creek Watershed Restoration Plan.	☑	☑		☑	☑	☑
2. Develop a plan to better balance public access needs with habitat/resource protection.					☑	
3. Prioritize land parcels for acquisition that promote water quality and critical habitat protection.	☑				☑	
4. Develop procedural guidelines to address unconventional pollutants as they are discovered.	☑		☑		☑	
5. Review and improve current land use practices for each city and unincorporated areas in the watershed to predict land use impacts on public health, natural and aquatic resources and recreational benefits.	☑		☑	☑	☑	
6. Develop and implement better enforcement programs. Specifically address: • BMP implementation at construction sites; • Polluted discharges from restaurants and gas stations; • Improper grading practices; • Pervious surface requirements; and • Buffer zone setbacks	☑	☑	☑	☑	☑	☑

MOVING FORWARD ON WATERSHED RESTORATION PRIORITIES **(Table 4.2)**	**Issues to be Addressed**					
	Improve Water Quality	Reduce Excess Flow	Reduce Health Risks	Improve Land Use Management	Habitat Restoration and Protection	Enforcement and Education
7. Encourage watershed municipalities to integrate a watershed planning perspective into General Plans and local ordinances. Concepts to be considered include: • Setting slope minimums for hillside building/construction; • Establishing native plant vegetation requirements; • Preventing disturbing natural drainage channels; • Minimizing habitat fragmentation; • Retaining runoff on-site to the max. extent practicable (including pervious surfaces requirements for new and substantial redevelopment projects); • Preventing sediment loadings to creeks/streams both during and after construction; • Cumulative watershed-based review of development projects; • Setting standards for streets, sidewalks, driveways and parking lots; • Establishing 200-ft buffer-zone standards near sensitive habitats; and • Establishing setback standards for corrals and stables located near creek and stream banks.	☑	☑		☑	☑	
Watershed Studies and Research						
8. Map all existing and potential sources of pollution in the watershed and use measures to pinpoint exact sources of these pollutants. In particular, identify all sources and relative contributions of pathogens and nutrients.	☑		☑		☑	
9. Identify and develop a monitoring program to fill gaps in data where they exist throughout the watershed.	☑	☑		☑	☑	☑
10. Establish TMDLs for pollutants of concern in the Malibu Creek watershed.	☑	☑	☑		☑	
11. Establish minimum biological standards (habitat needs) for native species. Consider the physical tolerances of birds, plants and aquatic species.					☑	
12. Evaluate the impacts of breaching on Malibu Lagoon aquatic species and birds. Design a lagoon water level management plan based on this research.					☑	

MOVING FORWARD ON WATERSHED RESTORATION PRIORITIES **(Table 4.2)**	**Issues to be Addressed**					
	Improve Water Quality	Reduce Excess Flow	Reduce Health Risks	Improve Land Use Management	Habitat Restoration and Protection	Enforcement and Education
13. Determine appropriate seasonal flows into Malibu Creek and Lagoon. Evaluate the feasibility of treating creek and storm drain flows before they reach Malibu Lagoon and consider alternative uses for excess flows.		☑				
14. Assess/determine the impacts of nearby septic system effluent on lower Malibu Creek and Lagoon.	☑	☑	☑			
15. Conduct a household irrigation survey to better determine reasons for excess runoff from residential property.		☑				
Habitat Restoration and Other "On the Ground" Activities						
16. Regulate Malibu Lagoon water levels while minimizing the impacts to local habitats and species.	☑				☑	
17. Prevent/reduce sedimentation along stream banks, roadways and at construction sites.	☑			☑	☑	☑
18. Identify locations for and create buffer zones for sensitive habitats watershed-wide. Promote the need for buffer zones at the municipal, county and state level.				☑	☑	
19. Remove exotic plant, aquatic and animal species in the watershed. Prioritize the most prolific and invasive species for removal first.					☑	
20. Remove barriers to fish migration, particularly in the lower watershed, and enhance fish habitats.					☑	
21. Improve and increase wetlands habitat in the lower watershed.					☑	
22. Enhance bird habitats in Lower Malibu Creek and Lagoon. Consider: • Preventing human and pet intrusion; • Placement of informative/warning signs; • Education of lifeguards and beach-goers; • Removal of invasive species, planting of native species; • Trash can lids; and • Appropriate lagoon water levels.	☑				☑	☑

MOVING FORWARD ON WATERSHED RESTORATION PRIORITIES **(Table 4.2)**	**Issues to be Addressed** Improve Water Quality	Reduce Excess Flow	Reduce Health Risks	Improve Land Use Management	Habitat Restoration and Protection	Enforcement and Education
23. Reduce trash inputs into the watershed. Consider: • Requiring outdoor, bird-proof lids in parks, and at beaches and restaurants/shopping centers. • Installing more trash cans where needed in parklands and at beaches. • Promoting/expanding comprehensive recycling programs for paper cardboard, plastics, aluminum and glass • Establishing a permanent recycling center for all watershed residents. • Posting bilingual informative signs in areas most frequently visited.					☑	☑
24. Reduce sources of nutrients, pathogens and bacteria into the watershed. Specifically: • Implement livestock BMPs for horse owners. See #7 above. • Implement siting, monitoring, maintenance, replacement requirements and inspection programs for septic systems. Establish discharge standards for septic system effluent. • Storm drain discharges: identify and eliminate sources entering storm drains (on-going). • Promote year-round diversion of Tapia effluent from Malibu Creek; improve nutrient removal process; and maximize reuse potential.	☑		☑			☑
25. Identify and eliminate illicit connections on a regular basis.	☑		☑	☑		
26. Reduce impacts of landfill operations on nearby habitats. Implement mitigation measures where necessary.					☑	
27. Develop and conduct both general and focused education programs watershed-wide. Specifically, improve outreach to: • Homeowners about: 1) sources of household waste and their impacts to water quality, and 2) the need for water conservation and runoff reduction. • Contractors and developers about how their activities adversely impact water quality and habitats. Incorporate information on smart developing/designs to retain storm water runoff on site. • Horse and other livestock owners about how animal waste impacts water quality, and ways to minimize this source of pollution. • Septic system users (commercial and residential) about the need for and importance of maintaining appropriately functioning septic systems.	☑		☑			☑

MOVING FORWARD ON WATERSHED RESTORATION PRIORITIES **(Table 4.2)**	Issues to be Addressed					
	Improve Water Quality	Reduce Excess Flow	Reduce Health Risks	Improve Land Use Management	Habitat Restoration and Protection	Enforcement and Education
28. Promote/mandate water conservation practices by: 1) using native, drought-tolerant plants, 2) installing ultra low flow toilets and irrigation sensors, 3) providing price incentives to reduce water usage, 4) incorporating storm water retention designs into all new construction plans and 5) distributing recycled water to the maximum extent practicable.		☑				
29. Implement the coordinated Malibu Creek Watershed Monitoring Program (developed by the Monitoring and Modeling subcommittee) and develop a centralized database for the monitoring data.	☑					☑

Acronyms

BMPs	Best Management Practices
BRP	Bay Restoration Plan (Santa Monica Bay Restoration Project)
BOD	Biochemical Oxygen Demand
CalTrans	California Department of Transportation
CCC	California Coastal Commission
CDS	Continuous Deflection System
cfs	Cubic feet per second
COG	Council of Governments
CSDLAC	County Sanitation Districts of Los Angeles County
DHS	Los Angeles County Department of Health Services
DO	Dissolved Oxygen
EA	Environmental Assessment
EIR	Environmental Impact Report
EPA	U.S. Environmental Protection Agency
EPA 319(h)	U.S. EPA Nonpoint Source Reduction Grant Program
EPA 205(j)	U.S. EPA Water Quality Planning Grant Program
GIS	Geographical Information System
GPS	Global Positioning System
JPA	Joint Powers Authority
LAC-DPW	Los Angeles County Department of Public Works
LARWQCB	Los Angeles Regional Water Quality Control Board
LVMWD	Las Virgenes Municipal Water District
MCW	Malibu Creek Watershed
MEP	Maximum Extent Practicable
mg/l	Milligrams per liter
MTA	Metropolitan Transportation Authority
MWD	Metropolitan Water District
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NO_2, NO_3, N	Nitrogen Compounds
NPDES	National Pollutant Discharge Elimination System
NPS	National Parks Service
PIE	Public Involvement and Education
PSA	Public Service Announcement
PSDS	Private Septic Disposal System
RCDSMM	Resource Conservation District of the Santa Monica Mountains
Regional Board	Los Angeles Regional Water Quality Control Board
SCAG	Southern California Association of Governments
SEAs	Significant Ecological Areas
SCS	Soil Conservation Service
SMBRP	Santa Monica Bay Restoration Project
State Parks	California Department of Parks and Recreation

SWRCB	State Water Resources Control Board
RCDSMM	Resource Conservation District of the Santa Monica Mountains
TAC	Technical Advisory Committee
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
UCLA	University of California, Los Angeles
ULFT	Ultra Low Flow Toilets
WDR	Waste Discharge Requirements

Definitions

Best Management Practices	Activities, practices, facilities and/or procedures that when implemented to their maximum efficiency will prevent or reduce pollutants in discharges.
Bathymetry	The science of measuring the depths of the ocean, seas, etc.
Benthic	Organisms living on or in the sea floor.
Bio-criteria	Narrative descriptions or numerical values that are used to describe the reference condition of aquatic biota inhabiting waters of a designated aquatic life use. These criteria are used to determine if waters are affected by chemical pollution or other factors.
Biosolids	The solids portion of human waste removed through primary treatment of wastewater. Formerly called sludge.
BOD	Bio-chemical Oxygen Demand. The amount of dissolved oxygen needed to decompose organic matter in wastewater. A high BOD indicates an impaired waterbody with little oxygen remaining for aquatic life.
Breach (lagoon)	Naturally or artificially breaking open the sand barrier that separates Malibu Lagoon from Santa Monica Bay.
Carnivore	Any of an order of fanged, flesh-eating mammals including the dog, bear, cat and seal.
Catch Basin	A sieve-like device at the entrance to a storm drain system to stop matter from entering which could block up the system.
Clean Water Act (CWA)	The Federal Water Pollution Control Act enacted in 1972 by public law and amended by the Water Quality Act of 1987. The Clean Water Act prohibits the discharge of pollutants to waters of the United States unless said discharge is in accordance with an NPDES permit.
Coliform	Relating to, resembling or being the aerobic bacillus normally found in the colon of humans and animals. A coliform count is often used as an indicator or fecal contamination of water supplies.

Delineation (wetlands)	Identification and/or outline an area which encompasses wetlands.
DO	Dissolved Oxygen. The amount of oxygen present in water. A low DO indicates an impaired waterbody with little oxygen remaining to support aquatic life.
Enterococcus	Any of a genus (streptococcus) of non-motile, usually parasitic, gram positive bacteria occurring in the intestinal tract that may be a cause of disease when found in other parts of the body.
Eutrophication	The process in which a nutrient-rich waterbody becomes degraded due to decreased levels of oxygen caused by excessive growth of bacteria. High eutrophication indicates an impaired waterbody with little or no oxygen remaining to support aquatic life.
Extirpate	To remove or destroy completely; exterminate; abolish.
Grey Water	Wastewater discharged from household sinks, showers, washing machines, dishwashers, etc. that does not come into contact with human waste.
Hydrology	The science dealing with the waters of the earth, their distribution on the surface and underground, and the cycle involving evaporation, precipitation, flow to the seas, etc.
Illicit Connection	Any discharge to the storm drain system that is prohibited under local, state or federal statutes, ordinances, codes or regulations. This includes all non-storm water discharges except discharges pursuant to an NPDES permit and discharges that are exempted or conditionally exempted in accordance with section II of the 1996 Municipal Storm Water NPDES permit.
Macroinvertebrate	Larger animals without backbones or spines (e.g., shrimp, lobster).
MBAS	Methyl Buyl Activated Substances. Soap and/or detergent compounds which indicate human inputs into a waterbody. MBAS markers are often found in grey water discharges.

Morphodynamics	(Definition for this report only). The constantly changing hydrological conditions associated with the Lower Malibu Creek and Lagoon estuarine system; particular attention is given to the morphodynamics of sand bar formation and breaching occurrences, tidal regime, wave climate and creek flows.
Nonpoint Source Discharge	Discharge resulting from widespread, diffuse, or unidentifiable sources of contaminants that comes from more than one point which cannot be controlled or easily monitored.
NPDES	National Pollutant Discharge Elimination System. A permit issued by the US Environmental Protection Agency, State Water Resources Control Board or California Regional Water Quality Control Boards pursuant to the Clean Water Act that authorizes discharges to waters of the United States and requires the reduction of pollutants or sets pollutant limits in the discharges.
Nutrients	Elements necessary for plant growth. Nitrogen and phosphorus are the most common elements. Excess nutrients in waterbodies can stimulate plant and algae growth.
Pathogen	Any agent, especially a microorganism, able to cause disease.
pH	A symbol for the degree of acidity or alkalinity of a solution, which ranges from 0 to 14. A neutral substance will have a pH value of 7, which is the value of distilled water. Lower number are acidic and higher numbers are alkaline (basic).
Piezometer	Any of various instruments used in measuring pressure or compressibility (e.g., to measure water pressure)
Point Source Discharge	Discharge from single, known sources, such as publicly owned treatment works (POTWs) or industrial facilities, from which contaminants enter a waterbody.
Porter Cologne Act	An Act passed by the California legislature in 1967, to provide for the orderly and efficient administration of the water resources of the state. Periodic amendments have been made since its original adoption date.
Potable	Fit to drink; drinkable.
Primary Treatment	A treatment process in which the solids portion of wastewater is

	allowed to settle out before the remaining effluent is discharged. This process does not remove suspended and colloidal matter.
Proposition A Funds	Bond funds totaling $8 million which were approved by Los Angeles County voters in 1994 And 1998. These funds are specifically earmarked for capital improvement projects to prevent or reduce urban runoff pollution from entering Santa Monica Bay and its watershed.
Riparian Habitats	Those habitats located adjacent to or living on the bank of a lake, pond, river, creek or stream.
Secondary Treatment	A biological treatment process in which effluent that has received primary treatment is further processed to remove about 85% of the BOD and suspended solids present (e.g., trickle filters or anaerobic digestion) before being discharged.
Sedimentation	The deposit or formation of sediment. Increased sedimentation into waterbodies can increase turbidity and smother natural spawning grounds.
Spawning Grounds	A location where eggs, sperm or young (offspring) are produced or deposited.
Storm-ceptorJ	An in-situ, non-mechanical device which is positioned to receive and separate out trash and other debris found in storm drain flows before they reach receiving waters.
Taxonomical	Classification of plants and animals into natural, related groups based on some common factor of each, as structure, embryology or biochemistry.
Telemetry	Transmission of measurements of physical phenomena, such as temperature, to a distant recorder or observer.
Tertiary Treatment	A treatment process in which effluent that has received both primary and secondary treatment is further processed to remove nutrients and most of the remaining suspended solids before being discharged.

Turbidity	Muddy or cloudy water from having the sediment stirred up. Increased turbidity reduces the amount of light that can penetrate through the water column.
US EPA 205(j) Grant Funds	United States Environmental Protection Agency. Under section 205(j) of the Clean Water Act, grant funds are provided for water quality planning and assessment projects designed to prevent or reduce the release of pollutants into waters of the United States.
US EPA 319(h) Grant Funds	United States Environmental Protection Agency. Under section 319(h) of the Clean Water Act, grant funds are provided for nonpoint source implementation projects to reduce, prevent or eliminate water pollution and to enhance water quality for waters of the United States.
WDR	Waste Discharge Requirement. Waste discharge conditions adversely affecting waters of the state are regulated by the State and Regional Water Quality Control Boards under the Porter-Cologne Act. Permits, called Waste Discharge Requirements, are issued for discharges not covered under the federal NPDES permit (usually for non-surface water discharges).
Xeriscape	Dry landscaping.

References

1. Agency/Watershed Stakeholders.

   - California Department of Parks and Recreation
   - City of Agoura Hills
   - City of Calabasas
   - City of Malibu
   - City of Thousand Oaks
   - City of Westlake Village
   - County of Los Angeles, Fire Department
   - County of Los Angeles, Department of Health Services
   - County of Los Angeles, Department of Public Works
   - Heal the Bay
   - Las Virgenes Municipal Water District
   - Los Angeles Regional Water Quality Control Board
   - Malibu Lands Coastal Conservancy
   - National Park Service, Santa Monica Mountains National Recreation Area
   - Resource Conservation District of the Santa Monica Mountains
   - Santa Monica Audubon
   - Supervisor Zev Yaroslavsky's Office
   - Triunfo Sanitation District
   - Ron Rindge
   - Victoria Wikle

2. Malibu Creek Watershed Executive Advisory Council, meeting minutes (January,1997 – June, 2000).
3. 1996 Municipal NPDES Storm Water Permit Ordinances for Agoura Hills, Calabasas, Malibu and Westlake Village
4. *Comprehensive Malibu Creek Watershed Mediation Effort, Final Report*. Common Ground: Center for Cooperative Solutions, University Extension, University of California, Davis. May 1994.
5. *Enhanced Monitoring Program on Lower Malibu Creek and Lagoon*. Rich Ambrose, et.al. (UCLA). 1995.
6. *Expedited Reconnaissance Study, Draft*. Robert L. Davis, Colonel, Corps of Engineers. June, 1998.
7. *Lower Malibu Creek and Barrier Lagoon System Resource Enhancement and Management.* Draft Final Report. California State Coastal Conservancy and UCLA. February, 1999.
8. *Malibu Creek Natural Resources Plan*. US Department of Agriculture, Natural Resource Conservation Service. March 1995.
9. *Malibu Creek Watershed Monitoring Program, Draft*. Malibu Creek Watershed Advisory Council Monitoring and Modeling Subcommittee. April 1999.
10. *Omission Accomplished: The Lack of a Regional Water Board Enforcement Program, 1992-1997*. Heal the Bay. January, 1998.

11. *Study of Potential Water Quality Impacts on Malibu Creek and Lagoon From On-site Septic Systems*. Final Report. Prepared for the City of Malibu by URS Greiner Woodward Clyde. June, 1999.

12. *Study of Water Quality in the Malibu Lagoon Area, City of Malibu, California – Phase II.* Final Report. Prepared for the City of Malibu by URS Greiner Woodward Clyde. April, 2000.

13. *Tapia Gets More Limits.* Heal the Bay newsletter. Spring 1999.

14. *Waste Discharge Requirements for Municipal Storm Water and Urban Runoff Discharges Within the County of Los Angeles*. Order No. 96-054 (NPDES No. CAS614001). State of California, California Regional Water Quality Control Board, Los Angeles Region. 1996

15. *Water Quality Control Plan, Los Angeles Region.* Los Angeles Regional Water Quality Control Board. June, 1994.

16. *Preliminary Report of the Malibu Technical Investigation.* Los Angeles Regional Water Quality Control Board. August 18, 2000.

Appendix y-L: Vermont Avenue Stormwater Capture and Green Street Project Supporting Documents

(Please see Appendix CD for documents)

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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD

LOS ANGELES REGION

320 W. 4th Street, Suite 200, Los Angeles, California 90013

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ORDER NO. R4-2012-0175
NPDES PERMIT NO. CAS004001

WASTE DISCHARGE REQUIREMENTS
FOR MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) DISCHARGES WITHIN THE COASTAL WATERSHEDS OF LOS ANGELES COUNTY, EXCEPT THOSE DISCHARGES ORIGINATING FROM THE CITY OF LONG BEACH MS4

The municipal discharges of storm water and non-storm water by the Los Angeles County Flood Control District, the County of Los Angeles, and 84 incorporated cities within the coastal watersheds of Los Angeles County with the exception of the City of Long Beach (hereinafter referred to separately as Permittees and jointly as the Dischargers) from the discharge points identified below are subject to waste discharge requirements as set forth in this Order.

I. FACILITY INFORMATION

Table 1. Discharger Information

Dischargers	The Los Angeles County Flood Control District, the County of Los Angeles, and 84 incorporated cities within the coastal watersheds of Los Angeles County with the exception of the City of Long Beach (See Table 4)
Name of Facility	Municipal Separate Storm Sewer Systems (MS4s) within the coastal watersheds of Los Angeles County with the exception of the City of Long Beach MS4
Facility Address	Various (see Table 2)
The U.S. Environmental Protection Agency (USEPA) and the California Regional Water Quality Control Board, Los Angeles Region (Regional Water Board) have classified the Greater Los Angeles County MS4 as a large municipal separate storm sewer system (MS4) pursuant to 40 CFR section 122.26(b)(4) and a major facility pursuant to 40 CFR section 122.2.	

Table 2. Facility Information

Permittee (WDID)	**Contact Information**	
Agoura Hills (*4B190147001*)	**Mailing Address**	30001 Ladyface Court
		Agoura Hills, CA 91301
	Facility Contact, Title, and E-mail	Ken Berkman, City Engineer kberkman@agoura-hills.ca.us

Permittee (WDID)	Contact Information	
Alhambra (***4B190148001***)	**Mailing Address**	111 South First Street
		Alhambra, CA 91801-3796
	Facility Contact and E-mail	David Dolphin ddolphin@cityofalhambra.org
Arcadia (***4B190149001***)	**Mailing Address**	11800 Goldring Road
		Arcadia, CA 91006-5879
	Facility Contact, Title, Phone, and E-mail	Vanessa Hevener, Environmental Services Officer (626) 305-5327 vhevener@ci.arcadia.ca.us
Artesia (***4B190150001***)	**Mailing Address**	18747 Clarkdale Avenue
		Artesia, CA 90701-5899
	Facility Contact, Title, and E-mail	Maria Dadian, Director of Public Works mdadian@cityofartesia.ci.us
Azusa (***4B190151001***)	**Mailing Address**	213 East Foothill Boulevard
		Azusa, CA 91702
	Facility Contact, Title, and E-mail	Carl Hassel, City Engineer chassel@ci.azusa.ca.us
Baldwin Park (***4B190152001***)	**Mailing Address**	14403 East Pacific Avenue
		Baldwin Park, CA 91706-4297
	Facility Contact, Title, and E-mail	David Lopez, Associate Engineer dlopez@baldwinpark.com
Bell (***4B190153001***)	**Mailing Address**	6330 Pine Avenue
		Bell, CA 90201-1291
	Facility Contact, Title, and E-mail	Terri Rodrigue, City Engineer trodrigue@cityofbell.org
Bell Gardens (***4B190139002***)	**Mailing Address**	7100 South Garfield Avenue
		Bell Gardens, CA 90201-3293
	Facility Contact, Title, and Phone	John Oropeza, Director of Public Works (562) 806-7700
Bellflower (***4B190154001***)	**Mailing Address**	16600 Civic Center Drive
		Bellflower, CA 90706-5494
	Facility Contact, Title, and E-mail	Bernie Iniguez, Environmental Services Manager biniguez@bellflower.org
Beverly Hills (***4B190132002***)	**Mailing Address**	455 North Rexford Drive
		Beverly Hills, CA 90210
	Facility Contact, Title, and E-mail	Vincent Chee, Project Civil Engineer kgettler@beverlyhills.org
Bradbury (***4B190155001***)	**Mailing Address**	600 Winston Avenue
		Bradbury, CA 91010-1199
	Facility Contact, Title, and E-mail	Elroy Kiepke, City Engineer mkeith@cityofbradbury.org
Burbank (***4B190101002***)	**Mailing Address**	P.O. Box 6459
		Burbank, CA 91510
	Facility Contact, Title, and E-mail	Bonnie Teaford, Public Works Director bteaford@ci.burbank.ca.us
Calabasas (***4B190157001***)	**Mailing Address**	100 Civic Center Way
		Calabasas, CA 91302-3172
	Facility Contact, Title, and E-mail	Alex Farassati, ESM afarassati@cityofcalabasas.com
Carson (***4B190158001***)	**Mailing Address**	P.O. Box 6234
		Carson, CA 90745
	Facility Contact, Title,	Patricia Elkins, Building Construction Manager

Permittee (WDID)	Contact Information	
	and E-mail	pelkins@carson.ca.us
Cerritos (*4B190159001*)	**Mailing Address**	P.O. Box 3130
		Cerritos, CA 90703-3130
	Facility Contact, Title, and E-mail	Mike O'Grady, Environmental Services mo'grady@cerritos.us
Claremont (*4B190160001*)	**Mailing Address**	207 Harvard Avenue
		Claremont, CA 91711-4719
	Facility Contact, Title, and E-mail	Craig Bradshaw, City Engineer cbradshaw@ci.claremont.ca.us
Commerce (*4B190161001*)	**Mailing Address**	2535 Commerce Way
		Commerce, CA 90040-1487
	Facility Contact and E-mail	Gina Nila gnila@ci.commerce.ca.us
Compton (*4B190162001*)	**Mailing Address**	205 South Willowbrook Avenue
		Compton, CA 90220-3190
	Facility Contact, Title, and Phone	Hien Nguyen, Assistant City Engineer (310) 761-1476
Covina (*4B190163001*)	**Mailing Address**	125 East College Street
		Covina, CA 91723-2199
	Facility Contact, Title, and E-mail	Vivian Castro, Environmental Services Manager vcastro@covinaca.gov
Cudahy (*4B190164001*)	**Mailing Address**	P.O. Box 1007
		Cudahy, CA 90201-6097
	Facility Contact, Title, and E-mail	Hector Rodriguez, City Manager hrodriguez@cityofcudahy.ca.us
Culver City (*4B190165001*)	**Mailing Address**	9770 Culver Boulevard
		Culver City, CA 90232-0507
	Facility Contact, Title, and Phone	Damian Skinner, Manager (310) 253-6421
Diamond Bar (*4B190166001*)	**Mailing Address**	21825 East Copley Drive
		Diamond Bar, CA 91765-4177
	Facility Contact, Title, and E-mail	David Liu, Director of Public Works dliu@diamondbarca.gov
Downey (*4B190167001*)	**Mailing Address**	P.O. Box 7016
		Downey, CA 90241-7016
	Facility Contact , Title, and E-mail	Yvonne Blumberg yblumberg@downeyca.org
Duarte (*4B190168001*)	**Mailing Address**	1600 Huntington Drive
		Duarte, CA 91010-2592
	Facility Contact, Title, and Phone	Steve Esbenshades, Engineering Division Manager (626) 357-7931 ext. 233
El Monte (*4B190169001*)	**Mailing Address**	P.O. Box 6008
		El Monte, CA 91731
	Facility Contact, Title, and Phone	James A Enriquez, Director of Public Works (626) 580-2058
El Segundo (*4B190170001*)	**Mailing Address**	350 Main Street
		El Segundo, CA 90245-3895
	Facility Contact, Title, Phone, and E-mail	Stephanie Katsouleas, Public Works Director (310) 524-2356 skatsouleas@elsegundo.org
Gardena (*4B190118002*)	**Mailing Address**	P.O. Box 47003
		Gardena, CA 90247-3778

Permittee (WDID)	Contact Information	
	Facility Contact, Title, and E-mail	Ron Jackson, Building Maintenance Supervisor jfelix@ci.gardena.ci.us
Glendale (*4B190171001*)	**Mailing Address**	Engineering Section, 633 East Broadway, Room 209
		Glendale, CA 91206-4308
	Facility Contact, Title, and E-mail	Maurice Oillataguerre, Senior Environmental Program Scientist moillataguerre@ci.glendale.ca.us
Glendora (*4B190172001*)	**Mailing Address**	116 East Foothill Boulevard
		Glendora, CA 91741
	Facility Contact, Title, and E-mail	Dave Davies, Deputy Director of Public Works ddavies@ci.glendora.ca.us
Hawaiian Gardens (*4B190173001*)	**Mailing Address**	21815 Pioneer Boulevard
		Hawaiian Gardens, CA 90716
	Facility Contact, Title, and E-mail	Joseph Colombo, Director of Community Development jcolombo@ghcity.org
Hawthorne (*4B190174001*)	**Mailing Address**	4455 West 126th Street
		Hawthorne, CA 90250-4482
	Facility Contact, Title, and E-mail	Arnold Shadbehr, Chief General Service and Public Works ashadbehr@cityofhawthorne.org
Hermosa Beach (*4B190175001*)	**Mailing Address**	1315 Valley Drive
		Hermosa Beach, CA 90254-3884
	Facility Contact, Title, and E-mail	Homayoun Behboodi, Associate Engineer hbehboodi@hermosabch.org
Hidden Hills (*4B190176001*)	**Mailing Address**	6165 Spring Valley Road
		Hidden Hills, CA 91302
	Facility Contact, Title, and Phone	Kimberly Colberts, Environmental Coordinator (310) 257-2004
Huntington Park (*4B190177001*)	**Mailing Address**	6550 Miles Avenue
		Huntington Park, CA 90255
	Facility Contact, Title, and Phone	Craig Melich, City Engineer and City Official (323) 584-6253
Industry (*4B190178001*)	**Mailing Address**	P.O. Box 3366
		Industry, CA 91744-3995
	Facility Contact and Title	Mike Nagaoka, Director of Public Safety
Inglewood (*4B190179001*)	**Mailing Address**	1 W. Manchester Blvd, 3rd Floor
		Inglewood, CA 90301-1750
	Facility Contact, Title, and E-mail	Lauren Amimoto, Senior Administrative Analyst lamimoto@cityofinglewood.org
Irwindale (*4B190180001*)	**Mailing Address**	5050 North Irwindale Avenue
		Irwindale, CA 91706
	Facility Contact, Title, and E-mail	Kwok Tam, Director of Public Works ktam@ci.irwindale.ca.us
La Canada Flintridge (*4B190181001*)	**Mailing Address**	1327 Foothill Boulevard
		La Canada Flintridge, CA 91011-2137
	Facility Contact, Title, and E-mail	Edward G. Hitti, Director of Public Works ehitti@lcf.ca.gov
La Habra Heights (*4B190182001*)	**Mailing Address**	1245 North Hacienda Boulevard
		La Habra Heights, CA 90631-2570
	Facility Contact, Title, and E-mail	Shauna Clark, City Manager shaunac@lhhcity.org
La Mirada	**Mailing Address**	13700 La Mirada Boulevard

Permittee (WDID)	**Contact Information**	
(*4B190183001*)		La Mirada, CA 90638-0828
	Facility Contact, Title, and E-mail	Steve Forster, Public Works Director sforster@cityoflamirada.org
La Puente (*4B190184001*)	**Mailing Address**	15900 East Marin Street
		La Puente, CA 91744-4788
	Facility Contact, Title, and E-mail	John DiMario, Director of Development Services jdimario@lapuente.org
La Verne (*4B190185001*)	**Mailing Address**	3660 "D" Street
		La Verne, CA 91750-3599
	Facility Contact, Title, and E-mail	Daniel Keesey, Director of Public Works dkeesey@ci.la-verne.ca.us
Lakewood (*4B190186001*)	**Mailing Address**	P.O. Box 158
		Lakewood, CA 90714-0158
	Facility Contact and E-mail	Konya Vivanti kvivanti@lakewoodcity.org
Lawndale (*4B190127002*)	**Mailing Address**	14717 Burin Avenue
		Lawndale, CA 90260
	Facility Contact and Title	Marlene Miyoshi, Senior Administrative Analyst
Lomita (*4B190187001*)	**Mailing Address**	P.O. Box 339
		Lomita, CA 90717-0098
	Facility Contact, Title, and E-mail	Tom A. Odom, City Administrator d.tomita@lomitacity.com
Los Angeles (*4B190188001*)	**Mailing Address**	1149 S. Broadway, 10th Floor
		Los Angeles, CA 90015
	Facility Contact, Title, and Phone	Shahram Kharaghani, Program Manager (213) 485-0587
Lynwood (*4B190189001*)	**Mailing Address**	11330 Bullis Road
		Lynwood, CA 90262-3693
	Facility Contact and Phone	Josef Kekula (310) 603-0220 ext. 287
Malibu (*4B190190001*)	**Mailing Address**	23825 Stuart Ranch Road
		Malibu, CA 90265-4861
	Facility Contact, Title, and E-mail	Jennifer Brown, Environmental Program Analyst jbrown@malibucity.org
Manhattan Beach (*4B190191001*)	**Mailing Address**	1400 Highland Avenue
		Manhattan Beach, CA 90266-4795
	Facility Contact, Title, and Email	Brian Wright, Water Supervisor bwright@citymb.info
Maywood (*4B190192001*)	**Mailing Address**	4319 East Slauson Avenue
		Maywood, CA 90270-2897
	Facility Contact, Title, and Phone	Andre Dupret, Project Manager (323) 562-5721
Monrovia (*4B190193001*)	**Mailing Address**	415 South Ivy Avenue
		Monrovia, CA 91016-2888
	Facility Contact and E-mail	Heather Maloney hmaloney@ci.monrovia.ca.gov
Montebello (*4B190194001*)	**Mailing Address**	1600 West Beverly Boulevard
		Montebello, CA 90640-3970
	Facility Contact and E-mail	Cory Roberts croberts@aaeinc.com
Monterey Park	**Mailing Address**	320 West Newmark Avenue

Permittee (WDID)	Contact Information	
(*4B190195001*)		Monterey Park, CA 91754-2896
	Facility Contact, Phone, and E-mail	Amy Ho (626) 307-1383 amho@montereypark.ca.gov John Hunter (Consultant) at jhunter@jhla.net
Norwalk (*4B190196001*)	**Mailing Address**	P.O. Box 1030
		Norwalk, CA 90651-1030
	Facility Contact and Title	Chino Consunji, City Engineer
Palos Verdes Estates (*4B190197001*)	**Mailing Address**	340 Palos Verdes Drive West
		Palos Verdes Estates, CA 90274
	Facility Contact, Title, and E-mail	Allan Rigg, Director of Public Works arigg@pvestates.org
Paramount (*4B190198001*)	**Mailing Address**	16400 Colorado Avenue
		Paramount, CA 90723-5091
	Facility Contact, Title, and E-mail	Chris Cash, Utility and Infrastructure Assistant Director ccash@paramountcity,org
Pasadena (*4B190199001*)	**Mailing Address**	P.O. Box 7115
		Pasadena, CA 91109-7215
	Facility Contact and E-mail	Stephen Walker swalker@cityofpasadena.net
Pico Rivera (*4B190200001*)	**Mailing Address**	P.O. Box 1016
		Pico Rivera, CA 90660-1016
	Facility Contact, Title, and E-mail	Art Cervantes, Director of Public Works acervantes@pico-rivera.org
Pomona (*4B190145003*)	**Mailing Address**	P.O. Box 660
		Pomona, CA 91769-0660
	Facility Contact, Title, and E-mail	Julie Carver, Environmental Programs Coordinator Julie_Carver@ci.pomona.ca.us
Rancho Palos Verdes (*4B190201001*)	**Mailing Address**	30940 Hawthorne Boulevard
		Rancho Palos Verdes, CA 90275
	Facility Contact, Title, and E-mail	Ray Holland, Interim Public Works Director clehr@rpv.com
Redondo Beach (*4B190143002*)	**Mailing Address**	P.O. Box 270
		Redondo Beach, CA 90277-0270
	Facility Contact, Title, and E-mail	Mike Shay, Principal Civil Engineer mshay@redondo.org
Rolling Hills (*4B190202001*)	**Mailing Address**	2 Portuguese Bend Road
		Rolling Hills, CA 90274-5199
	Facility Contact, Title, and E-mail	Greg Grammer, Assistant to the City Manager ggrammer@rollinghillsestatesca.gov
Rolling Hills Estates (*4B190203001*)	**Mailing Address**	4045 Palos Verdes Drive North
		Rolling Hills Estates, CA 90274
	Facility Contact, Title, and E-mail	Greg Grammer, Assistant to the City Manager ggrammer@rollinghillsestatesca.gov
Rosemead (*4B190204001*)	**Mailing Address**	8838 East Valley Boulevard
		Rosemead, CA 91770-1787
	Facility Contact, Title, and Phone	Chris Marcarello, Director of PW (626) 569-2118
San Dimas (*4B190205001*)	**Mailing Address**	245 East Bonita Avenue
		San Dimas, CA 91773-3002
	Facility Contact, Title,	Latoya Cyrus, Environmental Services Coordinator

Permittee (WDID)	Contact Information	
	and E-mail	lcyrus@ci.san-dimas.ca.us
San Fernando (*4B190206001*)	**Mailing Address**	117 Macneil Street
		San Fernando, CA 91340
	Facility Contact, Title, and E-mail	Ron Ruiz, Director of Public Works rruiz@sfcity.org
San Gabriel (*4B190207001*)	**Mailing Address**	425 South Mission Drive
		San Gabriel, CA 91775
	Facility Contact, Title, and Phone	Daren T. Grilley, City Engineer (626) 308-2806 ext. 4631
San Marino (*4B190208001*)	**Mailing Address**	2200 Huntington Drive
		San Marino, CA 91108-2691
	Facility Contact, Title, and E-mail	Chuck Richie, Director of Parks and Public Works crichie@cityofsanmarino.org
Santa Clarita (*4B190117001*)	**Mailing Address**	23920 West Valencia Boulevard, Suite 300
		Santa Clarita, CA 91355
	Facility Contact, Title, and Phone	Travis Lange, Environmental Services Manager (661) 255-4337
Santa Fe Springs (*4B190108003*)	**Mailing Address**	P.O. Box 2120
		Santa Fe Springs, CA 90670-2120
	Facility Contact, Title, and E-mail	Sarina Morales-Choate, Civil Engineer Assistant smorales-choate@santafesprings.org
Santa Monica (*4B190122002*)	**Mailing Address**	1685 Main Street
		Santa Monica, CA 90401-3295
	Facility Contact, Title, and E-mail	Neal Shapiro, Urban Runoff Coordinator nshapiro@smgov.net
Sierra Madre (*4B190209001*)	**Mailing Address**	232 West Sierra Madre Boulevard
		Sierra Madre, CA 91024-2312
	Facility Contact, Title, and Phone	James Carlson, Management Analyst (626) 355-7135 ext. 803
Signal Hill (*4B190210001*)	**Mailing Address**	2175 Cherry Avenue
		Signal Hill, CA 90755
	Facility Contact, Phone, and E-mail	John Hunter (562) 802-7880 jhunter@jlha.net
South El Monte (*4B190211001*)	**Mailing Address**	1415 North Santa Anita Avenue
		South El Monte, CA 91733-3389
	Facility Contact and Phone	Anthony Ybarra, City Manager (626) 579-6540
South Gate (*4B190212001*)	**Mailing Address**	8650 California Avenue
		South Gate, CA 90280
	Facility Contact, Phone, and E-mail	John Hunter (562) 802-7880 jhunter@jlha.net
South Pasadena (*4B190213001*)	**Mailing Address**	1414 Mission Street
		South Pasadena, CA 91030-3298
	Facility Contact, Phone, and E-mail	John Hunter (562) 802-7880 jhunter@jlha.net
Temple City (*4B190214001*)	**Mailing Address**	9701 Las Tunas Drive
		Temple City, CA 91780-2249
	Facility Contact,	Joe Lambert at (626) 285-2171 or

Permittee (WDID)	Contact Information	
	Phone, and E-mail	John Hunter at (562) 802-7880/jhunter@jlha.net
Torrance (*4B190215001*)	**Mailing Address**	3031 Torrance Boulevard
		Torrance, CA 90503-5059
	Facility Contact and Title	Leslie Cortez, Senior Administrative Assistant
Vernon (*4B190216001*)	**Mailing Address**	4305 Santa Fe Avenue
		Vernon, CA 90058-1786
	Facility Contact and Phone	Claudia Arellano (323) 583-8811
Walnut (*4B190217001*)	**Mailing Address**	P.O. Box 682
		Walnut, CA 91788
	Facility Contact and Title	Jack Yoshino, Senior Management Assistant
West Covina (*4B190218001*)	**Mailing Address**	P.O. Box 1440
		West Covina, CA 91793-1440
	Facility Contact, Title, and E-mail	Samuel Gutierrez, Engineering Technician sam.gutierrez@westcovina.org
West Hollywood (*4B190219001*)	**Mailing Address**	8300 Santa Monica Boulevard
		West Hollywood, CA 90069-4314
	Facility Contact, Title, and E-mail	Sharon Perlstein, City Engineer sperlstein@weho.org
Westlake Village (*4B190220001*)	**Mailing Address**	31200 Oak Crest Drive
		Westlake Village, CA 91361
	Facility Contact, Title, Phone, and E-mail	Joe Bellomo, Stormwater Program Manager (805) 279-6856 jbellomo@willdan.com
Whittier (*4B190221001*)	**Mailing Address**	13230 Penn Street
		Whittier, CA 90602-1772
	Facility Contact, Title, and E-mail	David Mochizuki, Director of Public Works dmochizuki@cityofwhittier.org
County of Los Angeles (*4B190107099*)	**Mailing Address**	900 South Fremont Avenue
		Alhambra, CA 91803
	Facility Contact, Title, Phone, and E-mail	Gary Hildebrand, Assistant Deputy Director, Division Engineer (626) 458-4300 ghildeb@dpw.lacounty.gov
Los Angeles County Flood Control District (*4B190107101*)	**Mailing Address**	900 South Fremont Avenue
		Alhambra, CA 91803
	Facility Contact, Title, Phone, and E-mail	Gary Hildebrand, Assistant Deputy Director, Division Engineer (626) 458-4300 ghildeb@dpw.lacounty.gov

Table 3. Discharge Location

Discharge Point	Effluent Description	Discharge Point Latitude	Discharge Point Longitude	Receiving Water
All Municipal Separate Storm Sewer System discharge points within Los Angeles County with the exception of the City of Long Beach	Storm Water and Non-Storm Water	Numerous	Numerous	Surface waters identified in Tables 2-1, 2-1a, 2-3, and 2-4, and Appendix 1, Table 1 of the *Water Quality Control Plan - Los Angeles Region* (*Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties*), and other unidentified tributaries to these surface waters within the following Watershed Management Areas: (1) Santa Clara River Watershed; (2) Santa Monica Bay Watershed Management Area, including Malibu Creek Watershed and Ballona Creek Watershed; (3) Los Angeles River Watershed; (4) Dominguez Channel and Greater Los Angeles/Long Beach Harbors Watershed Management Area; (5) Los Cerritos Channel and Alamitos Bay Watershed Management Area; (6) San Gabriel River Watershed; and (7) Santa Ana River Watershed.[1]

Table 4. Administrative Information

This Order was adopted by the California Regional Water Quality Control Board, Los Angeles Region on:	**November 8, 2012**
This Order becomes effective on:	**December 28, 2012**
This Order expires on:	**December 28, 2017**
In accordance with Title 23, Division 3, Chapter 9 of the California Code of Regulations and Title 40, Part 122 of the Code of Federal Regulations, each Discharger shall file a Report of Waste Discharge as application for issuance of new waste discharge requirements no later than:	**180 days prior to the Order expiration date above**

[1] Note that the Santa Ana River Watershed lies primarily within the boundaries of the Santa Ana Regional Water Quality Control Board. However, a portion of the Chino Basin subwatershed lies within the jurisdictions of Pomona and Claremont in Los Angeles County. The primary receiving waters within the Los Angeles County portion of the Chino Basin subwatershed are San Antonio Creek and Chino Creek.

In accordance with section 2235.4 of Title 23 of the California Code of Regulations, the terms and conditions of an expired permit are automatically continued pending issuance of a new permit if all requirements of the federal NPDES regulations on continuation of expired permits are complied with. Accordingly, if a new order is not adopted by the expiration date above, then the Permittees shall continue to implement the requirements of this Order until a new one is adopted.

I, Samuel Unger, Executive Officer, do hereby certify that this Order with all attachments is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, Los Angeles Region, on November 8, 2012.

Samuel Unger

Samuel Unger, Executive Officer

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II. FINDINGS

The California Regional Water Quality Control Board, Los Angeles Region (hereinafter Regional Water Board) finds:

A. Nature of Discharges and Sources of Pollutants

Storm water and non-storm water discharges consist of surface runoff generated from various land uses, which are conveyed via the municipal separate storm sewer system and ultimately discharged into surface waters throughout the region. Discharges of storm water and non-storm water from the Municipal Separate Storm Sewer Systems (MS4s) within the Coastal Watersheds of Los Angeles County convey pollutants to surface waters throughout the Los Angeles Region. In general, the primary pollutants of concern in these discharges identified by the Los Angeles County Flood Control District Integrated Receiving Water Impacts Report (1994-2005) are indicator bacteria, total aluminum, copper, lead, zinc, diazinon, and cyanide. Aquatic toxicity, particularly during wet weather, is also a concern based on a review of Annual Monitoring Reports from 2005-10. Storm water and non-storm water discharges of debris and trash are also a pervasive water quality problem in the Los Angeles Region though significant strides have been made by a number of Permittees in addressing this problem through the implementation of control measures to achieve wasteload allocations established in trash TMDLs.

Pollutants in storm water and non-storm water have damaging effects on both human health and aquatic ecosystems. Water quality assessments conducted by the Regional Water Board have identified impairment of beneficial uses of water bodies in the Los Angeles Region caused or contributed to by pollutant loading from municipal storm water and non-storm water discharges. As a result of these impairments, there are beach postings and closures, fish consumption advisories, local and global ecosystem and aesthetic impacts from trash and debris, reduced habitat for threatened and endangered species, among others. The Regional Water Board and USEPA have established 33 total maximum daily loads (TMDLs) that identify Los Angeles County MS4 discharges as one of the pollutant sources causing or contributing to these water quality impairments.

B. Permit History

Prior to the issuance of this Order, Regional Water Board Order No. 01-182 served as the NPDES Permit for MS4 storm water and non-storm water discharges within the Coastal Watersheds of the County of Los Angeles. The requirements of Order No. 01-182 applied to the Los Angeles County Flood Control District, the unincorporated areas of Los Angeles County under County jurisdiction, and 84 Cities within the Los Angeles County Flood Control District with the exception of the City of Long Beach. The first county-wide MS4 permit for the County of Los Angeles and the incorporated areas therein was Order No. 90-079, adopted by the Regional Water Board on June 18, 1990.

Under Order No. 01-182, the Los Angeles County Flood Control District was designated the Principal Permittee, and the County of Los Angeles and 84 incorporated Cities were each designated Permittees. The Principal Permittee coordinated and facilitated activities necessary to comply with the requirements of Order No. 01-182, but was not responsible for ensuring compliance of any of the other Permittees. The designation of a Principal Permittee has not been carried over from Order No. 01-182.

Order No. 01-182 was subsequently amended by the Regional Water Board on September 14, 2006 by Order No. R4-2006-0074 to incorporate provisions consistent with the assumptions and requirements of the Santa Monica Bay Beaches Dry Weather Bacteria TMDL (SMB Dry Weather Bacteria TMDL) waste load allocations (WLAs). As a result of a legal challenge to Order No. R4-2006-0074, the Los Angeles County Superior Court issued a peremptory writ of mandate on July 23, 2010 requiring the Regional Water Board to void and set aside the amendments adopted through Order No. R4-2006-0074 in Order No. 01-182. The Court concluded that the permit proceeding at which Order No. R4-2006-0074 was adopted was procedurally deficient. The Court did not address the substantive merits of the amendments themselves, and thus made no determination about the substantive validity of Order No. R4-2006-0074. In compliance with the writ of mandate, the Regional Water Board voided and set aside the amendments adopted through Order No. R4-2006-0074 on April 14, 2011. This Order reincorporates requirements equivalent to the 2006 provisions to implement the SMB Dry Weather Bacteria TMDL.

In addition, Order No. 01-182 was amended on August 9, 2007 by Order No. R4-2007-0042 to incorporate provisions consistent with the assumptions and requirements of the Marina del Rey Harbor Mothers' Beach and Back Basins Bacteria TMDL, and was again amended on December 10, 2009 by Order No. R4-2009-0130 to incorporate provisions consistent with the assumptions and requirements of the Los Angeles River Watershed Trash TMDL.

C. Permit Application

On June 12, 2006, prior to the expiration date of Order No. 01-182, all of the Permittees filed Reports of Waste Discharge (ROWD) applying for renewal of their waste discharge requirements that serve as an NPDES permit to discharge storm water and authorized and conditionally exempt non-storm water through their MS4 to surface waters. Specifically, the Los Angeles County Flood Control District (LACFCD) submitted an ROWD application on behalf of itself, the County of Los Angeles, and 78 other Permittees. Several Permittees under Order No. 01-182 elected to not be included as part of the Los Angeles County Flood Control District's ROWD. On June 12, 2006, the Cities of Downey and Signal Hill each submitted an individual ROWD application requesting a separate MS4 Permit; and the Upper San Gabriel River Watershed Coalition, comprised of the cities of Azusa, Claremont, Glendora, Irwindale, and Whittier also submitted an individual ROWD application requesting a separate MS4 Permit for these cities. In 2010, the LACFCD withdrew from its participation in the 2006 ROWD submitted in conjunction with the County and 78 other co-permittees, and submitted a new ROWD also requesting an individual MS4 permit. The LACFCD also requested that, if an individual MS4 permit was not issued to it, it no longer be designated as the

Principal Permittee and it be relieved of Principal Permittee responsibilities. The Regional Water Board evaluated each of the 2006 ROWDs and notified all of the Permittees that their ROWDs did not satisfy federal storm water regulations contained in the USEPA Interpretive Policy Memorandum on Reapplication Requirements for Municipal Separate Storm Sewer Systems; Final Rule, August 9, 1996 (61 *Fed Reg.* 41697). Because each ROWD did not satisfy federal requirements, the Regional Water Board deemed all four 2006 ROWDs incomplete. The Regional Water Board also evaluated the LACFCD's 2010 ROWD and found that it too did not satisfy federal requirements for MS4s.

Though five separate ROWDs were submitted, the Regional Water Board retains discretion as the permitting authority to determine whether to issue permits for discharges from MS4s on a system-wide or jurisdiction-wide basis (Clean Water Act (CWA) § 402(p)(3)(B)(i); 40 CFR section 122.26, subdivisions (a)(1)(v) and (a)(3)(ii)). Because of the complexity and networking of the MS4 within Los Angeles County, which often results in commingled discharges, the Regional Water Board has previously adopted a system-wide approach to permitting MS4 discharges within Los Angeles County.

In evaluating the five separate ROWDs, the Regional Water Board considered the appropriateness of permitting discharges from MS4s within Los Angeles County on a system-wide or jurisdiction-wide basis or a combination of both. Based on that evaluation, the Regional Water Board again determined that, because of the complexity and networking of the MS4 within Los Angeles County, that one system-wide permit is appropriate. In order to provide individual Permittees with more specific requirements, certain provisions of this Order are organized by watershed management area, which is appropriate given the requirements to implement 33 watershed-based TMDLs. The Regional Water Board also determined that because the LACFCD owns and operates large portions of the MS4 infrastructure, including but not limited to catch basins, storm drains, outfalls and open channels, in each coastal watershed management area within Los Angeles County, the LACFCD should remain a Permittee in the single system-wide permit; however, this Order relieves the LACFCD of its role as "Principal Permittee."

D. Permit Coverage and Facility Description

The Los Angeles County Flood Control District, the County of Los Angeles, and 84 incorporated cities within the Los Angeles County Flood Control District with the exception of the City of Long Beach (see Table 5, List of Permittees), hereinafter referred to separately as Permittees and jointly as the Dischargers, discharge storm water and non-storm water from municipal separate storm sewer systems (MS4s), also called storm drain systems. For the purposes of this Order, references to the "Discharger" or "Permittee" in applicable federal and state laws, regulations, plans, or policy are held to be equivalent to references to the Discharger, or Permittees herein.

The area covered under this Order encompasses more than 3,000 square miles. This area contains a vast drainage network that serves incorporated and unincorporated areas in every Watershed Management Area within the Los Angeles Region. Maps depicting the major drainage infrastructure within the area covered under this Order are included in Attachment C of this Order.

Table 5. List of Permittees

Agoura Hills	Hawaiian Gardens	Pomona
Alhambra	Hawthorne	Rancho Palos Verdes
Arcadia	Hermosa Beach	Redondo Beach
Artesia	Hidden Hills	Rolling Hills
Azusa	Huntington Park	Rolling Hills Estates
Baldwin Park	Industry	Rosemead
Bell	Inglewood	San Dimas
Bell Gardens	Irwindale	San Fernando
Bellflower	La Canada Flintridge	San Gabriel
Beverly Hills	La Habra Heights	San Marino
Bradbury	La Mirada	Santa Clarita
Burbank	La Puente	Santa Fe Springs
Calabasas	La Verne	Santa Monica
Carson	Lakewood	Sierra Madre
Cerritos	Lawndale	Signal Hill
Claremont	Lomita	South El Monte
Commerce	Los Angeles	South Gate
Compton	Lynwood	South Pasadena
Covina	Malibu	Temple City
Cudahy	Manhattan Beach	Torrance
Culver City	Maywood	Vernon
Diamond Bar	Monrovia	Walnut
Downey	Montebello	West Covina
Duarte	Monterey Park	West Hollywood
El Monte	Norwalk	Westlake Village
El Segundo	Palos Verdes Estates	Whittier
Gardena	Paramount	County of Los Angeles
Glendale	Pasadena	Los Angeles County Flood Control District
Glendora	Pico Rivera	

E. Los Angeles County Flood Control District

In 1915, the California Legislature enacted the Los Angeles County Flood Control Act, establishing the Los Angeles County Flood Control District (LACFCD). The objects and purposes of the Act are to provide for the control and conservation of the flood, storm and other waste waters within the flood control district. Among its other powers, the LACFCD also has the power to preserve, enhance, and add recreational features to lands or interests in lands contiguous to its properties for the protection, preservation, and use of the scenic beauty and natural environment for the properties or the lands. The LACFCD is governed, as a separate entity, by the County of Los Angeles Board of Supervisors.

The LACFCD's system includes the majority of drainage infrastructure within incorporated and unincorporated areas in every watershed, including approximately 500 miles of open channel, 3,500 miles of underground drains, and an estimated 88,000 catch basins, and several dams. Portions of the LACFCD's current system were originally unmodified natural rivers and water courses.

The LACFCD's system conveys both storm and non-storm water throughout the Los Angeles basin. Other Permittees' MS4s connect and discharge to the LACFCD's system.

The waters and pollutants discharged from the LACFCD's system come from various sources. These sources can include storm water and non-storm water from the Permittees under this permit and other NPDES and non-NPDES Permittees discharging into the LACFCD's system, including industrial waste water dischargers, waste water treatment facilities, industrial and construction stormwater Permittees, water suppliers, government entities, CERCLA potentially responsible parties, and Caltrans. Sources can also include discharges from school districts that do not operate large or medium-sized municipal storm sewers and discharges from entities that have waste discharge requirements or waivers of waste discharge requirements.

Unlike other Permittees, including the County of Los Angeles, the LACFCD does not own or operate any municipal sanitary sewer systems, public streets, roads, or highways.

The LACFCD in contrast to the County of Los Angeles has no planning, zoning, development permitting or other land use authority over industrial or commercial facilities, new developments or re-development projects, or development construction sites located in any incorporated or unincorporated areas within its service area. The Permittees that have such land use authority are responsible for implementing a storm water management program to inspect and control pollutants from industrial and commercial facilities, new development and re-development projects, and development construction sites within their jurisdictional boundaries. Nonetheless, as an owner and operator of MS4s, the LACFCD is required by federal regulations to control pollutant discharges into and from its MS4, including the ability to control through interagency agreements among co-Permittees and other owners of a MS4 the contribution of pollutants from one portion of the MS4 to another portion of the MS4.

F. Permit Scope

This Order regulates municipal discharges of storm water and non-storm water from the Permittees' MS4s. Section 122.26(b)(8) of title 40 of the Code of Federal Regulations (CFR) defines an MS4 as "a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): (i) [o]wned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of sewage, industrial wastes, storm water, or other wastes, including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the CWA that discharges to waters of the United States; (ii) [d]esigned or used for collecting or conveying storm water; (iii) [w]hich is not a combined sewer; and (iv) [w]hich is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2."

Storm water discharges consist of those discharges that originate from precipitation events. Federal regulations define "storm water" as "storm water runoff, snow melt runoff, and surface runoff and drainage." (40 CFR § 122.26(b)(13).) While "surface runoff and drainage" is not defined in federal law, USEPA's preamble to its final storm water regulations demonstrates that the term is related to precipitation events such as rain and/or snowmelt. (55 *Fed. Reg.* 47990, 47995-96 (Nov. 16, 1990)).

Non-storm water discharges consist of all discharges through an MS4 that do not originate from precipitation events. Non-storm water discharges through an MS4 are prohibited unless authorized under a separate NPDES permit; authorized by USEPA pursuant to Sections 104(a) or 104(b) of the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA); composed of natural flows; the result of emergency fire fighting activities; or conditionally exempted in this Order.

A permit issued to more than one Permittee for MS4 discharges may contain separate storm water management programs for particular Permittees or groups of Permittees. 40 CFR § 122.26(d)(2)(iv). Given the LACFCD's limited land use authority, it is appropriate for the LACFCD to have a separate and uniquely-tailored storm water management program. Accordingly, the storm water management program minimum control measures imposed on the LACFCD in Part VI.D of this Order differ in some ways from the minimum control measures imposed on other Permittees. Namely, aside from its own properties and facilities, the LACFCD is not subject to the Industrial/Commercial Facilities Program, the Planning and Land Development Program, and the Development Construction Program. However, as a discharger of storm and non-storm water, the LACFCD remains subject to the Public Information and Participation Program and the Illicit Connections and Illicit Discharges Elimination Program. Further, as the owner and operator of certain properties, facilities and infrastructure, the LACFCD remains subject to requirements of a Public Agency Activities Program.

G. Geographic Coverage and Watershed Management Areas

The municipal storm water and non-storm water discharges flow into receiving waters in the Watershed Management Areas of the Santa Clara River Watershed; Santa Monica Bay Watershed Management Area, including Malibu Creek Watershed and Ballona Creek Watershed; Los Angeles River Watershed; Dominguez Channel and Greater Los Angeles/Long Beach Harbors Watershed Management Area; Los Cerritos Channel and Alamitos Bay Watershed Management Area; San Gabriel River Watershed; and Santa Ana River Watershed.

This Order redefines Watershed Management Areas (WMAs) consistent with the delineations used in the Regional Water Board's Watershed Management Initiative. Permittees included in each of the WMAs are listed in Attachment K.

Maps depicting each WMA, its subwatersheds, and the major receiving waters therein are included in Attachment B.

Federal, state, regional or local entities in jurisdictions outside the Los Angeles County Flood Control District, and not currently named as Permittee to this Order, may operate MS4 facilities and/or discharge to the MS4 and water bodies covered by this Order. Pursuant to 40 CFR sections 122.26(d)(1)(ii) and 122.26(d)(2)(iv), each Permittee shall maintain the necessary legal authority to control the contribution of pollutants to its MS4 and shall include in its storm water management program a comprehensive planning process that includes intergovernmental coordination, where necessary.

Sources of MS4 discharges into receiving waters in the County of Los Angeles but not covered by this Order include the following:

- About 34 square miles of unincorporated area in Ventura County, which drain into Malibu Creek and then to Santa Monica Bay,
- About 9 square miles of the City of Thousand Oaks, which also drain into Malibu Creek and then to Santa Monica Bay, and
- About 86 square miles of area in Orange County, which drain into Coyote Creek and then into the San Gabriel River.

Specifically, the Orange County Flood Control District (OCFCD) owns and operates the Los Alamitos Retarding Basin and Pumping Station (Los Alamitos Retarding Basin). The Los Alamitos Retarding Basin is within the San Gabriel River Watershed, and is located adjacent to the Los Angeles and Orange County boundary. The majority of the 30-acre Los Alamitos Retarding Basin is in Orange County; however, the northwest corner of the facility is located in the County of Los Angeles. Storm water and non-storm water discharges, which drain to the Los Alamitos Retarding Basin, are pumped to the San Gabriel River Estuary (SGR Estuary) through pumps and subterranean piping. The pumps and discharge point are located in the County of Los Angeles.

The OCFCD pumps the water within the Los Alamitos Retarding Basin to the San Gabriel River Estuary through four discharge pipes, which are covered by tide gates. The discharge point is located approximately 700 feet downstream from the 2nd Street Bridge in Long Beach. The total pumping capacity of the four pumps is 800 cubic feet per second (cfs). There is also a 5 cfs sump pump that discharges nuisance flow continuously to the Estuary though a smaller diameter uncovered pipe.

The discharge from the Los Alamitos Retarding Basin is covered under the Orange County Municipal NPDES Storm Water Permit (NPDES Permit No. CAS618030, Santa Ana Regional Water Quality Control Board Order No. R8-2010-0062), which was issued to the County of Orange, Orange County Flood Control District and Incorporated Cities on May 22, 2009. The Orange County MS4 Permit references the San Gabriel River Metals and Selenium TMDL (Metals TMDL). The waste load allocations listed in the

Metals TMDL for Coyote Creek are included in the Orange County MS4 Permit. However, the Orange County MS4 Permit does not contain the dry weather copper waste load allocations assigned to the Estuary.

H. Legal Authorities

This Order is issued pursuant to CWA section 402 and implementing regulations adopted by the USEPA and chapter 5.5, division 7 of the California Water Code (commencing with section 13370). This Order serves as an NPDES permit for point source discharges from the Permittees' MS4s to surface waters. This Order also serves as waste discharge requirements (WDRs) pursuant to article 4, chapter 4, division 7 of the California Water Code (commencing with Section 13260).

I. Municipal Separate Storm Sewer System Requirements. The 1972 Clean Water Act[2] established the NPDES Program to regulate the discharge of pollutants from point sources to waters of the United States. However, pollution from storm water and dry-weather urban runoff was largely unabated for over a decade. In response to the 1987 Amendments to the Clean Water Act, USEPA developed Phase I of the NPDES Storm Water Permitting Program in 1990, which established a framework for regulating municipal and industrial discharges of storm water and non-storm water. The Phase I program addressed sources of storm water and dry-weather urban runoff that had the greatest potential to negatively impact water quality. In particular, under Phase I, USEPA required NPDES Permit coverage for discharges from medium and large MS4 with populations of 100,000 or more. Operators of MS4s regulated under the Phase I NPDES Storm Water Program were required to obtain permit coverage for municipal discharges of storm water and non-storm water to waters of the United States

Early in the history of this MS4 Permit, the Regional Water Board designated the MS4s owned and/or operated by the incorporated cities and Los Angeles County unincorporated areas within the Coastal Watersheds of Los Angeles County as a large MS4 due to the total population of Los Angeles County, including that of unincorporated and incorporated areas, and the interrelationship between the Permittees' MS4s, pursuant to 40 CFR section 122.26(b)(4). The total population of the cities and County unincorporated areas covered by this Order was 9,519,338 in 2000 and has increased by approximately 300,000 to 9,818,605 in 2010, according to the United States Census.

This Order implements the federal Phase I NPDES Storm Water Program requirements. These requirements include three fundamental elements: (i) a requirement to effectively prohibit non-storm water discharges through the MS4, (ii) requirements to implement controls to reduce the discharge of pollutants to the maximum extent practicable, and (iii) other provisions the Regional Water Board has determined appropriate for the control of such pollutants.

J. Background and Rationale for Requirements. The Regional Water Board developed the requirements in this Order based on information submitted as part of the Permittees' applications, through monitoring and reporting programs, and other available

[2] Federal Water Pollution Control Act; 33 U.S.C. § 1251 et seq., which, as amended in 1977, is commonly known as the Clean Water Act.

information. In accordance with federal regulations at 40 CFR section 124.8, a Fact Sheet (Attachment F) has been prepared to explain the principal facts and the significant factual, legal, methodological, and policy questions considered in preparing this Order. The Fact Sheet is hereby incorporated into this Order and also constitutes part of the Findings of the Regional Water Board for this Order. Attachments A through E and G through R are also incorporated into this Order.

K. **Water Quality Control Plans.** The Clean Water Act requires the Regional Water Board to establish water quality standards for each water body in its region. Water quality standards include beneficial uses, water quality objectives and criteria that are established at levels sufficient to protect those beneficial uses, and an antidegradation policy to prevent degrading waters. The Regional Water Board adopted a *Water Quality Control Plan - Los Angeles Region* (hereinafter Basin Plan) on June 13, 1994 and has amended it on multiple occasions since 1994. The Basin Plan designates beneficial uses, establishes water quality objectives, and contains implementation programs and policies to achieve those objectives for all waters in the Los Angeles Region. Pursuant to California Water Code section 13263(a), the requirements of this Order implement the Basin Plan. Beneficial uses applicable to the surface water bodies that receive discharges from the Los Angeles County MS4 generally include those listed below.

Table 6. Basin Plan Beneficial Uses

Discharge Point	Receiving Water Name	Beneficial Uses
All Municipal Separate Storm Sewer Systems (MS4s) discharge points within Los Angeles County coastal watersheds with the exception of the City of Long Beach	Multiple surface water bodies of the Los Angeles Region	Municipal and Domestic Supply (MUN); Agricultural Supply (AGR); Industrial Service Supply (IND); Industrial Process Supply (PROC); Ground Water Recharge (GWR); Freshwater Replenishment (FRSH); Navigation (NAV); Hydropower Generation (POW); Water Contact Recreation (REC-1); Limited Contact Recreation (LREC-1); Non-Contact Water Recreation (REC-2); Commercial and Sport Fishing (COMM); Warm Freshwater Habitat (WARM); Cold Freshwater Habitat (COLD); Preservation of Areas of Special Biological Significance (BIOL); Wildlife Habitat (WILD); Preservation of Rare and Endangered Species (RARE); Marine Habitat (MAR); Wetland Habitat (WET); Migration of Aquatic Organisms (MIGR); Spawning, Reproduction, and/or Early Development (SPWN); Shellfish Harvesting (SHELL)

1. **Total Maximum Daily Loads (TMDLs)**

Clean Water Act section 303(d)(1) requires each state to identify the waters within its boundaries that do not meet water quality standards. Water bodies that do not meet water quality standards are considered impaired and are placed on the state's "CWA Section 303(d) List". For each listed water body, the state is required to establish a TMDL of each pollutant impairing the water quality standards in that water body. A TMDL is a tool for implementing water quality standards and is based on the relationship between pollution sources and in-stream water quality conditions. The

TMDL establishes the allowable pollutant loadings for a water body and thereby provides the basis to establish water quality-based controls. These controls should provide the pollution reduction necessary for a water body to meet water quality standards. A TMDL is the sum of the allowable pollutant loads of a single pollutant from all contributing point sources (the waste load allocations or WLAs) and non-point sources (load allocations or LAs), plus the contribution from background sources and a margin of safety. (40 CFR section 130.2(i).) MS4 discharges are considered point source discharges.

Numerous receiving waters within Los Angeles County do not meet water quality standards or fully support beneficial uses and therefore have been classified as impaired on the State's 303(d) List. The Regional Water Board and USEPA have each established TMDLs to address many of these water quality impairments. Pursuant to CWA section 402(p)(B)(3)(iii) and 40 CFR section 122.44(d)(1)(vii)(B), this Order includes requirements that are consistent with and implement WLAs that are assigned to discharges from the Los Angeles County MS4 from 33 State-adopted and USEPA established TMDLs. This Order requires Permittees to comply with the TMDL Provisions in Part VI.E and Attachments L through R, which are consistent with the assumptions and requirements of the TMDL WLAs assigned to discharges from the Los Angeles County MS4. A comprehensive list of TMDLs by watershed management area and the Permittees subject to each TMDL is included in Attachment K.

Waste load allocations in these TMDLs are expressed in several ways depending on the nature of the pollutant and its impacts on receiving waters and beneficial uses. Bacteria WLAs assigned to MS4 discharges are expressed as the number of allowable exceedance days that a water body may exceed the Basin Plan water quality objectives for protection of the REC-1 beneficial use. Since the TMDLs and the WLAs contained therein are expressed as receiving water conditions, receiving water limitations have been included in this Order that are consistent with and implement the allowable exceedance day WLAs. Water quality-based effluent limitations are also included equivalent to the Basin Plan water quality objectives to allow the opportunity for Permittees to individually demonstrate compliance at an outfall or jurisdictional boundary, thus isolating the Permittee's pollutant contributions from those of other Permittees and from other pollutant sources to the receiving water.

WLAs for trash are expressed as progressively decreasing allowable amounts of trash discharges from a Permittee's jurisdictional area within the drainage area to the impaired water body. The Trash TMDLs require each Permittee to make annual reductions of its discharges of trash over a set period, until the numeric target of zero trash discharged from the MS4 is achieved. The Trash TMDLs specify a specific formula for calculating and allocating annual reductions in trash discharges from each jurisdictional area within a watershed. The formula results in specified annual amounts of trash that may be discharged from each jurisdiction into the receiving waters. Translation of the WLAs or compliance points described in the TMDLs into jurisdiction-specific load reductions from the baseline levels, as specified in the TMDL, logically results in the articulation of an annual limitation on the amount of a pollutant that may be discharged. The specification of allowable annual trash discharge amounts meets the definition of an “effluent limitation”, as that term is defined in subdivision (c) of section 13385.1 of the California Water Code. Specifically, the trash discharge limitations constitute a “numeric restriction … on the quantity [or] discharge rate … of a pollutant or pollutants that may be discharged from an authorized location.”

TMDL WLAs for other pollutants (e.g., metals and toxics) are expressed as concentration and/or mass and water quality-based effluent limitations have been specified consistent with the expression of the WLA, including any applicable averaging periods. Some TMDLs specify that, if certain receiving water conditions are achieved, such achievement constitutes attainment of the WLA. In these cases, receiving water limitations and/or provisions outlining these alternate means of demonstrating compliance are included in the TMDL provisions in Part VI.E of this Order.

The inclusion of water quality-based effluent limitations and receiving water limitations to implement applicable WLAs provides a clear means of identifying required water quality outcomes within the permit and ensures accountability by Permittees to implement actions necessary to achieve the limitations.

A number of the TMDLs for bacteria, metals, and toxics establish WLAs that are assigned jointly to a group of Permittees whose storm water and/or non-storm water discharges are or may be commingled in the MS4 prior to discharge to the receiving water subject to the TMDL. TMDLs address commingled MS4 discharges by assigning a WLA to a group of MS4 Permittees based on co-location within the same subwatershed. Permittees with co-mingled MS4 discharges are jointly responsible for meeting the water quality-based effluent limitations and receiving water limitations assigned to MS4 discharges in this Order. "Joint responsibility" means that the Permittees that have commingled MS4 discharges are responsible for implementing programs in their respective jurisdictions, or within the MS4 for which they are an owner and/or operator, to meet the water quality-based effluent limitations and/or receiving water limitations assigned to such commingled MS4 discharges.

In these cases, federal regulations state that co-permittees need only comply with permit conditions relating to discharges from the MS4 for which they are owners or operators (40 CFR § 122.26(a)(3)(vi)). Individual co-permittees are only responsible for their contributions to the commingled MS4 discharge. This Order does not require a Permittee to individually ensure that a commingled MS4 discharge meets the applicable water quality-based effluent limitations included in this Order, unless such Permittee is shown to be solely responsible for an exceedance.

Additionally, this Order allows a Permittee to clarify and distinguish their individual contributions and demonstrate that its MS4 discharge did not cause or contribute to exceedances of applicable water quality-based effluent limitations and/or receiving water limitations. If such a demonstration is made, though the Permittee's discharge may commingle with that of other Permittees, the Permittee would not be held jointly responsible for the exceedance of the water quality-based effluent limitation or receiving water limitation. Individual co-permittees who demonstrate compliance with the water quality-based effluent limitations will not be held responsible for violations by non-compliant co-permittees.

Given the interconnected nature of the Permittees' MS4s, however, the Regional Water Board expects Permittees to work cooperatively to control the contribution of pollutants from one portion of the MS4 to another portion of the system through inter-agency agreements or other formal arrangements.

L. Ocean Plan. In 1972, the State Water Resources Control Board (State Water Board) adopted the Water Quality Control Plan for Ocean Waters of California, California Ocean Plan (hereinafter Ocean Plan). The State Water Board adopted the most recent amended Ocean Plan on September 15, 2009. The Office of Administration Law approved it on March 10, 2010. On October 8, 2010, USEPA approved the 2009 Ocean Plan. The Ocean Plan is applicable, in its entirety, to the ocean waters of the State. In order to protect beneficial uses, the Ocean Plan establishes water quality objectives and a program of implementation. Pursuant to California Water Code section 13263(a), the requirements of this Order implement the Ocean Plan. The Ocean Plan identifies beneficial uses of ocean waters of the State to be protected as summarized in the table below.

Table 7. Ocean Plan Beneficial Uses

Discharge Point	Receiving Water Name	Beneficial Uses
All Municipal Separate Storm Sewer Systems (MS4s) discharge points within Los Angeles County coastal watersheds with the exception of the City of Long Beach	Pacific Ocean	Industrial Water Supply (IND); Water Contact (REC-1) and Non-Contact Recreation (REC-2), including aesthetic enjoyment; Navigation (NAV); Commercial and Sport Fishing (COMM); Mariculture; Preservation and Enhancement of Designated Areas of Special Biological Significance (ASBS); Rare and Endangered Species (RARE); Marine Habitat (MAR); Fish Migration (MIGR); Fish Spawning (SPWN) and Shellfish Harvesting (SHELL)

M. Antidegradation Policy

40 CFR section 131.12 requires that state water quality standards include an antidegradation policy consistent with the federal antidegradation policy. The State Water Board established California's antidegradation policy in State Water Board Resolution No. 68-16 ("Statement of Policy with Respect to Maintaining the Quality of the Waters of the State"). Resolution No. 68-16 incorporates the federal antidegradation policy where the federal policy applies under federal law. Resolution No. 68-16 requires that existing water quality be maintained unless degradation is

justified based on specific findings. The Regional Water Board's Basin Plan implements, and incorporates by reference, both the state and federal antidegradation policies. The permitted discharge is consistent with the antidegradation provision of section 131.12 and State Water Board Resolution No. 68-16.

N. Anti-Backsliding Requirements. Section 402(o)(2) of the CWA and federal regulations at 40 CFR section 122.44(l) prohibit backsliding in NPDES permits. These anti-backsliding provisions require effluent limitations in a reissued permit to be as stringent as those in the previous permit, with some exceptions where limitations may be relaxed. All effluent limitations in this Order are at least as stringent as the effluent limitations in the previous permit.

O. Endangered Species Act. This Order does not authorize any act that results in the taking of a threatened or endangered species or any act that is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish and Game Code, §§ 2050 to 2115.5) or the Federal Endangered Species Act (16 U.S.C.A., §§ 1531 to 1544). This Order requires compliance with requirements to protect the beneficial uses of waters of the United States. Permittees are responsible for meeting all requirements of the applicable Endangered Species Act.

P. Monitoring and Reporting. Section 308(a) of the federal Clean Water Act, and 40 CFR sections 122.41(h), (j)-(l), 122.41(i), and 122.48, require that all NPDES permits specify monitoring and reporting requirements. Federal regulations applicable to large and medium MS4s also specify additional monitoring and reporting requirements. (40 C.F.R. §§ 122.26(d)(2)(i)(F) & (d)(2)(iii)(D), 122.42(c).) California Water Code section 13383 authorizes the Regional Water Board to establish monitoring, inspection, entry, reporting, and recordkeeping requirements. The Monitoring and Reporting Program establishes monitoring, reporting, and recordkeeping requirements that implement the federal and State laws and/or regulations. This Monitoring and Reporting Program is provided in Attachment E.

Q. Standard and Special Provisions. Standard Provisions, which apply to all NPDES permits in accordance with 40 CFR section 122.41, and additional conditions applicable to specified categories of permits in accordance with 40 CFR section 122.42, are provided in Attachment D. Dischargers must comply with all standard provisions and with those additional conditions that are applicable under 40 CFR section 122.42 provided in Attachment D. The Regional Water Board has also included in Part VI of this Order various special provisions applicable to the Dischargers. A rationale for the various special provisions contained in this Order is provided in the attached Fact Sheet (Attachment F).

R. State Mandates

Article XIII B, Section 6(a) of the California Constitution provides that whenever "any state agency mandates a new program or higher level of service on any local government, the state shall provide a subvention of funds to reimburse that local government for the costs of the program or increased level of service." The requirements of this Order do not constitute state mandates that are subject to a subvention of funds for several reasons as described in detail in the attached Fact Sheet (Attachment F).

S. California Water Code Section 13241. The California Supreme Court has ruled that although California Water Code section 13263 requires the State and Regional Water Boards (collectively, Water Boards) to consider the factors set forth in California Water Code section 13241 when issuing an NPDES permit, the Water Boards may not consider the factors to justify imposing pollutant restriction that are less stringent than the applicable federal regulations require. (*City of Burbank v. State Water Resources Control Bd.* (2005) 35 Cal.4th 613, 618, 626-627). However, when the pollutant restrictions in an NPDES permit are more stringent than federal law requires, California Water Code section 13263 requires that the Water Boards consider the factors described in section 13241 as they apply to those specific restrictions. As noted in the preceding finding, the Regional Water Board finds that the requirements in this permit are not more stringent than the minimum federal requirements. Therefore, a 13241 analysis is not required for permit requirements that implement the effective prohibition on the discharge of non-storm water discharges into the MS4, or for controls to reduce the discharge of pollutants in storm water to the maximum extent practicable, or other provisions that the Regional Water Board has determined appropriate to control such pollutants, as those requirements are mandated by federal law. Notwithstanding the above, the Regional Water Board has developed an economic analysis of the permit's requirements, consistent with California Water Code section 13241. That analysis is provided in the Fact Sheet (Attachment F of this Order).

T. California Environmental Quality Act (CEQA). This action to adopt an NPDES Permit is exempt from the provisions of Chapter 3 of the California Environmental Quality Act (CEQA) (Public Resources Code, § 21100, et seq.) pursuant to California Water Code section 13389. (*County of Los Angeles v. Cal. Water Boards* (2006) 143 Cal.App.4th 985.)

U. Notification of Interested Parties. In accordance with State and federal laws and regulations, the Regional Water Board has notified the Permittees and interested agencies and persons of its intent to prescribe waste discharge requirements for the discharges authorized by this Order and has provided them with an opportunity to provide written and oral comments. Details of notification, as well as the meetings and workshops held on drafts of the permit, are provided in the Fact Sheet of this Order.

V. Consideration of Public Comment. The Regional Water Board, in a public meeting, heard and considered all oral and written comments pertaining to the discharges authorized by this Order and the requirements contained herein. The Regional Water Board has prepared written responses to all timely comments, which are incorporated by reference as part of this Order.

W. This Order serves as an NPDES permit pursuant to CWA section 402 or amendments thereto, and becomes effective fifty (50) days after the date of its adoption, provided that the Regional Administrator, USEPA, Region IX, expresses no objections.

X. This Order supersedes Order No. 01-182 as amended, except for enforcement purposes.

Y. Review by the State Water Board. Any person aggrieved by this action of the Regional Water Board may petition the State Water Board to review the action in accordance with California Water Code section 13320 and California Code of Regulations, title 23, sections 2050 and following. The State Water Board must *receive* the petition by 5:00 p.m., 30 days after the Regional Water Board action, except that if the thirtieth day following the action falls on a Saturday, Sunday, or state holiday, the petition must be received by the State Water Board by 5:00 p.m. on the next business day. Copies of the law and regulations applicable to filing petitions may be found on the Internet at: http://www.waterboards.ca.gov/public_notices/petitions/water_quality or will be provided upon request.

THEREFORE, IT IS HEREBY ORDERED, that the Dischargers, in order to meet the provisions contained in Division 7 of the California Water Code (commencing with section 13000), and regulations, plans, and policies adopted thereunder, and the provisions of the Clean Water Act and regulations and guidelines adopted thereunder, shall comply with the following requirements:

III. DISCHARGE PROHIBITIONS

A. Prohibitions – Non-Storm Water Discharges

1. **Prohibition of Non-Storm Water Discharges.** Each Permittee shall, for the portion of the MS4 for which it is an owner or operator, prohibit non-storm water discharges through the MS4 to receiving waters except where such discharges are either:

   a. Authorized non-storm water discharges separately regulated by an individual or general NPDES permit;

   b. Temporary non-storm water discharges authorized by USEPA[3] pursuant to sections 104(a) or 104(b) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) that either: (i) will comply with water quality standards as applicable or relevant and appropriate requirements (“ARARs”) under section 121(d)(2) of CERCLA; or (ii) are subject to either (a) a written waiver of ARARs by USEPA pursuant to section 121(d)(4) of CERCLA or (b) a written determination by USEPA that compliance with ARARs is not practicable considering the exigencies of the situation pursuant to 40 CFR. section 300.415(j);

   c. Authorized non-storm water discharges from emergency fire fighting activities (i.e., flows necessary for the protection of life or property)[4];

   d. Natural flows, including:

      i. Natural springs;

[3] These typically include short-term, high volume discharges resulting from the development or redevelopment of groundwater extraction wells, or USEPA or State-required compliance testing of potable water treatment plants, as part of a USEPA authorized groundwater remediation action under CERCLA.

[4] Discharges from vehicle washing, building fire suppression system maintenance and testing (e.g., sprinkler line flushing), fire hydrant maintenance and testing, and other routine maintenance activities are not considered emergency fire fighting activities.

ii. Flows from riparian habitats and wetlands;

iii. Diverted stream flows, authorized by the State or Regional Water Board;

iv. Uncontaminated ground water infiltration[5];

v. Rising ground waters, where ground water seepage is not otherwise covered by a NPDES permit[6]; or

e. Conditionally exempt non-storm water discharges in accordance with Parts III.A.2 and III.A.3 below.

2. Conditional Exemptions from Non-Storm Water Discharge Prohibition. The following categories of non-storm water discharges are conditionally exempt from the non-storm water discharge prohibition, provided they meet all required conditions specified below, or as otherwise approved by the Regional Water Board Executive Officer, in all areas regulated by this Order with the exception of direct discharges to Areas of Special Biological Significance (ASBS) within Los Angeles County. Conditional exemptions from the prohibition on non-storm water discharges through the MS4 to an ASBS are identified in Part III.A.3 below.

a. Conditionally Exempt Essential Non-Storm Water Discharges: These consist of those discharges that fall within one of the categories below; meet all required best management practices (BMPs) as specified in i. and ii. below, including those enumerated in the referenced BMP manuals; are essential public services discharge activities; and are directly or indirectly required by other state or federal statute and/or regulation:

i. Discharges from essential *non-emergency* fire fighting activities[7] provided appropriate BMPs are implemented based on the CAL FIRE, Office of the State Fire Marshal's *Water-Based Fire Protection Systems Discharge Best Management Practices Manual* (September 2011) for water-based fire protection system discharges, and based on Riverside County's *Best Management Practices Plan for Urban Runoff Management* (May 1, 2004) or equivalent BMP manual for fire training activities and post-emergency fire fighting activities;

ii. Discharges from drinking water supplier distribution systems, where not otherwise regulated by an individual or general NPDES permit[8], provided

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[5] Uncontaminated ground water infiltration is water other than waste water that enters the MS4 (including foundation drains) from the ground through such means as defective pipes, pipe joints, connections, or manholes. Infiltration does not include, and is distinguished from, inflow. (See 40 CFR § 35.2005(20).)

[6] A NPDES permit for discharges associated with ground water dewatering is required within the Los Angeles Region.

[7] This includes fire fighting training activities, which simulate emergency responses, and routine maintenance and testing activities necessary for the protection of life and property, including building fire suppression system maintenance and testing (e.g. sprinkler line flushing) and fire hydrant testing and maintenance. Discharges from vehicle washing are not considered essential and as such are not conditionally exempt from the non-storm water discharge prohibition.

[8] Drinking water supplier distribution system releases means sources of flows from drinking water storage, supply and distribution systems (including flows from system failures), pressure releases, system maintenance, distribution line testing, and flushing and dewatering of pipes, reservoirs, and vaults, and minor non-invasive well maintenance activities not involving chemical addition(s) where not otherwise regulated by NPDES Permit No. CAG674001, NPDES Permit No. CAG994005, or another separate NPDES permit.

appropriate BMPs are implemented based on the American Water Works Association (California-Nevada Section) *Guidelines for the Development of Your Best Management Practices (BMP) Manual for Drinking Water System Releases* (2005) or equivalent industry standard BMP manual. Additionally, each Permittee shall work with drinking water suppliers that may discharge to the Permittee's MS4 to ensure for all discharges greater than 100,000 gallons: (1) notification at least 72 hours prior to a planned discharge and as soon as possible after an unplanned discharge; (2) monitoring of any pollutants of concern[9] in the drinking water supplier distribution system release; and (3) record keeping by the drinking water supplier. Permittees shall require that the following information is maintained by the drinking water supplier(s) for all discharges to the MS4 (planned and unplanned) greater than 100,000 gallons: name of discharger, date and time of notification (for planned discharges), method of notification, location of discharge, discharge pathway, receiving water, date of discharge, time of the beginning and end of the discharge, duration of the discharge, flow rate or velocity, total number of gallons discharged, type of dechlorination equipment used, type of dechlorination chemicals used, concentration of residual chlorine, type(s) of sediment controls used, pH of discharge, type(s) of volumetric and velocity controls used, and field and laboratory monitoring data. Records shall be retained for five years and made available upon request by the Permittee or Regional Water Board.

b. Those discharges that fall within one of the categories below, provided that the discharge itself is not a source of pollutants and meets all required conditions specified in Table 8 or as otherwise specified or approved by the Regional Water Board Executive Officer:

i. Dewatering of lakes[10];

ii. Landscape irrigation;

iii. Dechlorinated/debrominated swimming pool/spa discharges[11], where not otherwise regulated by a separate NPDES permit;

iv. Dewatering of decorative fountains[12];

v. Non-commercial car washing by residents or by non-profit organizations;

[9] Pollutants of concern from drinking water supplier distribution system releases may include trash and debris, including organic matter, total suspended solids (TSS), residual chlorine, pH, and any pollutant for which there is a water quality-based effluent limitation (WQBEL) in Part VI.E applicable to discharges from the MS4 to the receiving water. Determination of the pollutants of concern for a particular discharge shall be based on an evaluation of the potential for the constituent(s) to be present in the discharge at levels that may cause or contribute to exceedances of applicable WQBELs or receiving water limitations.

[10] Dewatering of lakes does not include dewatering of drinking water reservoirs. Dewatering of drinking water reservoirs is addressed in Part III.A.2.a.ii.

[11] Conditionally exempt dechlorinated/debrominated swimming pool/spa discharges do not include swimming pool/spa filter backwash or swimming pool/spa water containing bacteria, detergents, wastes, or algaecides, or any other chemicals including salts from pools commonly referred to as "salt water pools" in excess of applicable water quality objectives.

[12] Conditionally exempt discharges from dewatering of decorative fountains do not include fountain water containing bacteria, detergents, wastes, or algaecides, or any other chemicals in excess of applicable water quality objectives.

vi. Street/sidewalk wash water[13].

3. **Conditional Exemptions from Non-Storm Water Discharge Prohibition within an ASBS**. The following non-storm water discharges from the MS4 directly to an ASBS are conditionally exempt pursuant to the California Ocean Plan as specified below, provided that:

   a. The discharges are essential for emergency response purposes, structural stability, slope stability or occur naturally, including the following discharges:

      i. Discharges associated with emergency fire fighting activities (i.e., flows necessary for the protection of life or property)[14];

      ii. Foundation and footing drains;

      iii. Water from crawl space or basement pumps;

      iv. Hillside dewatering;

      v. Naturally occurring ground water seepage via a MS4; and

      vi. Non-anthropogenic flows from a naturally occurring stream via a culvert or MS4, as long as there are no contributions of anthropogenic runoff.

   b. The discharges fall within one of the conditionally exempt essential non-storm water discharge categories in Part III.A.2.a. above.

   c. Conditionally exempt non-storm water discharges shall not cause or contribute[15] to an exceedance of applicable receiving water limitations and/or water quality-based effluent limitations in this Order or the water quality objectives in Chapter II of the Ocean Plan, or alter natural ocean water quality in an ASBS.

4. **Permittee Requirements.** Each Permittee shall:

   a. Develop and implement procedures to ensure that a discharger, if not a named Permittee in this Order, fulfills the following for non-storm water discharges to the Permittee's MS4:

      i. Notifies the Permittee of the planned discharge in advance, consistent with requirements in Table 8 or recommendations pursuant to the applicable BMP manual;

      ii. Obtains any local permits required by the MS4 owner(s) and/or operator(s);

[13] Conditionally exempt non-storm water discharges of street/sidewalk wash water only include those discharges resulting from use of high pressure, low volume spray washing using only potable water with no cleaning agents at an average usage of 0.006 gallons per square feet of sidewalk area in accordance with Regional Water Board Resolution No. 98-08. Conditionally exempt non-storm water discharges of street/sidewalk wash water do not include hosing of any sidewalk or street with a garden hose with a pressure nozzle.
[14] See note 4.
[15] Based on the water quality characteristics of the conditionally exempt non-storm water discharge itself.

iii. Provides documentation that it has obtained any other necessary permits or water quality certifications[16] for the discharge;

iv. Conducts monitoring of the discharge, if required by the Permittee;

v. Implements BMPs and/or control measures as specified in Table 8 or in the applicable BMP manual(s) as a condition of the approval to discharge into the Permittee's MS4; and

vi. Maintains records of its discharge to the MS4, consistent with requirements in Table 8 or recommendations pursuant to the applicable BMP manual. For lake dewatering, Permittees shall require that the following information is maintained by the lake owner / operator: name of discharger, date and time of notification, method of notification, location of discharge, discharge pathway, receiving water, date of discharge, time of the beginning and end of the discharge, duration of the discharge, flow rate or velocity, total number of gallons discharged, type(s) of sediment controls used, pH of discharge, type(s) of volumetric and velocity controls used, and field and laboratory monitoring data. Records shall be made available upon request by the Permittee or Regional Water Board.

b. Develop and implement procedures that minimize the discharge of landscape irrigation water into the MS4 by promoting conservation programs.

i. Permittees shall coordinate with the local water purveyor(s), where applicable, to promote landscape water use efficiency requirements for existing landscaping, use of drought tolerant, native vegetation, and the use of less toxic options for pest control and landscape management.

ii. Permittees shall develop and implement a coordinated outreach and education program to minimize the discharge of irrigation water and pollutants associated with irrigation water consistent with Part VI.D.4.c of this Order (Public Information and Participation Program).

c. Evaluate monitoring data collected pursuant to the Monitoring and Reporting Program (MRP) of this Order (Attachment E), and any other associated data or information, and determine whether any of the authorized or conditionally exempt non-storm water discharges identified in Parts III.A.1, III.A.2, and III.A.3 above are a source of pollutants that may be causing or contributing to an exceedance of applicable receiving water limitations in Part V and/or water quality-based effluent limitations in Part VI.E. To evaluate monitoring data, the Permittee shall either use applicable interim or final water quality-based effluent limitations for the pollutant or, if there are no applicable interim or final water quality-based effluent limitations for the pollutant, use applicable action levels provided in Attachment G. Based on non-storm water outfall-based monitoring as implemented through the MRP, if monitoring data show

[16] Pursuant to the Federal Clean Water Act § 401.

exceedances of applicable water quality-based effluent limitations or action levels, the Permittee shall take further action to determine whether the discharge is causing or contributing to exceedances of receiving water limitations in Part V.

d. If the Permittee determines that any of the conditionally exempt non-storm water discharges identified in Part III.A.2.b above is a source of pollutants that causes or contributes to an exceedance of applicable receiving water limitations and/or water quality-based effluent limitations, the Permittee(s) shall report its findings to the Regional Water Board in its annual report. Based on this determination, the Permittee(s) shall also either:

i. Effectively prohibit[17] the non-storm water discharge to the MS4; or

ii. Impose conditions in addition to those in Table 8, subject to approval by the Regional Water Board Executive Officer, on the non-storm water discharge such that it will not be a source of pollutants; or

iii. Require diversion of the non-storm water discharge to the sanitary sewer; or

iv. Require treatment of the non-storm water discharge prior to discharge to the receiving water.

e. If the Permittee determines that any of the authorized or conditionally exempt essential non-storm water discharges identified in Parts III.A.1.a through III.A.1.c, III.A.2.a, or III.A.3 above is a source of pollutants that causes or contributes to an exceedance of applicable receiving water limitations and/or water quality-based effluent limitations, the Permittee shall notify the Regional Water Board within 30 days if the non-storm water discharge is an authorized discharge with coverage under a separate NPDES permit or authorized by USEPA under CERCLA in the manner provided in Part III.A.1.b above, or a conditionally exempt essential non-storm water discharge or emergency non-storm water discharge.

f. If the Permittee prohibits the discharge from the MS4, as per Part III.A.4.d.i, then the Permittee shall implement procedures developed under Part VI.D.9 (Illicit Connections and Illicit Discharges Elimination Program) in order to eliminate the discharge to the MS4.

5. If a Permittee demonstrates that the water quality characteristics of a specific authorized or conditionally exempt essential non-storm water discharge resulted in an exceedance of applicable receiving water limitations and/or water quality-based effluent limitations during a specific sampling event, the Permittee shall not be found in violation of applicable receiving water limitations and/or water quality-based effluent limitations for that specific sampling event. Such

[17] To "effectively prohibit" means to not allow the non-storm water discharge through the MS4 unless the discharger obtains coverage under a separate NPDES permit prior to discharge to the MS4.

demonstration must be based on source specific water quality monitoring data from the authorized or conditionally exempt essential non-storm water discharge or other relevant information documenting the characteristics of the specific non-storm water discharge as identified in Table 8.

6. Notwithstanding the above, the Regional Water Board Executive Officer, based on an evaluation of monitoring data and other relevant information for specific categories of non-storm water discharges, may modify a category or remove categories of conditionally exempt non-storm water discharges from Parts III.A.2 and III.A.3 above if the Executive Officer determines that a discharge category is a source of pollutants that causes or contributes to an exceedance of applicable receiving water limitations and/or water quality-based effluent limitations, or may require that a discharger obtain coverage under a separate individual or general State or Regional Water Board permit for a non-storm water discharge.

Table 8. Required Conditions for Conditionally Exempt Non-Storm Water Discharges

Discharge Category	General Conditions Under Which Discharge Through the MS4 is Allowed	Conditions/BMPs that are Required to be Implemented Prior to Discharge Through the MS4
All Discharge Categories	See discharge specific conditions below.	Ensure conditionally exempt non-storm water discharges avoid potential sources of pollutants in the flow path to prevent introduction of pollutants to the MS4 and receiving water. Whenever there is a discharge of 100,000 gallons or more into the MS4, Permittees shall require advance notification by the discharger to the potentially affected MS4 Permittees, including at a minimum the LACFCD, if applicable, and the Permittee with jurisdiction over the land area from which the discharge originates.
Dewatering of lakes	Discharge allowed only if all necessary permits/water quality certifications for dredge and fill activities, including water diversions, are obtained prior to discharge.	Ensure procedures for advanced notification by the lake owner / operator to the Permittee(s) no less than 72 hours prior to the planned discharge. Immediately prior to discharge, visible trash on the shoreline or on the surface of the lake shall be removed and disposed of in a legal manner. Immediately prior to discharge, the discharge pathway and the MS4 inlet to which the discharge is directed, shall be inspected and cleaned out. Discharges shall be volumetrically and velocity controlled to minimize resuspension of sediments. Measures shall be taken to stabilize lake bottom sediments. Ensure procedures for water quality monitoring for pollutants of concern[18] in the lake. Ensure record-keeping of lake dewatering by the lake owner / operator.

[18] Pollutants of concern include, at a minimum, trash and debris, including organic matter, TSS, and any pollutant for which there is a water quality-based effluent limitation in Part VI.E for the lake and/or receiving water.

Landscape irrigation using potable water	Discharge allowed if runoff due to potable landscape irrigation is minimized through the implementation of an ordinance specifying water efficient landscaping standards, as well as an outreach and education program focusing on water conservation and landscape water use efficiency.	Implement BMPs to minimize runoff and prevent introduction of pollutants to the MS4 and receiving water. Implement water conservation programs to minimize discharge by using less water.
Landscape irrigation using reclaimed or recycled water	Discharge of reclaimed or recycled water runoff from landscape irrigation is allowed if the discharge is in compliance with the producer and distributor operations and management (O&M) plan, and all relevant portions thereof, including the Irrigation Management Plan.	Discharges must comply with applicable O&M Plans, and all relevant portions thereof, including the Irrigation Management Plan.

Dechlorinated/ debrominated swimming pool/spa discharges	Discharges allowed after implementation of specified BMPs. Pool or spa water containing copper-based algaecides is not allowed to be discharged to the MS4. Discharges of cleaning waste water and filter backwash allowed only if authorized by a separate NPDES permit.	Implement BMPs and ensure discharge avoids potential sources of pollutants in the flow path to prevent introduction of pollutants prior to discharge to the MS4 and receiving water. Swimming pool water must be dechlorinated or debrominated using holding time, aeration, and/or sodium thiosulfate. Chlorine residual in the discharge shall not exceed 0.1 mg/L. Swimming pool water shall not contain any detergents, wastes, or algaecides, or any other chemicals including salts from pools commonly referred to as "salt water pools" in excess of applicable water quality objectives.[19] Swimming pool discharges are to be pH adjusted, if necessary, and be within the range of 6.5 and 8.5 standard units. Swimming pool discharges shall be volumetrically and velocity controlled to promote evaporation and/or infiltration. Ensure procedures for advanced notification by the pool owner to the Permittee(s) at least 72 hours prior to planned discharge for discharges of 100,000 gallons or more. For discharges of 100,000 gallons or more, immediately prior to discharge, the discharge pathway and the MS4 inlet to which the discharge is directed, shall be inspected and cleaned out.
Dewatering of decorative fountains	Discharges allowed after implementation of specified BMPs. Fountain water containing copper-based algaecides may not be discharged to the MS4. Fountain water containing dyes my not be discharged to the MS4.	Implement BMPs and ensure discharge avoids potential sources of pollutants in the flow path to prevent introduction of pollutants prior to discharge to the MS4 and receiving water. Fountain water must be dechlorinated or debrominated using holding time, aeration, and/or sodium thiosulfate. Chlorine residual in the discharge shall not exceed 0.1 mg/L. Fountain discharges are to be pH adjusted, if necessary, and be within the range of 6.5 and 8.5 standard units. Fountain discharges shall be volumetrically and velocity controlled to promote evaporation and/or infiltration. Ensure procedures for advanced notification by the fountain owner to the Permittee(s) at least 72 hours prior to planned discharge for discharges of 100,000 gallons or more. For discharges of 100,000 gallons or more, immediately prior to discharge, the discharge pathway and the MS4 inlet to which the discharge is directed, shall be inspected and cleaned out.
Non-commercial car washing by residents or by non-	Discharges allowed after implementation of specified BMPs.	Implement BMPs and ensure discharge avoids potential sources of pollutants in the flow path to prevent introduction of pollutants prior to discharge to the MS4 and receiving water. Minimize the amount of water used by employing water conservation practices such as turning off

[19] Applicable mineral water quality objectives for surface waters are contained in Chapter 3 of the Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties.

profit organizations		nozzles or kinking the hose when not spraying a car, and using a low volume pressure washer. Encourage use of biodegradable, phosphate free detergents and non-toxic cleaning products. Where possible, wash cars on a permeable surface where wash water can percolate into the ground (e.g. gravel or grassy areas). Empty buckets of soapy or rinse water into the sanitary sewer system (e.g., sinks or toilets).
Street/sidewalk wash water	Discharges allowed after implementation of specified BMPs.	Sweeping should be used as an alternate BMP whenever possible and sweepings should be disposed of in the trash. BMPs shall be in accordance with Regional Water Board Resolution No. 98-08 that requires: 1) removal of trash, debris, and free standing oil/grease spills/leaks (use absorbent material if necessary) from the area before washing and 2) use of high pressure, low volume spray washing using only potable water with no cleaning agents at an average usage of 0.006 gallons per square feet of sidewalk area. In areas of unsanitary conditions (e.g., areas where the congregation of transient populations can reasonably be expected to result in a significant threat to water quality), whenever practicable, Permittees shall collect and divert street and alley wash water from the Permittee’s street and sidewalk cleaning public agency activities to the sanitary sewer.

IV. EFFLUENT LIMITATIONS AND DISCHARGE SPECIFICATIONS

A. Effluent Limitations

1. **Technology Based Effluent Limitations**: Each Permittee shall reduce pollutants in storm water discharges from the MS4 to the maximum extent practicable (MEP).

2. **Water Quality-Based Effluent Limitations (WQBELs).** This Order establishes WQBELs consistent with the assumptions and requirements of all available TMDL waste load allocations assigned to discharges from the Permittees' MS4s.

    a. Each Permittee shall comply with applicable WQBELs as set forth in Part VI.E of this Order, pursuant to applicable compliance schedules.

B. Land Discharge Specifications – Not Applicable

C. Reclamation Specifications – Not Applicable

V. RECEIVING WATER LIMITATIONS

A. Receiving Water Limitations

1. Discharges from the MS4 that cause or contribute to the violation of receiving water limitations are prohibited.

2. Discharges from the MS4 of storm water, or non-storm water, for which a Permittee is responsible[20], shall not cause or contribute to a condition of nuisance.

3. The Permittees shall comply with Parts V.A.1 and V.A.2 through timely implementation of control measures and other actions to reduce pollutants in the discharges in accordance with the storm water management program and its components and other requirements of this Order including any modifications. The storm water management program and its components shall be designed to achieve compliance with receiving water limitations. If exceedances of receiving water limitations persist, notwithstanding implementation of the storm water management program and its components and other requirements of this Order, the Permittee shall assure compliance with discharge prohibitions and receiving water limitations by complying with the following procedure:

    a. Upon a determination by either the Permittee or the Regional Water Board that discharges from the MS4 are causing or contributing to an exceedance of an applicable Receiving Water Limitation, the Permittee shall promptly notify and thereafter submit an Integrated Monitoring Compliance Report (as described in the Program Reporting Requirements, Part XVIII.A.5 of the Monitoring and Reporting Program) to the Regional Water Board for approval. The Integrated Monitoring Compliance shall describe the BMPs that are currently being

[20] Pursuant to 40 CFR § 122.26(a)(3)(vi), a Permittee is only responsible for discharges of storm water and non-storm water from the MS4 for which it is an owner or operator.

implemented by the Permittee and additional BMPs, including modifications to current BMPs that will be implemented to prevent or reduce any pollutants that are causing or contributing to the exceedances of receiving water limitations. The Integrated Monitoring Compliance Report shall include an implementation schedule. This Integrated Monitoring Compliance Report shall be incorporated in the annual Storm Water Report unless the Regional Water Board directs an earlier submittal. The Regional Water Board may require modifications to the Integrated Monitoring Compliance Report.

b. The Permittee shall submit any modifications to the Integrated Monitoring Compliance Report required by the Regional Water Board within 30 days of notification.

c. Within 30 days following the Regional Water Board Executive Officer's approval of the Integrated Monitoring Compliance Report, the Permittee shall revise the storm water management program and its components and monitoring program to incorporate the approved modified BMPs that have been and will be implemented, an implementation schedule, and any additional monitoring required.

d. The Permittee shall implement the revised storm water management program and its components and monitoring program according to the approved implementation schedule.

4. So long as the Permittee has complied with the procedures set forth in Part V.A.3. above and is implementing the revised storm water management program and its components, the Permittee does not have to repeat the same procedure for continuing or recurring exceedances of the same receiving water limitations unless directed by the Regional Water Board to modify current BMPs or develop additional BMPs.

B. Ground Water Limitations – Not Applicable

VI. PROVISIONS

A. Standard Provisions

1. Federal Standard Provisions. Each Permittee shall comply with all Standard Provisions included in Attachment D of this Order, in accordance with 40 CFR sections 122.41 and 122.42.

2. Legal Authority

a. Each Permittee must establish and maintain adequate legal authority, within its respective jurisdiction, to control pollutant discharges into and from its MS4 through ordinance, statute, permit, contract or similar means. This legal authority must, at a minimum, authorize or enable the Permittee to:

i. Control the contribution of pollutants to its MS4 from storm water discharges associated with industrial and construction activity and control the quality of storm water discharged from industrial and construction sites. This requirement applies both to industrial and construction sites with coverage under an NPDES permit, as well as to those sites that do not have coverage under an NPDES permit.

ii. Prohibit all non-storm water discharges through the MS4 to receiving waters not otherwise authorized or conditionally exempt pursuant to Part III.A;

iii. Prohibit and eliminate illicit discharges and illicit connections to the MS4;

iv. Control the discharge of spills, dumping, or disposal of materials other than storm water to its MS4;

v. Require compliance with conditions in Permittee ordinances, permits, contracts or orders (i.e., hold dischargers to its MS4 accountable for their contributions of pollutants and flows);

vi. Utilize enforcement mechanisms to require compliance with applicable ordinances, permits, contracts, or orders;

vii. Control the contribution of pollutants from one portion of the shared MS4 to another portion of the MS4 through interagency agreements among Co-permittees;

viii. Control of the contribution of pollutants from one portion of the shared MS4 to another portion of the MS4 through interagency agreements with other owners of the MS4 such as the State of California Department of Transportation;

ix. Carry out all inspections, surveillance, and monitoring procedures necessary to determine compliance and noncompliance with applicable municipal ordinances, permits, contracts and orders, and with the provisions of this Order, including the prohibition of non-storm water discharges into the MS4 and receiving waters. This means the Permittee must have authority to enter, monitor, inspect, take measurements, review and copy records, and require regular reports from entities discharging into its MS4;

x. Require the use of control measures to prevent or reduce the discharge of pollutants to achieve water quality standards/receiving water limitations;

xi. Require that structural BMPs are properly operated and maintained; and

xii. Require documentation on the operation and maintenance of structural BMPs and their effectiveness in reducing the discharge of pollutants to the MS4.

b. Each Permittee must submit a statement certified by its chief legal counsel that the Permittee has the legal authority within its jurisdiction to implement and enforce each of the requirements contained in 40 CFR § 122.26(d)(2)(i)(A-F) and this Order. Each Permittee shall submit this certification annually as part of its Annual Report beginning with the first Annual Report required under this Order. These statements must include:

i. Citation of applicable municipal ordinances or other appropriate legal authorities and their relationship to the requirements of 40 CFR § 122.26(d)(2)(i)(A)-(F) and of this Order; and

ii. Identification of the local administrative and legal procedures available to mandate compliance with applicable municipal ordinances identified in subsection (i) above and therefore with the conditions of this Order, and a statement as to whether enforcement actions can be completed administratively or whether they must be commenced and completed in the judicial system.

3. Fiscal Resources

a. Each Permittee shall conduct a fiscal analysis of the annual capital and operation and maintenance expenditures necessary to implement the requirements of this Order.

b. Each Permittee shall also enumerate and describe in its Annual Report the source(s) of funds used in the past year, and proposed for the coming year, to meet necessary expenditures on the Permittee's storm water management program.

4. Responsibilities of the Permittees

a. Each Permittee is required to comply with the requirements of this Order applicable to discharges within its boundaries. Permittees are not responsible for the implementation of the provisions applicable to other Permittees. Each Permittee shall:

i. Comply with the requirements of this Order and any modifications thereto.

ii. Coordinate among its internal departments and agencies, as necessary, to facilitate the implementation of the requirements of this Order applicable to such Permittees in an efficient and cost-effective manner.

iii. Participate in intra-agency coordination (e.g. Planning Department, Fire Department, Building and Safety, Code Enforcement, Public Health, Parks and Recreation, and others) and inter-agency coordination (e.g. co-Permittees, other NPDES permittees) necessary to successfully implement the provisions of this Order.

5. Public Review

a. All documents submitted to the Regional Water Board in compliance with the terms and conditions of this Order shall be made available to members of the public pursuant to the Freedom of Information Act (5 U.S.C. § 552 (as amended)) and the Public Records Act (Cal. Government Code § 6250 et seq.).

b. All documents submitted to the Regional Water Board Executive Officer for approval shall be made available to the public for a 30-day period to allow for public comment.

6. Regional Water Board Review

Any formal determination or approval made by the Regional Water Board Executive Officer pursuant to the provisions of this Order may be reviewed by the Regional Water Board. A Permittee(s) or a member of the public may request such review upon petition within 30 days of the effective date of the notification of such decision to the Permittee(s) and interested parties on file at the Regional Water Board.

7. Reopener and Modification

a. This Order may be modified, revoked, reissued, or terminated in accordance with the provisions of 40 CFR sections 122.44, 122.62, 122.63, 122.64, 124.5, 125.62, and 125.64. Causes for taking such actions include, but are not limited to:

i. Endangerment to human health or the environment resulting from the permitted activity, including information that the discharge(s) regulated by this Order may have the potential to cause or contribute to adverse impacts on water quality and/or beneficial uses;

ii. Acquisition of newly-obtained information that would have justified the application of different conditions if known at the time of Order adoption;

iii. To address changed conditions identified in required reports or other sources deemed significant by the Regional Water Board;

iv. To incorporate provisions as a result of future amendments to the Basin Plan, such as a new or revised water quality objective or the adoption or reconsideration of a TMDL, including the program of implementation. Within 18 months of the effective date of a revised TMDL or as soon as practicable thereafter, where the revisions warrant a change to the provisions of this Order, the Regional Water Board may modify this Order consistent with the assumptions and requirements of the revised WLA(s), including the program of implementation;

v. To incorporate provisions as a result of new or amended statewide water quality control plans or policies adopted by the State Water Board, or in consideration of any State Water Board action regarding the precedential language of State Water Board Order WQ 99-05;

vi. To incorporate provisions as a result of the promulgation of new or amended federal or state laws or regulations, USEPA guidance concerning regulated activities, or judicial decisions that becomes effective after adoption of this Order.

vii. To incorporate effluent limitations for toxic constituents determined to be present in significant amount in the discharge through a more comprehensive monitoring program included as part of this Order and based on the results of the reasonable potential analysis;

viii. In accordance with the provisions set forth in 40 CFR Parts 122 and 124, to include requirements for the implementation of the watershed management approach or to include new Minimum Levels (MLs); and/or

ix. To include provisions or modifications to WQBELs in Part VI.E and Attachments L-R in this Order prior to the final compliance deadlines, if practicable, that would allow an action-based, BMP compliance demonstration approach with regard to final WQBELs for storm water discharges. Such modifications shall be based on the Regional Water Board's evaluation of whether Watershed Management Programs in Part VI.C. have resulted in attainment of interim WQBELs for storm water and review of relevant research, including but not limited to data and information provided by Permittees and other stakeholders, on storm water quality and the efficacy and reliability of storm water control technologies. Provisions or modifications to WQBELs in Part VI.E. shall only be included in this Order where there is evidence that storm water control technologies can reliably achieve final WQBELs.

b. After notice and opportunity for a hearing, this Order may be terminated or modified for cause, including, but not limited to:

i. Violation of any term or condition contained in this Order;

ii. Obtaining this Order by misrepresentation, or failure to disclose all relevant facts; or

iii. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

c. The filing of a request by a Permittee for a modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any condition of this Order.

d. This Order may be modified to make corrections or allowances for changes in the permitted activity, following the procedures at 40 CFR section 122.63, if processed as a minor modification. Minor modifications may only:

i. Correct typographical errors; or

ii. Require more frequent monitoring or reporting by a Permittee.

8. Any discharge of waste to any point(s) other than specifically described in this Order is prohibited, and constitutes a violation of this Order.

9. A copy of this Order shall be maintained by each Permittee so as to be available during normal business hours to Permittee employees responsible for implementation of the provisions of this Order and members of the public.

10. The discharge of any product registered under the Federal Insecticide, Fungicide, and Rodenticide Act to any waste stream that may ultimately be released to waters of the United States, is prohibited, unless specifically authorized elsewhere in this Order or another NPDES permit. This requirement is not applicable to products used for lawn and agricultural purposes.

11. Oil or oily material, chemicals, refuse, or other pollutionable materials shall not be stored or deposited in areas where they may be picked up by rainfall and carried off of the property and/or discharged to surface waters. Any such spill of such materials shall be contained and removed immediately.

12. If there is any storage of hazardous or toxic materials or hydrocarbons at a facility owned and/or operated by a Permittee and if the facility is not manned at all times, a 24-hour emergency response telephone number shall be prominently posted where it can easily be read from the outside.

13. Enforcement

a. Violation of any of the provisions of this Order may subject the violator to any of the penalties described herein or in Attachment D of this Order, or any combination thereof, at the discretion of the prosecuting authority; except that only one kind of penalty may be applied for each kind of violation.

b. Failure to comply with provisions or requirements of this Order, or violation of other applicable laws or regulations governing discharges through the MS4 to receiving waters, may subject a Permittee to administrative or civil liabilities, criminal penalties, and/or other enforcement remedies to ensure compliance. Additionally, certain violations may subject a Permittee to civil or criminal enforcement from appropriate local, state, or federal law enforcement entities.

c. The California Water Code provides that any person who violates a waste discharge requirement or a provision of the California Water Code is subject to civil penalties of up to $5,000 per day, $10,000 per day, or $25,000 per day of violation, or when the violation involves the discharge of pollutants, is subject to civil penalties of up to $10 per gallon per day or $25 per gallon per day of violation; or some combination thereof, depending on the violation, or upon the combination of violations.

d. California Water Code section 13385(h)(1) requires the Regional Water Board to assess a mandatory minimum penalty of three-thousand dollars ($3,000) for each serious violation. Pursuant to California Water Code section 13385(h)(2), a "serious violation" is defined as any waste discharge that violates the effluent limitations contained in the applicable waste discharge requirements for a Group II pollutant by 20 percent or more, or for a Group I pollutant by 40 percent or more. Appendix A of 40 CFR section 123.45 specifies the Group I and II pollutants. Pursuant to California Water Code section 13385.1(a)(1), a "serious violation" is also defined as "a failure to file a discharge monitoring report required pursuant to Section 13383 for each complete period of 30 days following the deadline for submitting the report, if the report is designed to ensure compliance with limitations contained in waste discharge requirements that contain effluent limitations."

e. California Water Code section 13385(i) requires the Regional Water Board to assess a mandatory minimum penalty of three-thousand dollars ($3,000) for each violation whenever a person violates a waste discharge requirement effluent limitation in any period of six consecutive months, except that the requirement to assess the mandatory minimum penalty shall not be applicable to the first three violations within that time period.

f. Pursuant to California Water Code section 13385.1(d), for the purposes of section 13385.1 and subdivisions (h), (i), and (j) of section 13385, "effluent limitation" means a numeric restriction or a numerically expressed narrative restriction, on the quantity, discharge rate, concentration, or toxicity units of a pollutant or pollutants that may be discharged from an authorized location. An effluent limitation may be final or interim, and may be expressed as a prohibition. An effluent limitation, for these purposes, does not include a receiving water limitation, a compliance schedule, or a best management practice.

g. Unlike subdivision (c) of California Water Code section 13385, where violations of effluent limitations may be assessed administrative civil liability on a per day basis, the mandatory minimum penalties provisions identified above require the Regional Water Board to assess mandatory minimum penalties for "each violation" of an effluent limitation. Some water quality-based effluent limitations in Attachments L through R of this Order (e.g., trash, as described immediately below) are expressed as annual effluent limitations. Therefore, for such limitations, there can be no more than one violation of each interim or final effluent limitation per year.

h. Trash TMDLs.

i. Consistent with the 2009 amendments to Order No. 01-182 to incorporate the Los Angeles River Trash TMDL, the water quality-based effluent limitations in Attachments L through R of this Order for trash are expressed as annual effluent limitations. Therefore, for such limitations, there can be no more than one violation of each interim or final effluent limitation per year. Trash is considered a Group I pollutant, as specified in Appendix A to 40 CFR section 123.45. Therefore, each annual violation of a trash effluent limitation in Attachments L through R of this Order by forty percent or more would be considered a "serious violation" under California Water Code section 13385(h). With respect to the final effluent limitation of zero trash, any detectable discharge of trash necessarily is a serious violation, in accordance with the State Water Board's Enforcement Policy. Violations of the effluent limitations in Attachments L through R of this Order would not constitute "chronic" violations that would give rise to mandatory liability under California Water Code section 13385(i) because four or more violations of the effluent limitations subject to a mandatory penalty cannot occur in a period of six consecutive months.

ii. For the purposes of enforcement under California Water Code section 13385, subdivisions (a), (b), and (c), not every storm event may result in trash discharges. In trash TMDLs adopted by the Regional Water Board, the Regional Water Board states that improperly deposited trash is mobilized during storm events of greater than 0.25 inches of precipitation. Therefore, violations of the effluent limitations are limited to the days of a storm event of greater than 0.25 inches. Once a Permittee has violated the annual effluent limitation, any subsequent discharges of trash during any day of a storm event of greater than 0.25 inches during the same storm year constitutes an additional "day in which the violation [of the effluent limitation] occurs".

14. This Order does not exempt any Permittee from compliance with any other laws, regulations, or ordinances that may be applicable.

15. The provisions of this Order are severable. If any provisions of this Order or the application of any provision of this Order to any circumstance is held invalid, the application of such provision to other circumstances and the remainder of this Order shall not be affected.

B. Monitoring and Reporting Program (MRP) Requirements

Dischargers shall comply with the MRP and future revisions thereto, in Attachment E of this Order or may, in coordination with an approved Watershed Management Program per Part VI.C, implement a customized monitoring program that achieves the five Primary Objectives set forth in Part II.A. of Attachment E and includes the elements set forth in Part II.E. of Attachment E.

C. Watershed Management Programs

1. General

a. The purpose of this Part VI.C is to allow Permittees the flexibility to develop Watershed Management Programs to implement the requirements of this Order on a watershed scale through customized strategies, control measures, and BMPs.

b. Participation in a Watershed Management Program is voluntary and allows a Permittee to address the highest watershed priorities, including complying with the requirements of Part V.A. (Receiving Water Limitations), Part VI.E (Total Maximum Daily Load Provisions) and Attachments L through R, by customizing the control measures in Parts III.A.4 (Prohibitions – Non-Storm Water Discharges) and VI.D (Minimum Control Measures).

c. Customized strategies, control measures, and BMPs shall be implemented on a watershed basis, where applicable, through each Permittee's storm water management program and/or collectively by all participating Permittees through a Watershed Management Program.

d. The Watershed Management Programs shall ensure that discharges from the Permittee's MS4: (i) achieve applicable water quality-based effluent limitations in Part VI.E and Attachments L through R pursuant to the corresponding compliance schedules, (ii) do not cause or contribute to exceedances of receiving water limitations in Parts V.A and VI.E and Attachments L through R, and (iii) do not include non-storm water discharges that are effectively prohibited pursuant to Part III.A. The programs shall also ensure that controls are implemented to reduce the discharge of pollutants to the maximum extent practicable (MEP) pursuant to Part IV.A.1.

e. Watershed Management Programs shall be developed either collaboratively or individually using the Regional Water Board's Watershed Management Areas (WMAs). Where appropriate, WMAs may be separated into subwatersheds to focus water quality prioritization and implementation efforts by receiving water.

f. Each Watershed Management Program shall be consistent with Part VI.C.5-C.8 and shall:

i. Prioritize water quality issues resulting from storm water and non-storm water discharges from the MS4 to receiving waters within each WMA,

ii. Identify and implement strategies, control measures, and BMPs to achieve the outcomes specified in Part VI.C.1.d,

iii. Execute an integrated monitoring program and assessment program pursuant to Attachment E – MRP, Part IV to determine progress towards achieving applicable limitations and/or action levels in Attachment G, and

iv. Modify strategies, control measures, and BMPs as necessary based on analysis of monitoring data collected pursuant to the MRP to ensure that applicable water quality-based effluent limitations and receiving water limitations and other milestones set forth in the Watershed Management Program are achieved in the required timeframes.

v. Provide appropriate opportunity for meaningful stakeholder input, including but not limited to, a permit-wide watershed management program technical advisory committee (TAC) that will advise and participate in the development of the Watershed Management Programs and enhanced Watershed Management Programs from month 6 through the date of program approval. The composition of the TAC may include at least one Permittee representative from each Watershed Management Area for which a Watershed Management Program will be developed, and must include a minimum of one public representative from a non-governmental organization with public membership, and staff from the Regional Water Board and USEPA Region IX.

g. Permittees may elect to develop an enhanced Watershed Management Program (EWMP). An EWMP is one that comprehensively evaluates opportunities, within the participating Permittees' collective jurisdictional area in a Watershed Management Area, for collaboration among Permittees and other partners on multi-benefit regional projects that, wherever feasible, retain (i) all non-storm water runoff and (ii) all storm water runoff from the 85th percentile, 24-hour storm event for the drainage areas tributary to the projects, while also achieving other benefits including flood control and water supply, among others. In drainage areas within the EWMP area where retention of the 85th percentile, 24-hour storm event is not feasible, the EWMP shall include a Reasonable Assurance Analysis to demonstrate that applicable water quality based effluent limitations and receiving water limitations shall be achieved through implementation of other watershed control measures. An EWMP shall:

i. Be consistent with the provisions in Part VI.C.1.a.-f and VI.C.5-C.8;

ii. Incorporate applicable State agency input on priority setting and other key implementation issues;

iii. Provide for meeting water quality standards and other CWA obligations by utilizing provisions in the CWA and its implementing regulations, policies and guidance;

iv. Include multi-benefit regional projects to ensure that MS4 discharges achieve compliance with all final WQBELs set forth in Part VI.E. and do not cause or contribute to exceedances of receiving water limitations in Part V.A. by retaining through infiltration or capture and reuse the storm water volume from the 85th percentile, 24-hour storm for the drainage areas tributary to the multi-benefit regional projects.;

v. In drainage areas where retention of the storm water volume from the 85th percentile, 24-hour event is not technically feasible, include other watershed control measures to ensure that MS4 discharges achieve compliance with all interim and final WQBELs set forth in Part VI.E. with compliance deadlines occurring after approval of a EWMP and to ensure that MS4 discharges do not cause or contribute to exceedances of receiving water limitations in Part V.A.;

vi. Maximize the effectiveness of funds through analysis of alternatives and the selection and sequencing of actions needed to address human health and water quality related challenges and non-compliance;

vii. Incorporate effective innovative technologies, approaches and practices, including green infrastructure;

viii. Ensure that existing requirements to comply with technology-based effluent limitations and core requirements (e.g., including elimination of non-storm water discharges of pollutants through the MS4, and controls to reduce the discharge of pollutants in storm water to the maximum extent practicable) are not delayed;

ix. Ensure that a financial strategy is in place.

2. Compliance with Receiving Water Limitations Not Otherwise Addressed by a TMDL through a WMP or EWMP

a. For receiving water limitations in Part V.A. associated with water body-pollutant combinations not addressed through a TMDL, but which a Permittee elects to address through a Watershed Management Program or EWMP as set forth in this Part VI.C., a Permittee shall comply as follows:

i. For pollutants that are in the same class[21] as those addressed in a TMDL for the watershed and for which the water body is identified as impaired on the State's Clean Water Act Section 303(d) List as of the effective date of this Order:

(1) Permittees shall demonstrate that the Watershed Control Measures to achieve the applicable TMDL provisions identified pursuant to Part VI.C.5.b.iv.(3) will also adequately address contributions of the pollutant(s) within the same class from MS4 discharges to receiving waters, consistent with the assumptions and requirements of the corresponding TMDL provisions, including interim and final requirements and deadlines for their achievement, such that the MS4 discharges of the pollutant(s) will not cause or contribute to exceedances of receiving water limitations in Part V.A.

[21] Pollutants are considered in a similar class if they have similar fate and transport mechanisms, can be addressed via the same types of control measures, and within the same timeline already contemplated as part of the Watershed Management Program for the TMDL.

(2) Permittees shall include the water body-pollutant combination(s) in the Reasonable Assurance Analysis in Part VI.C.5.b.iv.(5).

(3) Permittees shall identify milestones and dates for their achievement consistent with those in the corresponding TMDL.

ii. For pollutants that are not in the same class as those addressed in a TMDL for the watershed, but for which the water body is identified as impaired on the State's Clean Water Act Section 303(d) List as of the effective date of this Order:

(1) Permittees shall assess contributions of the pollutant(s) from MS4 discharges to the receiving waters and sources of the pollutant(s) within the drainage area of the MS4 pursuant to Part VI.C.5.a.iii.

(2) Permittees shall identify Watershed Control Measures pursuant to Part VI.C.5.b. that will adequately address contributions of the pollutant(s) from MS4 discharges to receiving waters such that the MS4 discharges of the pollutant(s) will not cause or contribute to exceedances of receiving water limitations in Part V.A.

(3) Permittees shall include the water body-pollutant in the Reasonable Assurance Analysis in Part VI.C.5.b.iv.(5).

(4) Permittees shall identify enforceable requirements and milestones and dates for their achievement to control MS4 discharges such that they do not cause or contribute to exceedances of receiving water limitations within a timeframe(s) that is as short as possible, taking into account the technological, operation, and economic factors that affect the design, development, and implementation of the control measures that are necessary. The time between dates shall not exceed one year. Milestones shall relate to a specific water quality endpoint (e.g., x% of the MS4 drainage area is meeting the receiving water limitations) and dates shall relate either to taking a specific action or meeting a milestone.

(5) Where the final date(s) in (4) is beyond the term of this Order, the following conditions shall apply:

(a) For an EWMP, in drainage areas where retention of (i) all non-storm water runoff and (ii) all storm water runoff from the 85^{th} percentile, 24-hour storm event will be achieved, each participating Permittee shall continue to target implementation of watershed control measures in its existing storm water management program, including watershed control measures to eliminate non-storm water discharges that are a source of pollutants to receiving waters.

(b) For a WMP and in areas of a EWMP where retention of the volume in (a) is technically infeasible and where the Regional Water Board determines that MS4 discharges cause or contribute to the water quality impairment, participating Permittees may initiate development of a stakeholder-proposed TMDL upon approval of the Watershed Management Program or EWMP. For MS4 discharges from these drainage areas to the receiving waters, any extension of this compliance mechanism beyond the term of this Order shall be consistent with the implementation schedule in a TMDL for the waterbody pollutant combination(s) adopted by the Regional Water Board.

iii. For pollutants for which there are exceedances of receiving water limitations in Part V.A., but for which the water body is not identified as impaired on the State's Clean Water Act Section 303(d) List as of the effective date of this Order:

(1) Upon an exceedance of a receiving water limitation, based on data collected pursuant to the MRP and approved IMPs and CIMPs, Permittees shall assess contributions of the pollutant(s) from MS4 discharges to the receiving waters and sources of the pollutant(s) within the drainage area of the MS4 pursuant to Part VI.C.5.a.iii.

(2) If MS4 discharges are identified as a source of the pollutant(s) that has caused or contributed to, or has the potential to cause or contribute to, the exceedance(s) of receiving water limitations in Part V.A., Permittees shall address contributions of the pollutant(s) from MS4 discharges through modifications to the WMP or EWMP pursuant to Part VI.C.8.a.ii.

(a) In a modified WMP or EWMP, Permittees shall identify Watershed Control Measures pursuant to Part VI.C.5.b. that will adequately address contributions of the pollutant(s) from MS4 discharges to receiving waters such that the MS4 discharges of the pollutant(s) will not cause or contribute to exceedances of receiving water limitations in Part V.A.

(b) Permittees shall modify the Reasonable Assurance Analysis pursuant to Part VI.C.5.b.iv.(5) to address the pollutant(s).

(c) Permittees shall identify enforceable requirements and milestones and dates for their achievement to control MS4 discharges such that they do not cause or contribute to exceedances of receiving water limitations within a timeframe(s) that is as short as possible, taking into account the technological, operation, and economic factors that affect the design, development, and implementation of the control measures that are necessary. The time between dates shall not exceed one year. Milestones shall relate to a specific water quality endpoint (e.g., x% of the MS4 drainage area is meeting the receiving water limitations) and dates shall relate either to taking a specific action or meeting a milestone.

(d) Where the final date(s) in (4) is beyond the term of this Order, the following conditions shall apply:

(i) For an EWMP, in drainage areas where retention of (i) all non-storm water runoff and (ii) all storm water runoff from the 85th percentile, 24-hour storm event will be achieved, each participating Permittee shall continue to target implementation of watershed control measures in its existing storm water management program, including watershed control measures to eliminate non-storm water discharges that are a source of pollutants to receiving waters.

(ii) For a WMP and in areas of a EWMP where retention of the volume in (a) is technically infeasible, for newly identified exceedances of receiving water limitations, a Permittee may request that the Regional Water Board approve a modification to its WMP or EWMP to include these additional water body-pollutant combinations.

b. A Permittee's full compliance with all requirements and dates for their achievement in an approved Watershed Management Program or EWMP shall constitute a Permittee's compliance with the receiving water limitations provisions in Part V.A. of this Order for the specific water body-pollutant combinations addressed by an approved Watershed Management Program or EWMP.

c. If a Permittee fails to meet any requirement or date for its achievement in an approved Watershed Management Program or EWMP, the Permittee shall be subject to the provisions of Part V.A. for the waterbody-pollutant combination(s) that were to be addressed by the requirement.

d. Upon notification of a Permittee's intent to develop a WMP or EWMP and prior to approval of its WMP or EWMP, a Permittee's full compliance with all of the following requirements shall constitute a Permittee's compliance with the receiving water limitations provisions in Part V.A. not otherwise addressed by a TMDL, if all the following requirements are met:

i. Provides timely notice of its intent to develop a WMP or EWMP,

ii. Meets all interim and final deadlines for development of a WMP or EWMP,

iii. For the area to be covered by the WMP or EWMP, targets implementation of watershed control measures in its existing storm water management program, including watershed control measures to eliminate non-storm water discharges of pollutants through the MS4 to receiving waters, to address known contributions of pollutants from MS4 discharges that cause or contribute to exceedances of receiving water limitations, and

iv. Receives final approval of its WMP or EWMP within 28 or 40 months, respectively.

3. Compliance with Receiving Water Limitations Addressed by a TMDL through a WMP or EWMP

a. A Permittee's full compliance with all requirements and dates for their achievement in an approved Watershed Management Program or EWMP shall constitute a Permittee's compliance with provisions pertaining to applicable interim water quality based effluent limitations and interim receiving water limitations in Part VI.E. and Attachments L-R for the pollutant(s) addressed by the approved Watershed Management Program or EWMP.

b. Upon notification of a Permittee's intent to develop a WMP or EWMP and prior to approval of its WMP or EWMP, a Permittee's full compliance with all of the following requirements shall constitute a Permittee's compliance with the receiving water limitations provisions in Part V.A., if all the following requirements are met:

i. Provides timely notice of its intent to develop a WMP or EWMP,

ii. Meets all interim and final deadlines for development of a WMP or EWMP,

iii. For the area to be covered by the WMP or EWMP, targets implementation of watershed control measures in its existing storm water management program, including watershed control measures to eliminate non-storm water discharges of pollutants through the MS4 to receiving waters, to address known contributions of pollutants from MS4 discharges that cause or contribute to exceedances of receiving water limitations, and

iv. Receives final approval of its WMP or EWMP within 28 or 40 months, respectively.

c. Subdivision b. does not apply to receiving water limitations corresponding to final compliance deadlines pursuant to TMDL provisions in Part VI.E. that have passed or will occur prior to approval of a WMP or EWMP.

4. Process

a. Timelines for Implementation

i. Implementation of the following requirements shall occur per the schedule specified in Table 9 below:

Table 9. Watershed Management Program Implementation Requirements

Part	Provision	Due Date
VI.C.4.b	Notify Regional Water Board of intent to develop Watershed Management Program or enhanced WMP and request submittal date for draft program plan	6 months after Order effective date
VI.C.4.c	For Permittee(s) that elect not to implement the conditions of Part VI.C.4.c.i or c.ii, submit draft plan to Regional Water Board	1 year after Order effective date
VI.C.4.c VI.C.4.c.iv	For Permittee(s) that elect to implement the conditions of Part VI.C.4.c.i or c.ii, submit draft plan to Regional Water Board For Permittees that elect to collaborate on an enhanced WMP that meets the requirements of Part VI.C.4.c.iv,submit draft plan to Regional Water Board	18 months after Order effective date 18 months after Order effective date, provide final work plan for development of enhanced WMP 30 months after Order effective date, submit draft plan
VI.C.4.c	Comments provided to Permittees by Regional Water Board	4 months after submittal of draft plan
VI.C.4.c	Submit final plan to Regional Water Board	3 months after receipt of Regional Water Board comments on draft plan
VI.C.4.c	Approval or denial of final plan by Regional Water Board or by the Executive Officer on behalf of the Regional Water Board	3 months after submittal of final plan
VI.C.6	Begin implementation of Watershed Management Program or EWMP	Upon approval of final plan
VI.C.8	Comprehensive evaluation of Watershed Management	Every two years from date of

	Program or EWMP and submittal of modifications to plan	approval

b. Permittees that elect to develop a Watershed Management Program or EWMP must notify the Regional Water Board no later than six months after the effective date of this Order.

i. Such notification shall specify if the Permittee(s) are requesting a 12-month or 18-month submittal date for the draft Watershed Management Program, per Part VI.C.4.c.i – ii, or if the Permittees are requesting a 18/30-month submittal date for the draft EWMP per Part VI.C.4.c.iv.

ii. As part of their notice of intent to develop a WMP or EWMP, Permittees shall identify all applicable interim and final trash WQBELs and all other final WQBELs and receiving water limitations pursuant to Part VI.E. and the applicable attachment(s) with compliance deadlines occurring prior to approval of a WMP or EWMP. Permittees shall identify watershed control measures, where possible from existing TMDL implementation plans, that will be implemented by participating Permittees concurrently with the development of a Watershed Management Program or EWMP to ensure that MS4 discharges achieve compliance with applicable interim and final trash WQBELs and all other final WQBELs and receiving water limitations set forth in Part VI.E. and the applicable attachment(s) by the applicable compliance deadlines occurring prior to approval of a WMP or EWMP.

iii. As part of their notification, Permittees electing to develop an EWMP shall submit all of the following in addition to the requirements of Part VI.C.4.b.i.-ii.:

(1) Plan concept and geographical scope,

(2) Cost estimate for plan development,

(3) Executed MOU/agreement among participating Permittees to fund plan development, or final draft MOU among participating Permittees along with a signed letter of intent from each participating City Manager or head of agency. If a final draft MOU is submitted, the MOU shall be fully executed by all participating Permittees within 12 months of the effective date of this Order.

(4) Interim milestones for plan development and deadlines for their achievement,

(5) Identification of, and commitment to fully implement, one structural BMP or a suite of BMPs at a scale that provides meaningful water quality improvement within each watershed covered by the plan within 30 months of the effective date of this Order in addition to

watershed control measures to be implemented pursuant to b.ii. above. The structural BMP or suite of BMPs shall be subject to approval by the Regional Water Board Executive Officer, and

(6) Demonstration that the requirements in Parts VI.C.4.c.iv.(1) and (2) have been met.

c. Permittees that elect to develop a Watershed Management Program shall submit a draft plan to the Regional Water Board as follows:

i. For Permittees that elect to collaborate on the development of a Watershed Management Program, Permittees shall submit the draft Watershed Management Program no later than 18 months after the effective date of this Order if the following conditions are met in greater than 50% of the land area covered by the WMP:

(1) Demonstrate that there are LID ordinances in place and/or commence development of a Low Impact Development (LID) ordinance(s) meeting the requirements of this Order's Planning and Land Development Program within 60 days of the effective date of the Order and have a draft ordinance within 6 months of the effective date of the Order, and

(2) Demonstrate that there are green streets policies in place and/or commence development of a policy(ies) that specifies the use of green street strategies for transportation corridors within 60 days of the effective date of the Order and have a draft policy within 6 months of the effective date of the Order.

(3) Demonstrate in the notification of the intent to develop a Watershed Management Program that Parts VI.C.4.c.i(1) and (2) have been met in greater than 50% of the watershed area.

ii. For a Permittee that elects to develop an individual Watershed Management Program, the Permittee shall submit the draft Watershed Management Program no later than 18 months after the effective date of this Order if the following conditions are met:

(1) Demonstrate that there is a LID ordinance in place for the Permittee's jurisdiction and/or commence development of a Low Impact Development (LID) ordinance for the Permittee's jurisdiction meeting the requirements of this Order's Planning and Land Development Program within 60 days of the effective date of the Order and have a draft ordinance within 6 months of the effective date of the Order, and

(2) Demonstrate that there is a green streets policy in place for the Permittee's jurisdiction and/or commence development of a policy

that specifies the use of green street strategies for transportation corridors within the Permittee's jurisdiction within 60 days of the effective date of the Order and have a draft policy within 6 months of the effective date of the Order.

(3) Demonstrate in the notification of the intent to develop a Watershed Management Program that Parts VI.C.4.c.ii.(1) and (2) have been met.

iii. For Permittees that elect not to implement the conditions under Part VI.C.4.c.i. or Part VI.C.4.c.ii., Permittees shall submit the draft Watershed Management Program no later than 12 months after the effective date of this Order.

iv. For Permittees that elect to collaborate on the development of an EWMP, Permittees shall submit the work plan for development of the EWMP no later than 18 months after the effective date of this Order, and shall submit the draft program no later than 30 months after the effective date of this Order if the following conditions are met in greater than 50% of the land area in the watershed:

(1) Demonstrate that there are LID ordinances in place and/or commence development of a Low Impact Development (LID) ordinance(s) meeting the requirements of this Order's Planning and Land Development Program within 60 days of the effective date of the Order and have a draft ordinance within 6 months of the effective date of the Order, and

(2) Demonstrate that there are green streets policies in place and/or commence development of a policy(ies) that specifies the use of green street strategies for transportation corridors within 60 days of the effective date of the Order and have a draft policy within 6 months of the effective date of the Order.

(3) Demonstrate in the notification of the intent to develop an EWMP that Parts VI.C.4.c.iv.(1) and (2) have been met in greater than 50% of the watershed area.

d. Until the Watershed Management Program or EWMP is approved by the Regional Water Board or by the Executive Officer on behalf of the Regional Water Board, Permittees that elect to develop a Watershed Management Program or EWMP shall:

i. Continue to implement watershed control measures in their existing storm water management programs, including actions within each of the six categories of minimum control measures consistent with 40 CFR section 122.26(d)(2)(iv),

ii. Continue to implement watershed control measures to eliminate non-storm water discharges through the MS4 that are a source of pollutants to receiving waters consistent with CWA section 402(p)(3)(B)(ii), and

iii. Implement watershed control measures, where possible from existing TMDL implementation plans, to ensure that MS4 discharges achieve compliance with interim and final trash WQBELs and all other final WQBELs and receiving water limitations pursuant to Part VI.E. and set forth in Attachments L through R by the applicable compliance deadlines occurring prior to approval of a WMP or EWMP.

e. Permittees that do not elect to develop a Watershed Management Program or EWMP, or that do not have an approved WMP or EWMP within 28 or 40 months, respectively, of the effective date of this Order, shall be subject to the baseline requirements in Part VI.D and shall demonstrate compliance with receiving water limitations pursuant to Part V.A. and with applicable interim water quality-based effluent limitations in Part VI.E pursuant to subparts VI.E.2.d.i.(1)-(3).

f. Permittees subject to the Middle Santa Ana River Watershed Bacteria Indicator TMDL shall submit a Comprehensive Bacteria Reduction Plan (CBRP) for dry weather to the Regional Water Board Executive Officer no later than nine months after the effective date of this Order. The CBRP shall describe, in detail, the specific actions that have been taken or will be taken to achieve compliance with the dry weather water quality-based effluent limitations and the receiving water limitations for the Middle Santa Ana River Watershed Bacteria Indicator TMDL by December 31, 2015. The CBRP shall also establish a schedule for developing a CBRP to comply with the water quality-based effluent limitations and the receiving water limitations for the Middle Santa Ana River Bacteria TMDL during wet weather by December 31, 2025. The CBRP may be developed in lieu of the Watershed Management Program for MS4 discharges of bacteria within the Middle Santa Ana River Watershed.

5. Program Development

a. Identification of Water Quality Priorities

Permittees shall identify the water quality priorities within each WMA that will be addressed by the Watershed Management Program. At a minimum, these priorities shall include achieving applicable water quality-based effluent limitations and/or receiving water limitations established pursuant to TMDLs, as set forth in Part VI.E and Attachments L through R of this Order.

i. Water Quality Characterization. Each plan shall include an evaluation of existing water quality conditions, including characterization of storm water and non-storm water discharges from the MS4 and receiving water quality, to support identification and prioritization/sequencing of management actions.

ii. Water Body-Pollutant Classification. On the basis of the evaluation of existing water quality conditions, water body-pollutant combinations shall be classified into one of the following three categories:

(1) Category 1 (Highest Priority): Water body-pollutant combinations for which water quality-based effluent limitations and/or receiving water limitations are established in Part VI.E and Attachments L through R of this Order.

(2) Category 2 (High Priority): Pollutants for which data indicate water quality impairment in the receiving water according to the State's Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (State Listing Policy) and for which MS4 discharges may be causing or contributing to the impairment.

(3) Category 3 (Medium Priority): Pollutants for which there are insufficient data to indicate water quality impairment in the receiving water according to the State's Listing Policy, but which exceed applicable receiving water limitations contained in this Order and for which MS4 discharges may be causing or contributing to the exceedance.

iii. Source Assessment. Utilizing existing information, potential sources within the watershed for the water body-pollutant combinations in Categories 1 - 3 shall be identified.

(1) Permittees shall identify known and suspected storm water and non-storm water pollutant sources in discharges to the MS4 and from the MS4 to receiving waters and any other stressors related to MS4 discharges causing or contributing to the water quality priorities. The identification of known and suspected sources of the highest water quality priorities shall consider the following:

(a) Review of available data, including but not limited to:

(i) Findings from the Permittees' Illicit Connections and Illicit Discharge Elimination Programs;

(ii) Findings from the Permittees' Industrial/Commercial Facilities Programs;

(iii) Findings from the Permittees' Development Construction Programs;

(iv) Findings from the Permittees' Public Agency Activities Programs;

(v) TMDL source investigations;

(vi) Watershed model results;

(vii) Findings from the Permittees' monitoring programs, including but not limited to TMDL compliance monitoring and receiving water monitoring; and

(viii) Any other pertinent data, information, or studies related to pollutant sources and conditions that contribute to the highest water quality priorities.

(b) Locations of the Permittees' MS4s, including, at a minimum, all MS4 major outfalls and major structural controls for storm water and non-storm water that discharge to receiving waters.

(c) Other known and suspected sources of pollutants in non-storm water or storm water discharges from the MS4 to receiving waters within the WMA.

iv. Prioritization. Based on the findings of the source assessment, the issues within each watershed shall be prioritized and sequenced. Watershed priorities shall include at a minimum:

(1) TMDLs

(a) Controlling pollutants for which there are water quality-based effluent limitations and/or receiving water limitations with interim or final compliance deadlines within the permit term, or TMDL compliance deadlines that have already passed and limitations have not been achieved.

(b) Controlling pollutants for which there are water quality-based effluent limitations and/or receiving water limitations with interim or final compliance deadlines between September 6, 2012 and October 25, 2017.

(2) Other Receiving Water Considerations

(a) Controlling pollutants for which data indicate impairment or exceedances of receiving water limitations in the receiving water and the findings from the source assessment implicates discharges from the MS4 shall be considered the second highest priority.

b. Selection of Watershed Control Measures

i. Permittees shall identify strategies, control measures, and BMPs to implement through their individual storm water management programs, and collectively on a watershed scale, with the goal of creating an efficient program to focus individual and collective resources on watershed priorities.

ii. The objectives of the Watershed Control Measures shall include:

(1) Prevent or eliminate non-storm water discharges to the MS4 that are a source of pollutants from the MS4 to receiving waters.

(2) Implement pollutant controls necessary to achieve all applicable interim and final water quality-based effluent limitations and/or receiving water limitations pursuant to corresponding compliance schedules.

(3) Ensure that discharges from the MS4 do not cause or contribute to exceedances of receiving water limitations.

iii. Watershed Control Measures may include:

(1) Structural and/or non-structural controls and operation and maintenance procedures that are designed to achieve applicable water quality-based effluent limitations, receiving water limitations in Part VI.E and/or Attachments L through R;

(2) Retrofitting areas of existing development known or suspected to contribute to the highest water quality priorities with regional or sub-regional controls or management measures; and

(3) Stream and/or habitat rehabilitation or restoration projects where stream and/or habitat rehabilitation or restoration are necessary for, or will contribute to demonstrable improvements in the physical, chemical, and biological receiving water conditions and restoration and/or protection of water quality standards in receiving waters.

iv. The following provisions of this Order shall be incorporated as part of the Watershed Management Program:

(1) Minimum Control Measures.

(a) Permittees shall assess the minimum control measures (MCMs) as defined in Part VI.D.4 to Part VI.D.10 of this Order to identify opportunities for focusing resources on the high priority issues in each watershed. For each of the following minimum control measures, Permittees shall identify potential modifications that will address watershed priorities:

(i) Development Construction Program

(ii) Industrial/Commercial Facilities Program

(iii) Illicit Connection and Illicit Discharges Detection and Elimination Program

(iv) Public Agency Activities Program

(v) Public Information and Participation Program

(b) At a minimum, the Watershed Management Program shall include management programs consistent with 40 CFR section 122.26(d)(2)(iv)(A)-(D).

(c) If the Permittee(s) elects to eliminate a control measure identified in Parts VI.D.4, VI.D.5, VI.D.6 and VI.D.8 to VI.D.10 because that specific control measure is not applicable to the Permittee(s), the Permittee(s) shall provide a justification for its elimination. The Planning and Land Development Program is not eligible for elimination.

(d) Such customized actions, once approved as part of the Watershed Management Program, shall replace in part or in whole the requirements in Parts VI.D.4, VI.D.5, VI.D.6 and VI.D.8 to VI.D.10 for participating Permittees.

(2) Non-Storm Water Discharge Measures. Where Permittees identify non-storm water discharges from the MS4 as a source of pollutants that cause or contribute to exceedance of receiving water limitations, the Watershed Control Measures shall include strategies, control measures, and/or BMPs that must be implemented to effectively eliminate the source of pollutants consistent with Parts III.A and VI.D.10. These may include measures to prohibit the non-storm water discharge to the MS4, additional BMPs to reduce pollutants in the non-storm water discharge or conveyed by the non-storm water discharge, diversion to a sanitary sewer for treatment, or strategies to require the non-storm water discharge to be separately regulated under a general NPDES permit.

(3) TMDL Control Measures. Permittees shall compile control measures that have been identified in TMDLs and corresponding implementation plans. Permittees shall identify those control measures to be modified, if any, to most effectively address TMDL requirements within the watershed. If not sufficiently identified in previous documents, or if implementation plans have not yet been developed (e.g., USEPA established TMDLs), the Permittees shall evaluate and identify control measures to achieve water quality-based effluent limitations and/or

receiving water limitations established in this Order pursuant to these TMDLs.

(a) TMDL control measures shall include where necessary control measures to address both storm water and non-storm water discharges from the MS4.

(b) TMDL control measures may include baseline or customized activities covered under the general MCM categories in Part VI.D as well as BMPs and other control measures covered under the non-storm water discharge provisions of Part III.A of this Order.

(c) The WMP shall include, at a minimum, those actions that will be implemented during the permit term to achieve interim and/or final water quality-based effluent limitations and/or receiving water limitations with compliance deadlines within the permit term.

(4) Each plan shall include the following components:

(a) Identification of specific structural controls and non-structural best management practices, including operational source control and pollution prevention, and any other actions or programs to achieve all water quality-based effluent limitations and receiving water limitations contained in this Part VI.E and Attachments L through R to which the Permittee(s) is subject;

(b) For each structural control and non-structural best management practice, the number, type, and location(s) and/or frequency of implementation;

(c) For any pollution prevention measures, the nature, scope, and timing of implementation;

(d) For each structural control and non-structural best management practice, interim milestones and dates for achievement to ensure that TMDL compliance deadlines will be met; and

(e) The plan shall clearly identify the responsibilities of each participating Permittee for implementation of watershed control measures.

(5) Permittees shall conduct a Reasonable Assurance Analysis for each water body-pollutant combination addressed by the Watershed Management Program. A Reasonable Assurance Analysis (RAA) shall be quantitative and performed using a peer-reviewed model in the public domain. Models to be considered for the RAA, without exclusion, are the Watershed Management Modeling System (WMMS), Hydrologic Simulation Program-FORTRAN (HSPF), and the Structural BMP Prioritization and Analysis Tool (SBPAT). The RAA shall commence with assembly of all available, relevant subwatershed data collected within the last 10 years, including land use and pollutant

loading data, establishment of quality assurance/quality control (QA/QC) criteria, QA/QC checks of the data, and identification of the data set meeting the criteria for use in the analysis. Data on performance of watershed control measures needed as model input shall be drawn only from peer-reviewed sources. These data shall be statistically analyzed to determine the best estimate of performance and the confidence limits on that estimate for the pollutants to be evaluated. The objective of the RAA shall be to demonstrate the ability of Watershed Management Programs and EWMPs to ensure that Permittees' MS4 discharges achieve applicable water quality based effluent limitations and do not cause or contribute to exceedances of receiving water limitations.

(a) Permittees shall demonstrate using the RAA that the activities and control measures identified in the Watershed Control Measures will achieve applicable water quality-based effluent limitations and/or receiving water limitations in Attachments L through R with compliance deadlines during the permit term.

(b) Where the TMDL Provisions in Part VI.E and Attachments L through R do not include interim or final water quality-based effluent limitations and/or receiving water limitations with compliance deadlines during the permit term, Permittees shall identify interim milestones and dates for their achievement to ensure adequate progress toward achieving interim and final water quality-based effluent limitations and/or receiving water limitations with deadlines beyond the permit term.

(c) For water body-pollutant combinations not addressed by TMDLs, Permittees shall demonstrate using the RAA that the activities and control measures identified in the Watershed Control Measures will achieve applicable receiving water limitations as soon as possible.

(6) Permittees shall provide documentation that they have the necessary legal authority to implement the Watershed Control Measures identified in the plan, or that other legal authority exists to compel implementation of the Watershed Control Measures.

c. Compliance Schedules

Permittees shall incorporate compliance schedules in Attachments L through R into the plan and, where necessary develop interim milestones and dates for their achievement. Compliance schedules and interim milestones and dates for their achievement shall be used to measure progress towards addressing the highest water quality priorities and achieving applicable water quality-based effluent limitations and/or receiving water limitations.

i. Schedules must be adequate for measuring progress on a watershed scale once every two years.

ii. Schedules must be developed for both the strategies, control measures and BMPs implemented by each Permittee within its jurisdiction and for those that will be implemented by multiple Permittees on a watershed scale.

iii. Schedules shall incorporate the following:

(1) Compliance deadlines occurring within the permit term for all applicable interim and/or final water quality-based effluent limitations and/or receiving water limitations in Part VI.E and Attachments L through R of this Order,

(2) Interim milestones and dates for their achievement within the permit term for any applicable final water quality-based effluent limitation and/or receiving water limitation in Part VI.E and Attachments L through R, where deadlines within the permit term are not otherwise specified.

(3) For watershed priorities related to addressing exceedances of receiving water limitations in Part V.A and not otherwise addressed by Part VI.E:

(a) Milestones based on measureable criteria or indicators, to be achieved in the receiving waters and/or MS4 discharges,

(a) A schedule with dates for achieving the milestones, and

(b) A final date for achieving the receiving water limitations as soon as possible.

(c) The milestones and implementation schedule in (a)-(c) fulfill the requirements in Part V.A.3.a to prepare an Integrated Monitoring Compliance Report.

6. Watershed Management Program Implementation

Each Permittee shall begin implementing the Watershed Management Program or EWMP immediately upon approval of the plan by the Regional Water Board or the Executive Officer on behalf of the Regional Water Board.

a. Permittees may request an extension of deadlines for achievement of interim milestones established pursuant to Part VI.C.4.c.iii.(3) only. Permittees shall provide requests in writing at least 90 days prior to the deadline and shall include in the request the justification for the extension. Extensions shall be subject to approval by the Regional Water Board Executive Officer.

7. Integrated Watershed Monitoring and Assessment

Permittees in each WMA shall develop an integrated monitoring program as set forth in Part IV of the MRP (Attachment E) or implement a customized monitoring program with the primary objective of allowing for the customization of the outfall monitoring program (Parts VIII and IX) in conjunction with an approved Watershed Management Program or EWMP, as defined below. Each monitoring program shall assess progress toward achieving the water quality-based effluent limitations and/or receiving water limitations per the compliance schedules, and progress toward addressing the water quality priorities for each WMA. The customized monitoring program shall be submitted as part of the Watershed Management Program, or where Permittees elect to develop an EWMP, shall be submitted within 18 months of the effective date of this Order. If pursuing a customized monitoring program, the Permittee(s) shall provide sufficient justification for each element of the program that differs from the monitoring program requirements as set forth in Attachment E. Monitoring programs shall be subject to approval by the Executive Officer following a public comment period. The customized monitoring program shall be designed to address the Primary Objectives detailed in Attachment E, Part II.A and shall include the following program elements:

- Receiving Water Monitoring
- Storm Water Outfall Monitoring
- Non-Storm Water Outfall Monitoring
- New Development/Re-Development Effectiveness Tracking
- Regional Studies

8. Adaptive Management Process

a. Watershed Management Program Adaptive Management Process

i. Permittees in each WMA shall implement an adaptive management process, every two years from the date of program approval, adapting the Watershed Management Program or EWMP to become more effective, based on, but not limited to a consideration of the following:

(1) Progress toward achieving interim and/or final water quality-based effluent limitations and/or receiving water limitations in Part VI.E and Attachments L through R, according to established compliance schedules;

(2) Progress toward achieving improved water quality in MS4 discharges and achieving receiving water limitations through implementation of the watershed control measures based on an evaluation of outfall-based monitoring data and receiving water monitoring data;

(3) Achievement of interim milestones;

(4) Re-evaluation of the water quality priorities identified for the WMA based on more recent water quality data for discharges from the MS4 and the receiving water(s) and a reassessment of sources of pollutants in MS4 discharges;

(5) Availability of new information and data from sources other than the Permittees' monitoring program(s) within the WMA that informs the effectiveness of the actions implemented by the Permittees;

(6) Regional Water Board recommendations; and

(7) Recommendations for modifications to the Watershed Management Program solicited through a public participation process.

ii. Based on the results of the adaptive management process, Permittees shall report any modifications, including where appropriate new compliance deadlines and interim milestones, with the exception of those compliance deadlines established in a TMDL, necessary to improve the effectiveness of the Watershed Management Program or EWMP in the Annual Report, as required pursuant to Part XVIII.A.6 of the MRP (Attachment E), and as part of the Report of Waste Discharge (ROWD) required pursuant to Part II.B of Attachment D – Standard Provisions.

(1) The adaptive management process fulfills the requirements in Part V.A.4 to address continuing exceedances of receiving water limitations.

iii. Permittees shall implement any modifications to the Watershed Management Program or EWMP upon approval by the Regional Water Board Executive Officer or within 60 days of submittal if the Regional Water Board Executive Officer expresses no objections.

D. Storm Water Management Program Minimum Control Measures

1. General Requirements

a. Each Permittee shall implement the requirements in Parts VI.D.4 through VI.D.10 below, or may in lieu of the requirements in Parts VI.D.4 through VI.D.10 implement customized actions within each of these general categories of control measures as set forth in an approved Watershed Management Program per Part VI.C. Implementation shall be consistent with the requirements of 40 CFR § 122.26(d)(2)(iv).

b. Timelines for Implementation

i. Unless otherwise noted in Part VI.D, each Permittee that does not elect to develop a Watershed Management Program or EWMP per Part VI.C shall implement the requirements contained in Part VI.D within 6 months after the effective date of this Order. In the interim, a Permittee shall continue to implement its existing storm water management program, including actions within each of the six categories of minimum control measures consistent with 40 CFR section 122.26(d)(2)(iv).

ii. Permittees that elect to develop a Watershed Management Program or EWMP shall continue to implement their existing storm water management programs, including actions within each of the six categories of minimum control measures consistent with 40 CFR section 122.26(d)(2)(iv) until the Watershed Management Program or EWMP is approved by the Regional Water Board Executive Officer.

2. Progressive Enforcement and Interagency Coordination

a. Each Permittee shall develop and implement a Progressive Enforcement Policy to ensure that (1) regulated Industrial/Commercial facilities, (2) construction sites, (3) development and redevelopment sites with post-construction controls, and (4) illicit discharges are each brought into compliance with all storm water and non-storm water requirements within a reasonable time period as specified below.

i. Follow-up Inspections

In the event that a Permittee determines, based on an inspection or illicit discharge investigation conducted, that a facility or site operator has failed to adequately implement all necessary BMPs, that Permittee shall take progressive enforcement actions which, at a minimum, shall include a follow-up inspection within 4 weeks from the date of the initial inspection and/or investigation.

ii. Enforcement Action

In the event that a Permittee determines that a facility or site operator has failed to adequately implement BMPs after a follow-up inspection, that Permittee shall take enforcement action as established through authority in its municipal code and ordinances, through the judicial system, or refer the case to the Regional Water Board, per the Interagency Coordination provisions below.

iii. Records Retention

Each Permittee shall maintain records, per their existing record retention policies, and make them available on request to the Regional Water Board, including inspection reports, warning letters, notices of violations, and other enforcement records, demonstrating a good faith effort to bring facilities into compliance.

iv. Referral of Violations of Municipal Ordinances and California Water Code § 13260

A Permittee may refer a violation(s) of its municipal storm water ordinances and/or California Water Code section 13260 by Industrial and Commercial facilities and construction site operators to the Regional Water Board provided that the Permittee has made a good faith effort of applying its Progressive Enforcement Policy to achieve compliance with its own ordinances. At a minimum, a Permittee's good faith effort must be documented with:

(1) Two follow-up inspections, and

(2) Two warning letters or notices of violation.

v. Referral of Violations of the Industrial and Construction General Permits, including Requirements to File a Notice of Intent or No Exposure Certification

For those facilities or site operators in violation of municipal storm water ordinances and subject to the Industrial and/or Construction General Permits, Permittees may escalate referral of such violations to the Regional Water Board (promptly via telephone or electronically) after one inspection and one written notice of violation (copied to the Regional Water Board) to the facility or site operator regarding the violation. In making such referrals, Permittees shall include, at a minimum, the following documentation:

(1) Name of the facility or site,

(2) Operator of the facility or site,

(3) Owner of the facility or site,

(4) WDID Number (if applicable),

(5) Records of communication with the facility/site operator regarding the violation, which shall include at least one inspection report,

(6) The written notice of violation (copied to the Regional Water Board),

(7) For industrial sites, the industrial activity being conducted at the facility that is subject to the Industrial General Permit, and

(8) For construction sites, site acreage and Risk Factor rating.

b. Investigation of Complaints Transmitted by the Regional Water Board Staff

Each Permittee shall initiate, within one business day,[22] investigation of complaints from facilities within its jurisdiction. The initial investigation shall include, at a minimum, a limited inspection of the facility to confirm validity of the complaint and to determine if the facility is in compliance with municipal storm water ordinances and, if necessary, to oversee corrective action.

c. Assistance with Regional Water Board Enforcement Actions

As directed by the Regional Water Board Executive Officer, Permittees shall assist Regional Water Board enforcement actions by:

i. Assisting in identification of current owners, operators, and lessees of properties and sites.

[22] Permittees may comply with the Permit by taking initial steps (such as logging, prioritizing, and tasking) to "initiate" the investigation within that one business day. However, the Regional Water Board would expect that the initial investigation, including a site visit, to occur within four business days.

ii. Providing staff, when available, for joint inspections with Regional Water Board inspectors.

iii. Appearing to testify as witnesses in Regional Water Board enforcement hearings.

iv. Providing copies of inspection reports and documentation demonstrating application of its Progressive Enforcement Policy.

3. Modifications/Revisions

a. Each Permittee shall modify its storm water management programs, protocols, practices, and municipal codes to make them consistent with the requirements in this Order.

4. Requirements Applicable to the Los Angeles County Flood Control District

a. Public Information and Participation Program (PIPP)

i. General

(1) The LACFCD shall participate in a regional Public Information and Participation Program (PIPP) or alternatively, shall implement its own PIPP that includes the requirements listed in this part. The LACFCD shall collaborate, as necessary, with other Permittees to implement PIPP requirements. The objectives of the PIPP are as follows:

(a) To measurably increase the knowledge of the target audience about the MS4, the adverse impacts of storm water pollution on receiving waters and potential solutions to mitigate the impacts.

(b) To measurably change the waste disposal and storm water pollution generation behavior of target audiences by encouraging the implementation of appropriate alternatives by providing information to the public.

(c) To involve and engage a diversity of socio-economic groups and ethnic communities in Los Angeles County to participate in mitigating the impacts of stormwater pollution.

ii. PIPP Implementation

(1) The LACFCD shall implement the PIPP requirements listed in this Part VI.D.5 using one or more of the following approaches:

(a) By participating in a collaborative PIPP covering the entire service area of the Los Angeles County Flood Control District,

(b) By participating in one or more Watershed Group sponsored PIPPs, and/or

(c) Individually within the service area of the Los Angeles County Flood Control District.

(2) If the LACFCD participates in a collaborative District-wide or Watershed Group PIPP, the LACFCD shall provide the contact information for their appropriate staff responsible for storm water public education activities to the designated PIPP coordinator and contact information changes no later than 30 days after a change occurs.

iii. Public Participation

(1) The LACFCD, in collaboration with the County of Los Angeles, shall continue to maintain the countywide hotline (888-CLEAN-LA) for public reporting of clogged catch basin inlets and illicit discharges/dumping, faded or missing catch basin labels, and general storm water management information.

(a) The LACFCD shall include the reporting information, updated when necessary, in public information, and the government pages of the telephone book, as they are developed or published.

(b) The LACFCD, in collaboration with the County of Los Angeles, shall continue to maintain the www.888cleanla.com website.

iv. Residential Outreach Program

(1) Working in conjunction with a District-wide or Watershed Group sponsored PIPP or individually, the LACFCD shall implement the following activities:

(a) Conduct storm water pollution prevention public service announcements and advertising campaigns

(b) Facilitate the dissemination of public education materials including, at a minimum, information on the proper handling (i.e., disposal, storage and/or use) of:

(i) Vehicle waste fluids

(ii) Household waste materials (i.e., trash and household hazardous waste)

(iii) Construction waste materials

(iv) Pesticides and fertilizers (including integrated pest management practices [IPM] to promote reduced use of pesticides),

(v) Green waste (including lawn clippings and leaves)

(vi) Animal wastes

(c) Facilitate the dissemination of activity-specific storm water pollution prevention public education materials, at a minimum, for the following points of purchase:

(i) Automotive parts stores

(ii) Home improvement centers / lumber yards / hardware stores / paint stores

(iii) Landscaping / gardening centers

(iv) Pet shops / feed stores

(d) Maintain a storm water website, which shall include educational material and opportunities for the public to participate in storm water pollution prevention and clean-up activities listed in Part VI.D.5.

(e) When implementing activities in (a)-(d), the LACFCD shall use effective strategies to educate and involve ethnic communities in storm water pollution prevention through culturally effective methods.

b. Industrial/Commercial Facilities Program

If the LACFCD operates, or has authority over, any facility(ies) identified in Part VI.D.6.b, LACFCD shall comply with the requirements in Part VI.D.6 for those facilities.

c. Public Agency Activities Program

i. General

(1) The LACFCD shall implement a Public Agency Activities Program to minimize storm water pollution impacts from LACFCD-owned or operated facilities and activities. Requirements for Public Agency Facilities and Activities consist of the following components:

(a) Public Construction Activities Management.

(b) Public Facility Inventory

(c) Public Facility and Activity Management

(d) Vehicle and Equipment Washing

(e) Landscape and Recreational Facilities Management

(f) Storm Drain Operation and Maintenance

(g) Parking Facilities Management

(h) Emergency Procedures

(i) Employee and Contractor Training

ii. Public Construction Activities Management

(1) The LACFCD shall implement and comply with the Planning and Land Development Program requirements in Part VI.D.7 of this Order at LACFCD-owned or operated public construction projects that are categorized under the project types identified in Part VI.D.7 of this Order.

(2) The LACFCD shall implement and comply with the appropriate Development Construction Program requirements in Part VI.D.8 of this Order at LACFCD-owned or operated construction projects as applicable.

(3) For LACFCD-owned or operated projects that disturb less than one acre of soil, the LACFCD shall require the implementation of an effective combination of erosion and sediment control BMPs from Table 13 (see Construction Development Program).

(4) The LACFCD shall obtain separate coverage under the Construction General Permit for all LACFCD-owned or operated construction sites that require coverage.

iii. Public Facility Inventory

(1) The LACFCD shall maintain an updated watershed-based inventory and map of all LACFCD-owned or operated facilities that are potential sources of storm water pollution. The incorporation of facility information into a GIS is recommended. Sources to be tracked include but are not limited to the following:

(a) Chemical storage facilities

(b) Equipment storage and maintenance facilities (including landscape maintenance-related operations)

(c) Fueling or fuel storage facilities

(d) Materials storage yards

(e) Pesticide storage facilities

(f) LACFCD buildings

(g) LACFCD vehicle storage and maintenance yards

(h) All other LACFCD-owned or operated facilities or activities that the LACFCD determines may contribute a substantial pollutant load to the MS4.

(2) The LACFCD shall include the following minimum fields of information for each LACFCD-owned or operated facility in its watershed-based inventory and map.

(a) Name of facility

(b) Name of facility manager and contact information

(c) Address of facility (physical and mailing)

(d) A narrative description of activities performed and principal products used at each facility and status of exposure to storm water.

(e) Coverage under the Industrial General Permit or other individual or general NPDES permits or any applicable waiver issued by the Regional or State Water Board pertaining to storm water discharges.

(3) The LACFCD shall update its inventory and map once during the Permit term. The update shall be accomplished through a collection of new information obtained through field activities.

iv. Public Agency Facility and Activity Management

(1) The LACFCD shall obtain separate coverage under the Industrial General Permit for all LACFCD-owned or operated facilities where industrial activities are conducted that require coverage under the Industrial General Permit.

(2) The LACFCD shall implement the following measures for flood management projects:

(a) Develop procedures to assess the impacts of flood management projects on the water quality of receiving waterbodies; and

(b) Evaluate existing structural flood control facilities during the planning phases of major maintenance or rehabilitation projects to determine if retrofitting the facility to provide additional pollutant removal from storm water is feasible.

(3) The LACFCD shall implement and maintain the general and activity-specific BMPs listed in Table 18 (BMPs for Public Agency Facilities and Activities) or an equivalent set of BMPs when such activities occur at LACFCD-owned or operated facilities and field activities (e.g., project sites) including but not limited to the facility types listed in Part VI.D.9.c above, and at any area that includes the activities described in Table 18, or that have the potential to discharge pollutants in storm water.

(4) Any contractors hired by the LACFCD to conduct Public Agency Activities shall be contractually required to implement and maintain the general and activity specific BMPs listed in Table 18 or an equivalent set of BMPs. The LACFCD shall conduct oversight of contractor activities to ensure these BMPs are implemented and maintained.

(5) Effective source control BMPs for the activities listed in Table 18 shall be implemented at LACFCD-owned or operated facilities, unless the pollutant generating activity does not occur. The LACFCD shall require implementation of additional BMPs where storm water from the MS4 discharges to a significant ecological area (SEA, see Attachment A for definition), a water body subject to TMDL Provisions in Part VI.E, or a CWA section 303(d) listed water body (see Part VI.E below). Likewise, for those BMPs that are not adequately protective of water quality standards, the LACFCD shall implement additional site-specific controls.

v. Vehicle and Equipment Washing

(1) The LACFCD shall implement and maintain the activity specific BMPs listed in Table 18 (BMPs for Public Agency Facilities and Activities) or an equivalent set of BMPs for all fixed vehicle and equipment washing areas;

(2) The LACFCD shall prevent discharges of wash waters from vehicle and equipment washing to the MS4 by implementing any of the following measures at existing facilities with vehicle or equipment wash areas:

(a) Self-contain, and haul off for disposal; or

(b) Equip with a clarifier or an alternative pre-treatment device and plumb to the sanitary sewer in accordance with applicable waste water provider regulations

(3) The LACFCD shall ensure that any LACFCD facilities constructed, redeveloped, or replaced shall not discharge wastewater from vehicle and equipment wash areas to the MS4 by plumbing all areas to the sanitary sewer in accordance with applicable waste water provider regulations, or self-containing all waste water/ wash water and hauling to a point of legal disposal.

vi. Landscape and Recreational Facilities Management

(1) The LACFCD shall implement and maintain the activity specific BMPs listed in Table 18 (BMPs for Public Agency Facilities and Activities) or an equivalent set of BMPs for all its public right-of-ways, flood control facilities and open channels and reservoirs, and landscape and recreational facilities and activities.

(2) The LACFCD shall implement an IPM program that includes the following:

(a) Pesticides are used only if monitoring indicates they are needed, and pesticides are applied according to applicable permits and established guidelines.

(b) Treatments are made with the goal of removing only the target organism.

(c) Pest controls are selected and applied in a manner that minimizes risks to human health, beneficial non-target organisms, and the environment.

(d) The use of pesticides, including Organophosphates and Pyrethroids, does not threaten water quality.

(e) Partner, as appropriate, with other agencies and organizations to encourage the use of IPM.

(f) Adopt and verifiably implement policies, procedures, and/ or ordinances requiring the minimization of pesticide use and encouraging the use of IPM techniques (including beneficial insects) for Public Agency Facilities and Activities.

(g) Policies, procedures, and ordinances shall include a schedule to reduce the use of pesticides that cause impairment of surface waters by implementing the following procedures:

(i) Prepare and annually update an inventory of pesticides used by all internal departments, divisions, and other operational units.

(ii) Quantify pesticide use by staff and hired contractors.

(iii) Demonstrate implementation of IPM alternatives where feasible to reduce pesticide use.

(3) The LACFCD shall implement the following requirements:

(a) Use a standardized protocol for the routine and non-routine application of pesticides (including pre-emergents), and fertilizers.

(b) Ensure there is no application of pesticides or fertilizers (1) when two or more consecutive days with greater than 50% chance of rainfall are predicted by NOAA, (2) within 48 hours of a ½-inch rain event, or (3) when water is flowing off the area where the application is to occur. This requirement does not apply to the application of aquatic pesticides or pesticides which require water for activation.

(c) Ensure that no banned or unregistered pesticides are stored or applied.

(d) Ensure that all staff applying pesticides are certified in the appropriate category by the California Department of Pesticide Regulation, or are under the direct supervision of a pesticide applicator certified in the appropriate category.

(e) Implement procedures to encourage the retention and planting of native vegetation to reduce water, pesticide and fertilizer needs; and

(f) Store pesticides and fertilizers indoors or under cover on paved surfaces, or use secondary containment.

(i) Reduce the use, storage, and handling of hazardous materials to reduce the potential for spills.

(ii) Regularly inspect storage areas.

vii. Storm Drain Operation and Management

(1) The LACFCD shall implement and maintain the activity specific BMPs listed in Table 18 or equivalent set of BMPs for storm drain operation and maintenance.

(2) Ensure that all the material removed from the MS4 does not reenter the system. Solid material shall be dewatered in a contained area and liquid material shall be disposed in accordance with any of the following measures:

(a) Self-contain, and haul off for legal disposal; or

(b) Equip with a clarifier or an alternative pre-treatment device; and plumb to the sanitary sewer in accordance with applicable waste water provider regulations.

(3) Catch Basin Cleaning

(a) In areas that are not subject to a trash TMDL, the LACFCD shall determine priority areas and shall update its map or list of catch basins with their GPS coordinates and priority:

<u>Priority A</u>: Catch basins that are designated as consistently generating the highest volumes of trash and/or debris.

<u>Priority B</u>: Catch basins that are designated as consistently generating moderate volumes of trash and/or debris.

<u>Priority C</u>: Catch basins that are designated as generating low volumes of trash and/or debris.

The map or list shall contain the rationale or data to support priority designations.

(b) In areas not subject to a trash TMDL, the LACFCD shall inspect its catch basins according to the following schedule:

<u>Priority A</u>: A minimum of 3 times during the wet season (October 1 through April 15) and once during the dry season every year.

<u>Priority B</u>: A minimum of once during the wet season and once during the dry season every year.

<u>Priority C</u>: A minimum of once per year.

Catch basins shall be cleaned as necessary on the basis of inspections. At a minimum, LACFCD shall ensure that any catch basin that is determined to be at least 25% full of trash shall be cleaned out. LACFCD shall maintain inspection and cleaning records for Regional Water Board review.

(c) In areas that are subject to a trash TMDL, the subject Permittees shall implement the applicable provisions in Part VI.E.

(4) Catch Basin Labels and Open Channel Signage

(a) LACFCD shall label all catch basin inlets that they own with a legible "no dumping" message.

(b) The LACFCD shall inspect the legibility of the catch basin stencil or label nearest the inlet prior to the wet season every year.

(c) The LACFCD shall record all catch basins with illegible stencils and re-stencil or re-label within 180 days of inspection.

(d) The LACFCD shall post signs, referencing local code(s) that prohibit littering and illegal dumping, at designated public access points to open channels, creeks, urban lakes, and other relevant waterbodies.

(5) Open Channel Maintenance

The LACFCD shall implement a program for Open Channel Maintenance that includes the following:

(a) Visual monitoring of LACFCD owned open channels and other drainage structures for trash and debris at least annually;

(b) Removal of trash and debris from open channels a minimum of once per year before the wet season;

(c) Elimination of the discharge of contaminants produced by storm drain maintenance and clean outs; and

(d) Proper disposal of debris and trash removed during open channel maintenance.

(6) Infiltration from Sanitary Sewer to MS4/Preventive Maintenance

(a) The LACFCD shall implement controls and measures to prevent and eliminate infiltration of seepage from sanitary sewers to its MS4 thorough routine preventive maintenance of its MS4.

(b) The LACFCD shall implement controls to limit infiltration of seepage from sanitary sewers to its MS4 where necessary. Such controls must include:

(i) Adequate plan checking for construction and new development;

(ii) Incident response training for its employees that identify sanitary sewer spills;

(iii) Code enforcement inspections;

(iv) MS4 maintenance and inspections;

(v) Interagency coordination with sewer agencies; and

(vi) Proper education of its staff and contractors conducting field operations on its MS4.

(7) LACFCD-Owned Treatment Control BMPs

(a) The LACFCD shall implement an inspection and maintenance program for all LACFCD-owned treatment control BMPs, including post-construction treatment control BMPs.

(b) The LACFCD shall ensure proper operation of all its treatment control BMPs and maintain them as necessary for proper operation, including all post-construction treatment control BMPs.

(c) Any residual water produced by a treatment control BMP and not being internal to the BMP performance when being maintained shall be:

(i) Hauled away and legally disposed of; or

(ii) Applied to the land without runoff; or

(iii) Discharged to the sanitary sewer system (with permits or authorization); or

(iv) Treated or filtered to remove bacteria, sediments, nutrients, and meet the limitations set in Table 19 (Discharge Limitations for Dewatering Treatment BMPs), prior to discharge to the MS4.

viii. Parking Facilities Management

LACFCD-owned parking lots exposed to storm water shall be kept clear of debris and excessive oil buildup and cleaned no less than 2 times per month and/or inspected no less than 2 times per month to determine if cleaning is necessary. In no case shall a LACFCD-owned parking lot be cleaned less than once a month.

ix. Emergency Procedures

The LACFCD may conduct repairs and rehabilitation of essential public service systems and infrastructure in emergency situations with a self-waiver of the provisions of this Order as follows:

(1) The LACFCD shall abide by all other regulatory requirements, including notification to other agencies as appropriate.

(2) Where the self-waiver has been invoked, the LACFCD shall notify the Regional Water Board Executive Officer of the occurrence of the emergency no later than 30 business days after the situation of emergency has passed.

(3) Minor repairs of essential public service systems and infrastructure in emergency situations (that can be completed in less than one week) are not subject to the notification provisions. Appropriate BMPs to reduce the threat to water quality shall be implemented.

x. Employee and Contractor Training

(1) The LACFCD shall, no later than one year after Order adoption and annually thereafter before June 30, train all of their employees and contractors in targeted positions (whose interactions, jobs, and activities affect storm water quality) on the requirements of the overall storm water management program to:

(a) Promote a clear understanding of the potential for activities to pollute storm water.

(b) Identify opportunities to require, implement, and maintain appropriate BMPs in their line of work.

(2) The LACFCD shall, no later than one year after Order adoption and annually thereafter before June 30, train all of their employees and contractors who use or have the potential to use pesticides or fertilizers (whether or not they normally apply these as part of their work). Outside contractors can self-certify, providing they certify they have received all applicable training required in the Order and have documentation to that effect. Training programs shall address:

(a) The potential for pesticide-related surface water toxicity.

(b) Proper use, handling, and disposal of pesticides.

(c) Least toxic methods of pest prevention and control, including IPM.

(d) Reduction of pesticide use.

(3) The LACFCD shall require appropriate training of contractor employees in targeted positions as described above.

d. Illicit Connections and Illicit Discharge Elimination Program

i. General

(1) The LACFCD shall continue to implement an Illicit Connection and Illicit Discharge (IC/ID) Program to detect, investigate, and eliminate IC/IDs to its MS4. The IC/ID Program must be implemented in accordance with the requirements and performance measures specified in the following subsections.

(2) As stated in Part VI.A.2 of this Order, each Permittee must have adequate legal authority to prohibit IC/IDs to the MS4 and enable enforcement capabilities to eliminate the source of IC/IDs.

(3) The LACFCD's IC/ID Program shall consist of at least the following major program components:

(a) An up-to-date map of LACFCD's MS4

(b) Procedures for conducting source investigations for IC/IDs

(c) Procedures for eliminating the source of IC/IDs

(d) Procedures for public reporting of illicit discharges

(e) Spill response plan

(f) IC/IDs education and training for LACFCD staff

ii. MS4 Mapping

(1) The LACFCD shall maintain an up-to-date and accurate electronic map of its MS4. If possible, the map should be maintained within a GIS. The map must show the following, at a minimum:

(a) Within one year of Permit adoption, the location of outfalls owned and maintained by the LACFCD. Each outfall shall be given an alphanumeric identifier, which must be noted on the map. Each mapped outfall shall be located using a geographic positioning system (GPS). Photographs of the major outfalls shall be taken to provide baseline information to track operation and maintenance needs over time.

(b) The location and length of open channels and underground storm drain pipes with a diameter of 36 inches or greater that are owned and operated by the LACFCD.

(c) The location and name of all waterbodies receiving discharges from those MS4 major outfalls identified in (a).

(d) All LACFCD's dry weather diversions installed within the MS4 to direct flows from the MS4 to the sanitary sewer system, including the owner and operator of each diversion.

(e) By the end of the Permit term, map all known permitted and documented connections to its MS4 system.

(2) The MS4 map shall be updated as necessary.

iii. Illicit Discharge Source Investigation and Elimination

(1) The LACFCD shall develop written procedures for conducting investigations to prioritize and identify the source of all illicit discharges to its MS4, including procedures to eliminate the discharge once the source is located.

(2) At a minimum, the LACFCD shall initiate[23] an investigation(s) to identify and locate the source within one business day of becoming aware of the illicit discharge.

(3) When conducting investigations, the LACFCD shall comply with the following:

(a) Illicit discharges suspected of being sanitary sewage and/or significantly contaminated shall be investigated first.

(b) The LACFCD shall track all investigations to document, at a minimum, the date(s) the illicit discharge was observed; the results

[23] Permittees may comply with the Permit by taking initial steps (such as logging, prioritizing, and tasking) to "initiate" the investigation within one business day. However, the Regional Water Board would expect that the initial investigation, including a site visit, occur within two business days of becoming aware of the illicit discharge.

of the investigation; any follow-up of the investigation; and the date the investigation was closed.

(c) The LACFCD shall prioritize and investigate the source of all observed illicit discharges to its MS4.

(d) If the source of the illicit discharge is found to be a discharge authorized under an NPDES permit, the LACFCD shall document the source and report to the Regional Water Board within 30 days of determination. No further action is required.

(e) If the source of the illicit discharge has been determined to originate from within the jurisdiction of other Permittee(s) with land use authority over the suspected responsible party/parties, the LACFCD shall immediately alert the appropriate Permittee(s) of the problem for further action by the Permittee(s).

(4) When taking corrective action to eliminate illicit discharges, the LACFCD shall comply with the following:

(a) If the source of the illicit discharge has been determined or suspected by the LACFCD to originate within an upstream jurisdiction(s), the LACFCD shall immediately notify the upstream jurisdiction(s), and notify the Regional Water Board within 30 days of such determination and provide all the information collected and efforts taken.

(b) Once the Permittee with land use authority over the suspected responsible party/parties has been alerted, the LACFCD may continue to work in cooperation with the Permittee(s) to notify the responsible party/parties of the problem, and require the responsible party/parties to immediately initiate necessary corrective actions to eliminate the illicit discharge. Upon being notified that the discharge has been eliminated, the LACFCD may, in conjunction with the Permittee(s) conduct a follow-up investigation to verify that the discharge has been eliminated and cleaned up to the satisfaction of the LACFCD. The LACFCD shall document its follow-up investigation. The LACFCD may seek recovery and remediation costs from responsible parties or require compensation for the cost of all inspection and investigation activities. Resulting enforcement actions shall follow the program's Progressive Enforcement Policy.

(c) If the source of the illicit discharge cannot be traced to a suspected responsible party, the LACFCD, in conjunction with other affected Permittees, shall continue implementing the illicit discharge/spill response plan.

(5) In the event the LACFCD and/or other Permittees are unable to eliminate an ongoing illicit discharge following full execution of its legal authority and in accordance with its Progressive Enforcement Policy, including the inability to find the responsible party/parties, or other circumstances prevent the full elimination of an ongoing illicit discharge, the LACFCD and/or other Permittees shall notify the Regional Water Board within 30 days of such determination and provide available information to the Regional Water Board.

iv. Identification and Response to Illicit Connections

(1) Investigation

The LACFCD, upon discovery or upon receiving a report of a suspected illicit connection, shall initiate an investigation within 21 days, to determine the following: (1) source of the connection, (2) nature and volume of discharge through the connection, and (3) responsible party for the connection.

(2) Elimination

The LACFCD, upon confirmation of an illicit connection to its MS4, shall ensure that the connection is:

(a) Permitted or documented, provided the connection will only discharge storm water and non-storm water allowable under this Order or other individual or general NPDES Permits/WDRs, or

(b) Eliminated within 180 days of completion of the investigation, using its formal enforcement authority, if necessary, to eliminate the illicit connection.

(3) Documentation

Formal records must be maintained for all illicit connection investigations and the formal enforcement taken to eliminate illicit connections.

v. Public Reporting of Non-Stormwater Discharges and Spills

(1) The LACFCD shall, in collaboration with the County, continue to maintain the 888-CLEAN-LA hotline and corresponding internet site at www.888cleanla.org to promote, publicize, and facilitate public reporting of illicit discharges or water quality impacts associated with discharges into or from MS4s.

(2) The LACFCD shall include information regarding public reporting of illicit discharges or improper disposal on the signage adjacent to open channels as required in Part VI.D.9.h.vi.(4).

(3) The LACFCD shall develop and maintain written procedures that document how complaint calls and internet submissions are received, documented, and tracked to ensure that all complaints are adequately addressed. The procedures shall be evaluated annually to determine whether changes or updates are needed to ensure that the procedures accurately document the methods employed by the LACFCD. Any identified changes shall be made to the procedures subsequent to the annual evaluation.

(4) The LACFCD shall maintain documentation of the complaint calls and internet submissions and record the location of the reported spill or IC/ID and the actions undertaken, including referrals to other agencies, in response to all IC/ID complaints.

vi. Illicit Discharge and Spill Response Plan

(1) The LACFCD shall implement an ID and spill response plan for all spills that may discharge into its system. The ID and spill response plan shall clearly identify agencies responsible for ID and spill response and cleanup, contact information, and shall contain at a minimum the following requirements:

(a) Coordination with spill response teams throughout all appropriate departments, programs and agencies so that maximum water quality protection is provided.

(b) Initiation of investigation of all public and employee ID and spill complaints within one business day of receiving the complaint to assess validity.

(c) Response to ID and spills within 4 hours of becoming aware of the ID or spill, except where such IDs or spills occur on private property, in which case the response should be within 2 hours of gaining legal access to the property.

(d) IDs or spills that may endanger health or the environment shall be reported to appropriate public health agencies and the Office of Emergency Services (OES).

vii. Illicit Connection and Illicit Discharge Education and Training

(1) The LACFCD must continue to implement a training program regarding the identification of IC/IDs for all LACFCD field staff, who, as part of their normal job responsibilities (e.g., storm drain inspection and maintenance), may come into contact with or otherwise observe an illicit discharge or illicit connection to its MS4. Contact information, including the procedure for reporting an illicit discharge, must be included in the LACFCD's fleet vehicles that are used by field staff. Training program documents must be available for review by the Regional Water Board.

(2) The LACFCD's training program should address, at a minimum, the following:

(a) IC/ID identification, including definitions and examples,

(b) investigation,

(c) elimination,

(d) cleanup,

(e) reporting, and

(f) documentation.

(3) The LACFCD must create a list of applicable positions which require IC/ID training and ensure that training is provided at least twice during the term of this Order. The LACFCD must maintain documentation of the training activities.

(4) New LACFCD staff members must be provided with IC/ID training within 180 days of starting employment.

(5) The LACFCD shall require its contractors to train their employees in targeted positions as described above.

5. Public Information and Participation Program

a. General

i. Each Permittee shall implement a Public Information and Participation Program (PIPP) that includes the requirements listed in this Part VI.D.5. Each Permittee shall be responsible for developing and implementing the PIPP and implementing specific PIPP requirements. The objectives of the PIPP are as follows:

(1) To measurably increase the knowledge of the target audiences about the MS4, the adverse impacts of storm water pollution on receiving waters and potential solutions to mitigate the impacts.

(2) To measurably change the waste disposal and storm water pollution generation behavior of target audiences by developing and encouraging the implementation of appropriate alternatives.

(3) To involve and engage a diversity of socio-economic groups and ethnic communities in Los Angeles County to participate in mitigating the impacts of storm water pollution.

b. PIPP Implementation

i. Each Permittee shall implement the PIPP requirements listed in this Part VI.D.4 using one or more of the following approaches:

(1) By participating in a County-wide PIPP,

(2) By participating in one or more Watershed Group sponsored PIPPs, and/or

(3) Or individually within its jurisdiction.

ii. If a Permittee participates in a County-wide or Watershed Group PIPP, the Permittee shall provide the contact information for their appropriate staff responsible for storm water public education activities to the designated PIPP coordinator and contact information changes no later than 30 days after a change occurs.

c. Public Participation

i. Each Permittee, whether participating in a County-wide or Watershed Group sponsored PIPP, or acting individually, shall provide a means for public reporting of clogged catch basin inlets and illicit discharges/dumping, faded or missing catch basin labels, and general storm water and non-storm water pollution prevention information.

(1) Permittees may elect to use the 888-CLEAN-LA hotline as the general public reporting contact or each Permittee or Watershed Group may establish its own hotline, if preferred.

(2) Each Permittee shall include the reporting information, updated when necessary, in public information, and the government pages of the telephone book, as they are developed or published.

(3) Each Permittee shall identify staff or departments who will serve as the contact person(s) and shall make this information available on its website.

(4) Each Permittee is responsible for providing current, updated hotline contact information to the general public within its jurisdiction.

ii. Organize events targeted to residents and population subgroups to educate and involve the community in storm water and non-storm water pollution prevention and clean-up (e.g., education seminars, clean-ups, and community catch basin stenciling).

d. Residential Outreach Program

i. Working in conjunction with a County-wide or Watershed Group sponsored PIPP or individually, each Permittee shall implement the following activities:

(1) Conduct storm water pollution prevention public service announcements and advertising campaigns

(2) Public education materials shall include but are not limited to information on the proper handling (i.e., disposal, storage and/or use) of:

(a) Vehicle waste fluids

(b) Household waste materials (i.e., trash and household hazardous waste, including personal care products and pharmaceuticals)

(c) Construction waste materials

(d) Pesticides and fertilizers (including integrated pest management practices [IPM] to promote reduced use of pesticides)

(e) Green waste (including lawn clippings and leaves)

(f) Animal wastes

(3) Distribute activity specific storm water pollution prevention public education materials at, but not limited to, the following points of purchase:

(a) Automotive parts stores

(b) Home improvement centers / lumber yards / hardware stores/paint stores

(c) Landscaping / gardening centers

(d) Pet shops / feed stores

(4) Maintain storm water websites or provide links to storm water websites via the Permittee's website, which shall include educational material and opportunities for the public to participate in storm water pollution prevention and clean-up activities listed in Part VI.D.4.

(5) Provide independent, parochial, and public schools within in each Permittee's jurisdiction with materials to educate school children (K-12) on storm water pollution. Material may include videos, live presentations, and other information. Permittees are encouraged to work with, or leverage, materials produced by other statewide agencies and associations such as the State Water Board's "Erase the Waste" educational program and the California Environmental Education Interagency Network (CEEIN) to implement this requirement.

(6) When implementing activities in subsections (1)-(5), Permittees shall use effective strategies to educate and involve ethnic communities in storm water pollution prevention through culturally effective methods.

6. Industrial/Commercial Facilities Program

a. General

i. Each Permittee shall implement an Industrial / Commercial Facilities Program that meets the requirements of this Part VI.D.6. The Industrial / Commercial

Facilities Program shall be designed to prevent illicit discharges into the MS4 and receiving waters, reduce industrial / commercial discharges of storm water to the maximum extent practicable, and prevent industrial / commercial discharges from the MS4 from causing or contributing to a violation of receiving water limitations. At a minimum, the Industrial / Commercial Facilities Program shall be implemented in accordance with the requirements listed in this Part VI.D.6, or as approved in a Watershed Management Program per Part VI.C. Minimum program components shall include the following components:

(1) Track

(2) Educate

(3) Inspect

(4) Ensure compliance with municipal ordinances at industrial and commercial facilities that are critical sources of pollutants in storm water

b. Track Critical Industrial / Commercial Sources

i. Each Permittee shall maintain an updated watershed-based inventory or database containing the latitude / longitude coordinates of all industrial and commercial facilities within its jurisdiction that are critical sources of storm water pollution. The inventory or database shall be maintained in electronic format and incorporation of facility information into a Geographical Information System (GIS) is recommended. Critical Sources to be tracked are summarized below:

(1) Commercial Facilities

(a) Restaurants

(b) Automotive service facilities (including those located at automotive dealerships)

(c) Retail Gasoline Outlets

(d) Nurseries and Nursery Centers (Merchant Wholesalers, Nondurable Goods, and Retail Trade)

(2) USEPA "Phase I" Facilities [as specified in 40 CFR §122.26(b)(14)(i)-(xi)]

(3) Other federally-mandated facilities [as specified in 40 CFR §122.26(d)(2)(iv)(C)]

(a) Municipal landfills

(b) Hazardous waste treatment, disposal, and recovery facilities

(c) Industrial facilities subject to section 313 "Toxic Release Inventory" reporting requirements of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) [42 U.S.C. § 11023]

(4) All other commercial or industrial facilities that the Permittee determines may contribute a substantial pollutant load to the MS4.

ii. Each Permittee shall include the following minimum fields of information for each critical source industrial and commercial facility identified in its watershed-based inventory or database:

(1) Name of facility

(2) Name of owner/ operator and contact information

(3) Address of facility (physical and mailing)

(4) North American Industry Classification System (NAICS) code

(5) Standard Industrial Classification (SIC) code

(6) A narrative description of the activities performed and/or principal products produced

(7) Status of exposure of materials to storm water

(8) Name of receiving water

(9) Identification of whether the facility is tributary to a CWA § 303(d) listed water body segment or water body segment subject to a TMDL, where the facility generates pollutants for which the water body segment is impaired.

(10) Ability to denote if the facility is known to maintain coverage under the State Water Board's General NPDES Permit for the Discharge of Stormwater Associated with Industrial Activities (Industrial General Permit) or other individual or general NPDES permits or any applicable waiver issued by the Regional or State Water Board pertaining to storm water discharges.

(11) Ability to denote if the facility has filed a No Exposure Certification with the State Water Board.

iii. Each Permittee shall update its inventory of critical sources at least annually. The update shall be accomplished through collection of new information obtained through field activities or through other readily available inter- and intra-agency informational databases (e.g., business licenses, pretreatment permits, sanitary sewer connection permits, and similar information).

c. Educate Industrial / Commercial Sources

i. At least once during the five-year period of this Order, each Permittee shall notify the owner/operator of each of its inventoried commercial and industrial sites identified in Part VI.D.6.b of the BMP requirements applicable to the site/source.

ii. Business Assistance Program

(1) Each Permittee shall implement a Business Assistance Program to provide technical information to businesses to facilitate their efforts to reduce the discharge of pollutants in storm water. Assistance shall be targeted to select business sectors or small businesses upon a determination that their activities may be contributing substantial pollutant

loads to the MS4 or receiving water. Assistance may include technical guidance and provision of educational materials. The Program may include:

(a) On-site technical assistance, telephone, or e-mail consultation regarding the responsibilities of business to reduce the discharge of pollutants, procedural requirements, and available guidance documents.

(b) Distribution of storm water pollution prevention educational materials to operators of auto repair shops; car wash facilities; restaurants and mobile sources including automobile/equipment repair, washing, or detailing; power washing services; mobile carpet, drape, or upholstery cleaning services; swimming pool, water softener, and spa services; portable sanitary services; and commercial applicators and distributors of pesticides, herbicides and fertilizers, if present.

d. Inspect Critical Commercial Sources

i. Frequency of Mandatory Commercial Facility Inspections

Each Permittee shall inspect all commercial facilities identified in Part VI.D.6.b twice during the 5-year term of the Order, provided that the first mandatory compliance inspection occurs no later than 2 years after the effective date of this Order. A minimum interval of 6 months between the first and the second mandatory compliance inspection is required. In addition, each Permittee shall implement the activities outlined in the following subparts.

ii. Scope of Mandatory Commercial Facility Inspections

Each Permittee shall inspect all commercial facilities to confirm that storm water and non-storm water BMPs are being effectively implemented in compliance with municipal ordinances. At each facility, inspectors shall verify that the operator is implementing effective source control BMPs for each corresponding activity. Each Permittee shall require implementation of additional BMPs where storm water from the MS4 discharges to a significant ecological area (SEA), a water body subject to TMDL provisions in Part VI.E, or a CWA § 303(d) listed impaired water body. Likewise, for those BMPs that are not adequately protective of water quality standards, a Permittee may require additional site-specific controls.

e. Inspect Critical Industrial Sources

Each Permittee shall conduct industrial facility compliance inspections as specified below.

i. Frequency of Mandatory Industrial Facility Compliance Inspections

(1) Minimum Inspection Frequency

Each Permittee shall perform an initial mandatory compliance inspection at all industrial facilities identified in Part VI.D.6.b no later than 2 years after the effective date of this Order. After the initial inspection, all facilities that have not filed a No Exposure Certification with the State Water Board are subject to a second mandatory compliance inspection. A minimum interval of 6 months between the first and the second mandatory compliance inspection is required. A facility need not be inspected more than twice during the term of the Order unless subject to an enforcement action as specified in Part VI.D.6.h below.

(2) Exclusion of Facilities Previously Inspected by the Regional Water Board

Each Permittee shall review the State Water Board's Storm Water Multiple Application and Report Tracking System (SMARTS) database[24] at defined intervals to determine if an industrial facility has recently been inspected by the Regional Water Board. The first interval shall occur approximately 2 years after the effective date of the Order. The Permittee does not need to inspect the facility if it is determined that the Regional Water Board conducted an inspection of the facility within the prior 24 month period. The second interval shall occur approximately 4 years after the effective date of the Order. Likewise, the Permittee does not need to inspect the facility if it is determined that the Regional Water Board conducted an inspection of the facility within the prior 24 month period.

(3) No Exposure Verification

As a component of the first mandatory inspection, each Permittee shall identify those facilities that have filed a No Exposure Certification with the State Water Board. Approximately 3 to 4 years after the effective date of the Order, each Permittee shall evaluate its inventory of industrial facilities and perform a second mandatory compliance inspection at a minimum of 25% of the facilities identified to have filed a No Exposure Certification. The purpose of this inspection is to verify the continuity of the no exposure status.

(4) Exclusion Based on Watershed Management Program

A Permittee is exempt from the mandatory inspection frequencies listed above if it is implementing industrial inspections in accordance with an approved Watershed Management Program per Part VI.C.

ii. Scope of Mandatory Industrial Facility Inspections

Each Permittee shall confirm that each industrial facility:

(1) Has a current Waste Discharge Identification (WDID) number for coverage under the Industrial General Permit, and that a Storm Water Pollution Prevention Plan (SWPPP) is available on-site; *or*

(2) Has applied for, and has received a current No Exposure Certification for facilities subject to this requirement;

(3) Is effectively implementing BMPs in compliance with municipal ordinances. Facilities must implement the source control BMPs identified

[24] SMARTS is accessible at https://smarts.waterboards.ca.gov/smarts/faces/SwSmartsLogin.jsp

in Table 10, unless the pollutant generating activity does not occur. The Permittees shall require implementation of additional BMPs where storm water from the MS4 discharges to a water body subject to TMDL Provisions in Part VI.E, or a CWA § 303(d) listed impaired water body. Likewise, if the specified BMPs are not adequately protective of water quality standards, a Permittee may require additional site-specific controls. For critical sources that discharge to MS4s that discharge to SEAs, each Permittee shall require operators to implement additional pollutant-specific controls to reduce pollutants in storm water runoff that are causing or contributing to exceedances of water quality standards.

(4) Applicable industrial facilities identified as not having either a current WDID or No Exposure Certification shall be notified that they must obtain coverage under the Industrial General Permit and shall be referred to the Regional Water Board per the Progressive Enforcement Policy procedures identified in Part VI.D.2.

f. Source Control BMPs for Commercial and Industrial Facilities

Effective source control BMPs for the activities listed in Table 10 shall be implemented at commercial and industrial facilities, unless the pollutant generating activity does not occur:

Table 10. Source Control BMPs at Commercial and Industrial Facilities

Pollutant-Generating Activity	BMP Narrative Description
Unauthorized Non-Storm water Discharges	Effective elimination of non-storm water discharges
Accidental Spills/ Leaks	Implementation of effective spills/ leaks prevention and response procedures
Vehicle/ Equipment Fueling	Implementation of effective fueling source control devices and practices
Vehicle/ Equipment Cleaning	Implementation of effective equipment/ vehicle cleaning practices and appropriate wash water management practices
Vehicle/ Equipment Repair	Implementation of effective vehicle/ equipment repair practices and source control devices
Outdoor Liquid Storage	Implementation of effective outdoor liquid storage source controls and practices
Outdoor Equipment Operations	Implementation of effective outdoor equipment source control devices and practices
Outdoor Storage of Raw Materials	Implementation of effective source control practices and structural devices
Storage and Handling of Solid Waste	Implementation of effective solid waste storage/ handling practices and appropriate control measures
Building and Grounds Maintenance	Implementation of effective facility maintenance practices

Pollutant-Generating Activity	**BMP Narrative Description**
Parking/ Storage Area Maintenance	Implementation of effective parking/ storage area designs and housekeeping/ maintenance practices
Storm water Conveyance System Maintenance Practices	Implementation of proper conveyance system operation and maintenance protocols
Pollutant-Generating Activity	**BMP Narrative Description from Regional Water Board Resolution No. 98-08**
Sidewalk Washing	**1.** Remove trash, debris, and free standing oil/grease spills/leaks (use absorbent material, if necessary) from the area before washing; and **2.** Use high pressure, low volume spray washing using only potable water with no cleaning agents at an average usage of 0.006 gallons per square feet of sidewalk area.
Street Washing	Collect and divert wash water to the sanitary sewer – publically owned treatment works (POTW). Note: POTW approval may be needed.

g. Significant Ecological Areas (SEAs)

See VI.D.6.e.ii.3.

h. Progressive Enforcement

Each Permittee shall implement its Progressive Enforcement Policy to ensure that Industrial / Commercial facilities are brought into compliance with all storm water requirements within a reasonable time period. See Part VI.D.2 for requirements for the development and implementation of a Progressive Enforcement Policy.

7. Planning and Land Development Program

a. Purpose

i. Each Permittee shall implement a Planning and Land Development Program pursuant to Part VI.D.7.b for all New Development and Redevelopment projects subject to this Order to:

(1) Lessen the water quality impacts of development by using smart growth practices such as compact development, directing development towards existing communities via infill or redevelopment, and safeguarding of environmentally sensitive areas.

(2) Minimize the adverse impacts from storm water runoff on the biological integrity of Natural Drainage Systems and the beneficial uses of water

bodies in accordance with requirements under CEQA (Cal. Pub. Resources Code § 21000 et seq.).

(3) Minimize the percentage of impervious surfaces on land developments by minimizing soil compaction during construction, designing projects to minimize the impervious area footprint, and employing Low Impact Development (LID) design principles to mimic predevelopment hydrology through infiltration, evapotranspiration and rainfall harvest and use.

(4) Maintain existing riparian buffers and enhance riparian buffers when possible.

(5) Minimize pollutant loadings from impervious surfaces such as roof tops, parking lots, and roadways through the use of properly designed, technically appropriate BMPs (including Source Control BMPs such as good housekeeping practices), LID Strategies, and Treatment Control BMPs.

(6) Properly select, design and maintain LID and Hydromodification Control BMPs to address pollutants that are likely to be generated, reduce changes to pre-development hydrology, assure long-term function, and avoid the breeding of vectors[25].

(7) Prioritize the selection of BMPs to remove storm water pollutants, reduce storm water runoff volume, and beneficially use storm water to support an integrated approach to protecting water quality and managing water resources in the following order of preference:

(a) On-site infiltration, bioretention and/or rainfall harvest and use.

(b) On-site biofiltration, off-site ground water replenishment, and/or off-site retrofit.

b. Applicability

i. New Development Projects

(1) Development projects subject to Permittee conditioning and approval for the design and implementation of post-construction controls to mitigate storm water pollution, prior to completion of the project(s), are:

(a) All development projects equal to 1 acre or greater of disturbed area and adding more than 10,000 square feet of impervious surface area

(b) Industrial parks 10,000 square feet or more of surface area

(c) Commercial malls 10,000 square feet or more surface area

(d) Retail gasoline outlets 5,000 square feet or more of surface area

(e) Restaurants (SIC 5812) 5,000 square feet or more of surface area

[25] Treatment BMPs when designed to drain within 96 hours of the end of rainfall minimize the potential for the breeding of vectors. See California Department of Public Health *Best Management Practices for Mosquito Control in California* (2012) at http://www.westnile.ca.gov/resources.php

(f) Parking lots 5,000 square feet or more of impervious surface area, or with 25 or more parking spaces

(g) Street and road construction of 10,000 square feet or more of impervious surface area shall follow USEPA guidance regarding Managing Wet Weather with Green Infrastructure: Green Streets[26] (December 2008 EPA-833-F-08-009) to the maximum extent practicable. Street and road construction applies to standalone streets, roads, highways, and freeway projects, and also applies to streets within larger projects.

(h) Automotive service facilities (SIC 5013, 5014, 5511, 5541, 7532-7534 and 7536-7539) 5,000 square feet or more of surface area

(i) Redevelopment projects in subject categories that meet Redevelopment thresholds identified in Part VI.D.6.b.ii (Redevelopment Projects) below

(j) Projects located in or directly adjacent to, or discharging directly to a Significant Ecological Area (SEA), where the development will:

(i) Discharge storm water runoff that is likely to impact a sensitive biological species or habitat; and

(ii) Create 2,500 square feet or more of impervious surface area

(k) Single-family hillside homes. To the extent that a Permittee may lawfully impose conditions, mitigation measures or other requirements on the development or construction of a single-family home in a hillside area as defined in the applicable Permittee's Code and Ordinances, each Permittee shall require that during the construction of a single-family hillside home, the following measures are implemented:

(i) Conserve natural areas

(ii) Protect slopes and channels

(iii) Provide storm drain system stenciling and signage

(iv) Divert roof runoff to vegetated areas before discharge unless the diversion would result in slope instability

(v) Direct surface flow to vegetated areas before discharge unless the diversion would result in slope instability.

ii. Redevelopment Projects

(1) Redevelopment projects subject to Permittee conditioning and approval for the design and implementation of post-construction controls to mitigate storm water pollution, prior to completion of the project(s), are:

(a) Land-disturbing activity that results in the creation or addition or replacement of 5,000 square feet or more of impervious surface area

[26] http://water.epa.gov/infrastructure/greeninfrastructure/index.cfm

on an already developed site on development categories identified in Part VI.D.6.c. (New Development/Redevelopment Performance Criteria).

(b) Where Redevelopment results in an alteration to more than fifty percent of impervious surfaces of a previously existing development, and the existing development was not subject to post-construction storm water quality control requirements, the entire project must be mitigated.

(c) Where Redevelopment results in an alteration of less than fifty percent of impervious surfaces of a previously existing development, and the existing development was not subject to post-construction storm water quality control requirements, only the alteration must be mitigated, and not the entire development.

(i) Redevelopment does not include routine maintenance activities that are conducted to maintain original line and grade, hydraulic capacity, original purpose of facility or emergency redevelopment activity required to protect public health and safety. Impervious surface replacement, such as the reconstruction of parking lots and roadways which does not disturb additional area and maintains the original grade and alignment, is considered a routine maintenance activity. Redevelopment does not include the repaving of existing roads to maintain original line and grade.

(ii) Existing single-family dwelling and accessory structures are exempt from the Redevelopment requirements unless such projects create, add, or replace 10,000 square feet of impervious surface area.

(d) In this section, Existing Development or Redevelopment projects shall mean all discretionary permit projects or project phases that have not been deemed complete for processing, or discretionary permit projects without vesting tentative maps that have not requested and received an extension of previously granted approvals within 90 days of adoption of the Order. Projects that have been deemed complete within 90 days of adoption of the Order are not subject to the requirements Section 7.c. For Permittee's projects the effective date shall be the date the governing body or their designee approves initiation of the project design.

(e) Specifically, the Newhall Ranch Project Phases I and II (a.k.a. the Landmark and Mission Village projects) are deemed to be an existing development that will at a minimum, be designed to comply with the Specific LID Performance Standards attached to the Waste Discharge Requirements (Order No. R4-2012-0139). All subsequent phases of the Newhall Ranch Project constructed during the term of this Order shall be subject to the requirements of this Order.

c. New Development/ Redevelopment Project Performance Criteria

i. Integrated Water Quality/Flow Reduction/Resources Management Criteria

(1) Each Permittee shall require all New Development and Redevelopment projects (referred to hereinafter as "new projects") identified in Part VI.D.7.b to control pollutants, pollutant loads, and runoff volume emanating from the project site by: (1) minimizing the impervious surface area and (2) controlling runoff from impervious surfaces through infiltration, bioretention and/or rainfall harvest and use.

(2) Except as provided in Part VI.D.7.c.ii. (Technical Infeasibility or Opportunity for Regional Ground Water Replenishment), Part VI.D.7.d.i (Local Ordinance Equivalence), or Part VI.D.7.c.v (Hydromodification), below, each Permittee shall require the project to retain on-site the Stormwater Quality Design Volume (SWQDv) defined as the runoff from:

(a) The 0.75-inch, 24-hour rain event or

(b) The 85th percentile, 24-hour rain event, as determined from the Los Angeles County 85th percentile precipitation isohyetal map, *whichever is greater*.

(3) Bioretention and biofiltration systems shall meet the design specifications provided in Attachment H to this Order unless otherwise approved by the Regional Water Board Executive Officer.

(4) When evaluating the potential for on-site retention, each Permittee shall consider the maximum potential for evapotranspiration from green roofs and rainfall harvest and use.

ii. Alternative Compliance for Technical Infeasibility or Opportunity for Regional Ground Water Replenishment

(1) In instances of technical infeasibility or where a project has been determined to provide an opportunity to replenish regional ground water supplies at an offsite location, each Permittee may allow projects to comply with this Order through the alternative compliance measures as described in Part VI.D.7.c.iii.

(2) To demonstrate technical infeasibility, the project applicant must demonstrate that the project cannot reliably retain 100 percent of the SWQDv on-site, even with the maximum application of green roofs and rainwater harvest and use, and that compliance with the applicable post-construction requirements would be technically infeasible by submitting a site-specific hydrologic and/or design analysis conducted and endorsed by a registered professional engineer, geologist, architect, and/or landscape architect. Technical infeasibility may result from conditions including the following:

(a) The infiltration rate of saturated in-situ soils is less than 0.3 inch per hour and it is not technically feasible to amend the in-situ soils to attain an infiltration rate necessary to achieve reliable performance of infiltration or bioretention BMPs in retaining the SWQDv on-site.

(b) Locations where seasonal high ground water is within 5 to 10 feet of the surface,

(c) Locations within 100 feet of a ground water well used for drinking water,

(d) Brownfield development sites where infiltration poses a risk of causing pollutant mobilization,

(e) Other locations where pollutant mobilization is a documented concern[27],

(f) Locations with potential geotechnical hazards, or

(g) Smart growth and infill or redevelopment locations where the density and/ or nature of the project would create significant difficulty for compliance with the on-site volume retention requirement.

(3) To utilize alternative compliance measures to replenish ground water at an offsite location, the project applicant shall demonstrate *(i)* why it is not advantageous to replenish ground water at the project site, *(ii)* that ground water can be used for beneficial purposes at the offsite location, and *(iii)* that the alternative measures shall also provide equal or greater water quality benefits to the receiving surface water than the Water Quality/Flow Reduction/Resource Management Criteria in Part VI.7.D.c.i.

iii. Alternative Compliance Measures

When a Permittee determines a project applicant has demonstrated that it is technically infeasible to retain 100 percent of the SWQDv on-site, or is proposing an alternative offsite project to replenish regional ground water supplies, the Permittee shall require one of the following mitigation options:

(1) On-site Biofiltration

(a) If using biofiltration due to demonstrated technical infeasibility, then the new project must biofiltrate 1.5 times the portion of the SWQDv that is not reliably retained on-site, as calculated by Equation 1 below.

Equation 1:

$$\mathbf{Bv = 1.5 * [SWQDv - Rv]}$$

Where:

Bv = biofiltration volume

[27] Pollutant mobilization is considered a documented concern at or near properties that are contaminated or store hazardous substances underground.

SWQDv = the storm water runoff from a 0.75 inch, 24-hour storm or the 85th percentile storm, *whichever is greater*.

Rv = volume reliably retained on-site

(b) Conditions for On-site Biofiltration

(i) Biofiltration systems shall meet the design specifications provided in Attachment H to this Order unless otherwise approved by the Regional Water Board Executive Officer.

(ii) Biofiltration systems discharging to a receiving water that is included on the Clean Water Act section 303(d) list of impaired water quality-limited water bodies due to nitrogen compounds or related effects shall be designed and maintained to achieve enhanced nitrogen removal capability. See Attachment H for design criteria for underdrain placement to achieve enhanced nitrogen removal.

(2) Offsite Infiltration

(a) Use infiltration or bioretention BMPs to intercept a volume of storm water runoff equal to the SWQDv, less the volume of storm water runoff reliably retained on-site, at an approved offsite project, and

(b) Provide pollutant reduction (treatment) of the storm water runoff discharged from the project site in accordance with the Water Quality Mitigation Criteria provided in Part VI.D.7.c.iv.

(c) The required offsite mitigation volume shall be calculated by Equation 2 below and equal to:

Equation 2:

$$Mv = 1.0 * [SWQDv - Rv]$$

Where:

Mv = mitigation volume

SWQDv = runoff from the 0.75 inch, 24-hour storm event or the 85th percentile storm, *whichever is greater*

Rv = the volume of storm water runoff reliably retained on-site.

(3) Ground Water Replenishment Projects

Permittees may propose, in their Watershed Management Program or EWMP, regional projects to replenish regional ground water supplies at offsite locations, provided the groundwater supply has a designated beneficial use in the Basin Plan.

(a) Regional groundwater replenishment projects must use infiltration, ground water replenishment, or bioretention BMPs to intercept a volume of storm water runoff equal to the SWQDv for new development and redevelopment projects, subject to Permittee conditioning and approval for the design and implementation of post-construction controls, within the approved project area, and

(b) Provide pollutant reduction (treatment) of the storm water runoff discharged from development projects, within the project area, subject to Permittee conditioning and approval for the design and implementation of post-construction controls to mitigate storm water pollution in accordance with the Water Quality Mitigation Criteria provided in Part VI.D.7.c.iv.

(c) Permittees implementing a regional ground water replenishment project in lieu of onsite controls shall ensure the volume of runoff captured by the project shall be equal to:

Equation 2:

$$Mv = 1.0 * [SWQDv - Rv]$$

Where:

Mv = mitigation volume

SWQDv = runoff from the 0.75 inch, 24-hour storm event or the 85th percentile storm, whichever is greater

Rv = the volume of storm water runoff reliably retained on-site.

(d) Regional groundwater replenishment projects shall be located in the same sub-watershed (defined as draining to the same HUC-12 hydrologic area in the Basin Plan) as the new development or redevelopment projects which did not implement on site retention BMPs . Each Permittee may consider locations outside of the HUC-12 but within the HUC-10 subwatershed area if there are no opportunities within the HUC-12 subwatershed or if greater pollutant reductions and/or ground water replenishment can be achieved at a location within the expanded HUC-10 subwatershed. The use of a mitigation, ground water replenishment, or retrofit project outside of the HUC-12 subwatershed is subject to the approval of the Executive Officer of the Regional Water Board.

(4) Offsite Project - Retrofit Existing Development

Use infiltration, bioretention, rainfall harvest and use and/or biofiltration BMPs to retrofit an existing development, with similar land uses as the new development or land uses associated with comparable or higher storm water runoff event mean concentrations (EMCs) than the new development.

Comparison of EMCs for different land uses shall be based on published data from studies performed in southern California. The retrofit plan shall be designed and constructed to:

(a) Intercept a volume of storm water runoff equal to the mitigation volume (Mv) as described above in Equation 2, except biofiltration BMPs shall be designed to meet the biofiltration volume as described in Equation 1 and

(b) Provide pollutant reduction (treatment) of the storm water runoff from the project site as described in the Water Quality Mitigation Criteria provided in Part VI.D.7.c.iv.

(5) Conditions for Offsite Projects

(a) Project applicants seeking to utilize these alternative compliance provisions may propose other offsite projects, which the Permittees may approve if they meet the requirements of this subpart.

(b) Location of offsite projects. Offsite projects shall be located in the same sub-watershed (defined as draining to the same HUC-12 hydrologic area in the Basin Plan) as the new development or redevelopment project. Each Permittee may consider locations outside of the HUC-12 but within the HUC-10 subwatershed area if there are no opportunities within the HUC-12 subwatershed or if greater pollutant reductions and/or ground water replenishment can be achieved at a location within the expanded HUC-10 subwatershed. The use of a mitigation, ground water replenishment, or retrofit project outside of the HUC-12 subwatershed is subject to the approval of the Executive Officer of the Regional Water Board.

(c) Project applicant must demonstrate that equal benefits to ground water recharge cannot be met on the project site.

(d) Each Permittee shall develop a prioritized list of offsite mitigation, ground water replenishment and/or retrofit projects, and when feasible, the mitigation must be directed to the highest priority project within the same HUC-12 or if approved by the Regional Water Board Executive Officer, the HUC-10 drainage area, as the new development project.

(e) Infiltration/bioretention shall be the preferred LID BMP for offsite mitigation or ground water replenishment projects. Offsite retrofit projects may include green streets, parking lot retrofits, green roofs, and rainfall harvest and use. Biofiltration BMPs may be considered for retrofit projects when infiltration, bioretention or rainfall harvest and use is technically infeasible.

(f) Each Permittee shall develop a schedule for the completion of offsite projects, including milestone dates to identify, fund, design, and construct the projects. Offsite projects shall be completed as soon as possible, and at the latest, within 4 years of the certificate of occupancy for the first project that contributed funds toward the construction of the offsite project, unless a longer period is otherwise authorized by the Executive Officer of the Regional Water Board. For public offsite projects, each Permittee must provide in their annual reports a summary of total offsite project funds raised to date and a description (including location, general design concept, volume of water expected to be retained, and total estimated budget) of all pending public offsite projects. Funding sufficient to address the offsite volume must be transferred to the Permittee (for public offsite mitigation projects) or to an escrow account (for private offsite mitigation projects) within one year of the initiation of construction.

(g) Offsite projects must be approved by the Permittee and may be subject to approval by the Regional Water Board Executive Officer, if a third-party petitions the Executive Officer to review the project. Offsite projects will be publicly noticed on the Regional Water Board's website for 30 days prior to approval.

(h) The project applicant must perform the offsite projects as approved by either the Permittee or the Regional Water Board Executive Officer or provide sufficient funding for public or private offsite projects to achieve the equivalent mitigation storm water volume.

(6) Regional Storm Water Mitigation Program

A Permittee or Permittee group may apply to the Regional Water Board for approval of a regional or sub-regional storm water mitigation program to substitute in part or wholly for New and Redevelopment requirements for the area covered by the regional or sub-regional storm water mitigation program. Upon review and a determination by the Regional Water Board Executive Officer that the proposal is technically valid and appropriate, the Regional Water Board may consider for approval such a program if its implementation meets all of the following requirements:

(a) Retains the runoff from the 85th percentile, 24-hour rain event or the 0.75 inch, 24-hour rain event, whichever is greater;
(b) Results in improved storm water quality;
(c) Protects stream habitat;
(d) Promotes cooperative problem solving by diverse interests;
(e) Is fiscally sustainable and has secure funding; and
(f) Is completed in five years including the construction and start-up of treatment facilities.
(g) Nothing in this provision shall be construed as to delay the implementation of requirements for new and redevelopment, as approved in this Order.

(7) Water Quality Mitigation Criteria

(a) Each Permittee shall require all New Development and Redevelopment projects that have been approved for offsite mitigation or ground water replenishment projects as defined in Part VI.D.7.c.ii-iii to also provide treatment of storm water runoff from the project site. Each Permittee shall require these projects to design and implement post-construction storm water BMPs and control measures to reduce pollutant loading as necessary to:

(i) Meet the pollutant specific benchmarks listed in Table 11 at the treatment systems outlet or prior to the discharge to the MS4, and

(ii) Ensure that the discharge does not cause or contribute to an exceedance of water quality standards at the Permittee's downstream MS4 outfall.

(b) Each Permittee may allow the project proponent to install flow-through modular treatment systems including sand filters, or other proprietary BMP treatment systems with a demonstrated efficiency at least equivalent to a sand filter. The sizing of the flow through treatment device shall be based on a rainfall intensity of:

(i) 0.2 inches per hour, or

(ii) The one year, one-hour rainfall intensity as determined from the most recent Los Angeles County isohyetal map, *whichever is greater*.

Table 11. Benchmarks Applicable to New Development Treatment BMPs[28]

Conventional Pollutants

Pollutant	Suspended Solids mg/L	Total P mg/L	Total N mg/L		TKN mg/L	
Effluent Concentration	14	0.13	1.28		1.09	

Metals

Pollutant	Total Cd µg/L	Total Cu µg/L	Total Cr µg/L	Total Pb µg/L	Total Zn µg/L
Effluent Concentration	0.3	6	2.8	2.5	23

[28] The treatment control BMP performance benchmarks were developed from the median effluent water quality values of the six highest performing BMPs, per pollutant, in the storm water BMP database (http://www.bmpdatabase.org/, last visited September 25, 2012).

(c) In addition to the requirements for controlling pollutant discharges as described in Part VI.D.7.c.iii. and the treatment benchmarks described above, each Permittee shall ensure that the new development or redevelopment will not cause or contribute to an exceedance of applicable water quality-based effluent limitations established in Part VI.E pursuant to Total Maximum Daily Loads (TMDLs).

iv. Hydromodification (Flow/ Volume/ Duration) Control Criteria

Each Permittee shall require all New Development and Redevelopment projects located within natural drainage systems as described in Part VI.D.7.c.iv.(1)(a)(iii) to implement hydrologic control measures, to prevent accelerated downstream erosion and to protect stream habitat in natural drainage systems. The purpose of the hydrologic controls is to minimize changes in post-development hydrologic storm water runoff discharge rates, velocities, and duration. This shall be achieved by maintaining the project's pre-project storm water runoff flow rates and durations.

(1) Description

(a) Hydromodification control in natural drainage systems shall be achieved by maintaining the Erosion Potential (Ep) in streams at a value of 1, unless an alternative value can be shown to be protective of the natural drainage systems from erosion, incision, and sedimentation that can occur as a result of flow increases from impervious surfaces and prevent damage to stream habitat in natural drainage system tributaries (see Attachment J - Determination of Erosion Potential).

(ii) Hydromodification control may include one, or a combination of on-site, regional or sub-regional hydromodification control BMPs, LID strategies, or stream and riparian buffer restoration measures. Any in-stream restoration measure shall not adversely affect the beneficial uses of the natural drainage systems.

(iii) Natural drainage systems that are subject to the hydromodification assessments and controls as described in this Part of the Order, include all drainages that have not been improved (e.g., channelized or armored with concrete, shotcrete, or rip-rap) or drainage systems that are tributary to a natural drainage system, except as provided in Part VI.D.7c.iv.(1)(b)--Exemptions to Hydromodification Controls [see below]. The clearing or dredging of a natural drainage system does not constitute an "improvement."

(iv) Until the State Water Board or the Regional Water Board adopts a final Hydromodification Policy or criteria, Permittees shall implement the Hydromodification Control Criteria described in Part VI.D.7.c.iv.(1)(c) to control the potential adverse impacts of changes in hydrology that may result from new development and redevelopment projects located within natural drainage systems as described in Part VI.D.7.c.iv.(1)(a)(iii).

(b) Exemptions to Hydromodification Controls. Permittees may exempt the following New Development and Redevelopment projects from implementation of hydromodification controls where assessments of downstream channel conditions and proposed discharge hydrology indicate that adverse hydromodification effects to beneficial uses of Natural Drainage Systems are unlikely:

(i) Projects that are replacement, maintenance or repair of a Permittee's existing flood control facility, storm drain, or transportation network.

(ii) Redevelopment Projects in the Urban Core that do not increase the effective impervious area or decrease the infiltration capacity of pervious areas compared to the pre-project conditions.

(iii) Projects that have any increased discharge directly or via a storm drain to a sump, lake, area under tidal influence, into a waterway that has a 100-year peak flow (Q100) of 25,000 cfs or more, or other receiving water that is not susceptible to hydromodification impacts.

(iv) Projects that discharge directly or via a storm drain into concrete or otherwise engineered (not natural) channels (e.g., channelized or armored with rip rap, shotcrete, etc.), which, in turn, discharge into receiving water that is not susceptible to hydromodification impacts (as in Parts VI.D.7.c.iv.(1)(b)(i)-(iii) above).

(v) LID BMPs implemented on single family homes are sufficient to comply with Hydromodification criteria.

(c) Hydromodification Control Criteria. The Hydromodification Control Criteria to protect natural drainage systems are as follows:

(i) Except as provided for in Part VI.D.7.c.iv.(1)(b), projects disturbing an area greater than 1 acre but less than 50 acres within natural drainage systems will be presumed to meet pre-development hydrology if one of the following demonstrations is made:

1. The project is designed to retain on-site, through infiltration, evapotranspiration, and/or harvest and use, the storm water volume from the runoff of the 95th percentile, 24-hour storm, or

2. The runoff flow rate, volume, velocity, and duration for the post-development condition do not exceed the pre-development condition for the 2-year, 24-hour rainfall event. This condition may be substantiated by simple screening models, including those described in *Hydromodification Effects on Flow Peaks*

and Durations in Southern California Urbanizing Watersheds (Hawley et al., 2011) or other models acceptable to the Executive Officer of the Regional Water Board, or

3. The Erosion Potential (Ep) in the receiving water channel will approximate 1, as determined by a Hydromodification Analysis Study and the equation presented in Attachment J. Alternatively, Permittees can opt to use other work equations to calculate Erosion Potential with Executive Officer approval.

(ii) Projects disturbing 50 acres or more within natural drainage systems will be presumed to meet pre-development hydrology based on the successful demonstration of one of the following conditions:

1. The site infiltrates on-site at least the runoff from a 2-year, 24-hour storm event, or
2. The runoff flow rate, volume, velocity, and duration for the post-development condition does not exceed the pre-development condition for the 2-year, 24-hour rainfall events. These conditions must be substantiated by hydrologic modeling acceptable to the Regional Water Board Executive Officer, or
3. The Erosion Potential (Ep) in the receiving water channel will approximate 1, as determined by a Hydromodification Analysis Study and the equation presented in Attachment J.

(c) Alternative Hydromodification Criteria

(i) Permittees may satisfy the requirement for Hydromodification Controls by implementing the hydromodification requirements in the County of Los Angeles Low Impact Development Manual (2009) for all projects disturbing an area greater than 1 acre within natural drainage systems.

(ii) Each Permittee may alternatively develop and implement watershed specific Hydromodification Control Plans (HCPs). Such plans shall be developed no later than one year after the effective date of this Order.

(iii) The HCP shall identify:

1. Stream classifications
2. Flow rate and duration control methods
3. Sub-watershed mitigation strategies
4. Stream and/or riparian buffer restoration measures, which will maintain the stream and tributary Erosion Potential at 1 unless

an alternative value can be shown to be protective of the natural drainage systems from erosion, incision, and sedimentation that can occur as a result of flow increases from impervious surfaces and prevent damage to stream habitat in natural drainage system tributaries.

(iv) The HCP shall contain the following elements:

1. Hydromodification Management Standards
2. Natural Drainage Areas and Hydromodification Management Control Areas
3. New Development and Redevelopment Projects subject to the HCP
4. Description of authorized Hydromodification Management Control BMPs
5. Hydromodification Management Control BMP Design Criteria
6. For flow duration control methods, the range of flows to control for, and goodness of fit criteria
7. Allowable low critical flow, Qc, which initiates sediment transport
8. Description of the approved Hydromodification Model
9. Any alternate Hydromodification Management Model and Design
10. Stream Restoration Measures Design Criteria
11. Monitoring and Effectiveness Assessment
12. Record Keeping
13. The HCP shall be deemed in effect upon Executive Officer approval.

v. Watershed Equivalence.

Regardless of the methods through which Permittees allow project applicants to implement alternative compliance measures, the subwatershed-wide (defined as draining to the same HUC-12 hydrologic area in the Basin Plan) result of all development must be at least the same level of water quality protection as would have been achieved if all projects utilizing these alternative compliance provisions had complied with Part VI.D.7.c.i (Integrated Water Quality/Flow Reduction/Resource Management Criteria).

vi. Annual Report

Each Permittee shall provide in their annual report to the Regional Water Board a list of mitigation project descriptions and estimated pollutant and flow reduction analyses (compiled from design specifications submitted by project applicants and approved by the Permittee(s)). Within 4 years of Order adoption, Permittees must submit in their Annual Report, a comparison of the expected aggregate results of alternative compliance projects to the results that would otherwise have been achieved by retaining on site the SWQDv.

d. Implementation

i. Local Ordinance Equivalence

A Permittee that has adopted a local LID ordinance prior to the adoption of this Order, and which includes a retention requirement numerically equal to the 0.75-inch, 24-hour rain event or the 85th percentile, 24-hour rain event, whichever is greater, may submit documentation to the Regional Water Board that the alternative requirements in the local ordinance will provide equal or greater reduction in storm water discharge pollutant loading and volume as would have been obtained through strict conformance with Part VI.D.7.c.i. (Integrated Water Quality/Flow Reduction Resources Management Criteria) or Part VI.D.7.c.ii. (Alternative Compliance Measures for Technical Infeasibility or Opportunity for Regional Ground water Replenishment) of this Order and, if applicable, Part VI.D.7.c.iv. (Hydromodification (Flow/Volume Duration) Control Criteria).

(1) Documentation shall be submitted within 180 days after the effective date of this Order.

(2) The Regional Water Board shall provide public notice of the proposed equivalency determination and a minimum 30-day period for public comment. After review and consideration of public comments, the Regional Water Board Executive Officer will determine whether implementation of the local ordinance provides equivalent pollutant control to the applicable provisions of this Order. Local ordinances that do not strictly conform to the provisions of this Order must be approved by the Regional Water Board Executive Officer as being "equivalent" in effect to the applicable provisions of this Order in order to substitute for the requirements in Parts VI.D.7.c.i and, where applicable, VI.D.7.c.iv.

(3) Where the Regional Water Board Executive Officer determines that a Permittee's local LID ordinance does not provide equivalent pollutant control, the Permittee shall either

(a) Require conformance with Parts VI.D.7.c.i and, where applicable, VI.D.7.c.iv, or

(b) Update its local ordinance to conform to the requirements herein within two years of the effective date of this Order.

ii. Project Coordination

(1) Each Permittee shall facilitate a process for effective approval of post-construction storm water control measures. The process shall include:

(a) Detailed LID site design and BMP review including BMP sizing calculations, BMP pollutant removal performance, and municipal approval; and

(b) An established structure for communication and delineated authority between and among municipal departments that have jurisdiction over project review, plan approval, and project construction through memoranda of understanding or an equivalent agreement.

iii. Maintenance Agreement and Transfer

(1) Prior to issuing approval for final occupancy, each Permittee shall require that all new development and redevelopment projects subject to post-construction BMP requirements, with the exception of simple LID BMPs implemented on single family residences, provide an operation and maintenance plan, monitoring plan, where required, and verification of ongoing maintenance provisions for LID practices, Treatment Control BMPs, and Hydromodification Control BMPs including but not limited to: final map conditions, legal agreements, covenants, conditions or restrictions, CEQA mitigation requirements, conditional use permits, and/ or other legally binding maintenance agreements. Permittees shall require maintenance records be kept on site for treatment BMPs implemented on single family residences.

(a) Verification at a minimum shall include the developer's signed statement accepting responsibility for maintenance until the responsibility is legally transferred; and either:

(i) A signed statement from the public entity assuming responsibility for BMP maintenance; or

(ii) Written conditions in the sales or lease agreement, which require the property owner or tenant to assume responsibility for BMP maintenance and conduct a maintenance inspection at least once a year; or

(iii) Written text in project covenants, conditions, and restrictions (CCRs) for residential properties assigning BMP maintenance responsibilities to the Home Owners Association; or

(iv) Any other legally enforceable agreement or mechanism that assigns responsibility for the maintenance of BMPs.

(b) Each Permittee shall require all development projects subject to post-construction BMP requirements to provide a plan for the operation and maintenance of all structural and treatment controls. The plan shall be submitted for examination of relevance to keeping the BMPs in proper working order. Where BMPs are transferred to Permittee for ownership and maintenance, the plan shall also include all relevant costs for upkeep of BMPs in the transfer. Operation and Maintenance plans for private BMPs shall be kept on-site for periodic review by Permittee inspectors.

iv. Tracking, Inspection, and Enforcement of Post-Construction BMPs

(1) Each Permittee shall implement a tracking system and an inspection and enforcement program for new development and redevelopment post-construction storm water no later than 60 days after Order adoption date.

(a) Implement a GIS or other electronic system for tracking projects that have been conditioned for post-construction BMPs. The electronic system, at a minimum, should contain the following information:

(i) Municipal Project ID

(ii) State WDID No.

(iii) Project Acreage

(iv) BMP Type and Description

(v) BMP Location (coordinates)

(vi) Date of Acceptance

(vii) Date of Maintenance Agreement

(viii) Maintenance Records

(ix) Inspection Date and Summary

(x) Corrective Action

(xi) Date Certificate of Occupancy Issued

(xii) Replacement or Repair Date

(b) Inspect all development sites upon completion of construction and prior to the issuance of occupancy certificates to ensure proper installation of LID measures, structural BMPs, treatment control BMPs and hydromodification control BMPs. The inspection may be combined with other inspections provided it is conducted by trained personnel.

(c) Verify proper maintenance and operation of post-construction BMPs previously approved for new development and redevelopment and operated by the Permittee. The post-construction BMP maintenance inspection program shall incorporate the following elements:

(i) The development of a Post-construction BMP Maintenance Inspection checklist

(ii) Inspection at least once every 2 years after project completion, of post-construction BMPs to assess operation conditions with particular attention to criteria and procedures for post-construction treatment control and hydromodification control BMP repair, replacement, or re-vegetation.

(d) For post-construction BMPs operated and maintained by parties other than the Permittee, the Permittee shall require the other parties to document proper maintenance and operations.

(e) Undertake enforcement action per the established Progressive Enforcement Policy as appropriate based on the results of the inspection. See Part VI.D.2 for requirements for the development and implementation of a Progressive Enforcement Policy.

8. Development Construction Program

a. Each Permittee shall develop, implement, and enforce a construction program that:

i. Prevents illicit construction-related discharges of pollutants into the MS4 and receiving waters.

ii. Implements and maintains structural and non-structural BMPs to reduce pollutants in storm water runoff from construction sites.

iii. Reduces construction site discharges of pollutants to the MS4 to the MEP.

iv. Prevents construction site discharges to the MS4 from causing or contributing to a violation of water quality standards.

b. Each Permittee shall establish for its jurisdiction an enforceable erosion and sediment control ordinance for all construction sites that disturb soil.

c. Applicability

The provisions contained in Part VI.D.8.d below apply exclusively to construction sites less than 1 acre. Provisions contained in Part VI.D.8.e – j, apply exclusively to construction sites 1 acre or greater. The requirements contained in this part apply to all activities involving soil disturbance with the exception of agricultural activities. Activities covered by this permit include but are not limited to grading, vegetation clearing, soil compaction, paving, re-paving and linear underground/overhead projects (LUPs).

d. Requirements for Construction Sites Less than One Acre

i. For construction sites less than 1 acre, each Permittee shall:

(1) Through the use of the Permittee's erosion and sediment control ordinance or and/or building permit, require the implementation of an effective combination of erosion and sediment control BMPs from Table 12 to prevent erosion and sediment loss, and the discharge of construction wastes.

Table 12. Applicable Set of BMPs for All Construction Sites

Erosion Controls	Scheduling
	Preservation of Existing Vegetation
Sediment Controls	Silt Fence
	Sand Bag Barrier
	Stabilized Construction Site Entrance/Exit
Non-Storm Water Management	Water Conservation Practices
	Dewatering Operations
Waste Management	Material Delivery and Storage
	Stockpile Management
	Spill Prevention and Control
	Solid Waste Management
	Concrete Waste Management
	Sanitary/Septic Waste Management

(2) Possess the ability to identify all construction sites with soil disturbing activities that require a permit, regardless of size, and shall be able to provide a list of permitted sites upon request of the Regional Water Board. Permittees may use existing permit databases or other tracking systems to comply with these requirements.

(3) Inspect construction sites on as needed based on the evaluation of the factors that are a threat to water quality. In evaluating the threat to water quality, the following factors shall be considered: soil erosion potential; site slope; project size and type; sensitivity of receiving water bodies; proximity to receiving water bodies; non-storm water discharges; past record of non-compliance by the operators of the construction site; and any water quality issues relevant to the particular MS4.

(4) Implement the Permittee's Progressive Enforcement Policy to ensure that construction sites are brought into compliance with the erosion and sediment control ordinance within a reasonable time period. See Part VI.D.2 for requirements for the development and implementation of a Progressive Enforcement Policy.

e. Each Permittee shall require operators of public and private construction sites within its jurisdiction to select, install, implement, and maintain BMPs that comply with its erosion and sediment control ordinance.

f. The requirements contained in this part apply to all activities involving soil disturbance with the exception of agricultural activities. Activities covered by this permit include but are not limited to grading, vegetation clearing, soil compaction, paving, re-paving and linear underground/overhead projects (LUPs).

g. Construction Site Inventory / Electronic Tracking System

i. Each Permittee shall use an electronic system to inventory grading permits, encroachment permits, demolition permits, building permits, or construction permits (and any other municipal authorization to move soil and/ or construct or destruct that involves land disturbance) issued by the Permittee. To satisfy this requirement, the use of a database or GIS system is recommended.

ii. Each Permittee shall complete an inventory and continuously update as new sites are permitted and sites are completed. The inventory / tracking system shall contain, at a minimum:

(1) Relevant contact information for each project (e.g., name, address, phone, email, etc. for the owner and contractor.

(2) The basic site information including location, status, size of the project and area of disturbance.

(3) The proximity all water bodies, water bodies listed as impaired by sediment-related pollutants, and water bodies for which a sediment-related TMDL has been adopted and approved by USEPA.

(4) Significant threat to water quality status, based on consideration of factors listed in Appendix 1 to the Statewide General Permit for Discharges of Storm Water Associated with Construction Activity (Construction General Permit).

(5) Current construction phase where feasible.

(6) The required inspection frequency.

(7) The project start date and anticipated completion date.

(8) Whether the project has submitted a Notice of Intent and obtained coverage under the Construction General Permit.

(9) The date the Permittee approved the Erosion and Sediment Control Plan (ESCP).

(10) Post-Construction Structural BMPs subject to Operation and Maintenance Requirements.

h. Construction Plan Review and Approval Procedures

i. Each Permittee shall develop procedures to review and approve relevant construction plan documents.

ii. The review procedures shall be developed and implemented such that the following minimum requirements are met:

(1) Prior to issuing a grading or building permit, each Permittee shall require each operator of a construction activity within its jurisdiction to prepare and submit an ESCP prior to the disturbance of land for the Permittee's review and written approval. The construction site operator shall be prohibited from commencing construction activity prior to receipt of written approval by the Permittee. Each Permittee shall not approve any ESCP unless it contains appropriate site-specific construction site BMPs that

meet the minimum requirements of a Permittee's erosion and sediment control ordinance.

(2) ESCPs must include the elements of a Storm Water Pollution Prevention Plan (SWPPP). SWPPPs prepared in accordance with the requirements of the Construction General Permit can be accepted as ESCPs.

(3) At a minimum, the ESCP must address the following elements:

(a) Methods to minimize the footprint of the disturbed area and to prevent soil compaction outside of the disturbed area.

(b) Methods used to protect native vegetation and trees.

(c) Sediment/Erosion Control.

(d) Controls to prevent tracking on and off the site.

(e) Non-storm water controls (e.g., vehicle washing, dewatering, etc.).

(f) Materials Management (delivery and storage).

(g) Spill Prevention and Control.

(h) Waste Management (e.g., concrete washout/waste management; sanitary waste management).

(i) Identification of site Risk Level as identified per the requirements in Appendix 1 of the Construction General Permit.

(4) The ESCP must include the rationale for the selection and design of the proposed BMPs, including quantifying the expected soil loss from different BMPs.

(5) Each Permittee shall require that the ESCP is developed and certified by a Qualified SWPPP Developer (QSD).

(6) Each Permittee shall require that all structural BMPs be designed by a licensed California Engineer.

(7) Each Permittee shall require that for all sites, the landowner or the landowner's agent sign a statement on the ESCP as follows:

(a) "I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is true, accurate, and complete. I am aware that submitting false and/ or inaccurate information, failing to update the ESCP to reflect current conditions, or failing to properly and/ or adequately implement the ESCP may result in revocation of grading and/ or other permits or other sanctions provided by law."

(8) Prior to issuing a grading or building permit, each Permittee must verify that the construction site operators have existing coverage under

applicable permits, including, but not limited to the State Water Board's Construction General Permit, and State Water Board 401 Water Quality Certification.

(9) Each Permittee shall develop and implement a checklist to be used to conduct and document review of each ESCP.

i. BMP Implementation Level

i. Each Permittee shall implement technical standards for the selection, installation and maintenance of construction BMPs for all construction sites within its jurisdiction.

ii. The BMP technical standards shall require:

(1) The use of BMPs that are tailored to the risks posed by the project. Sites are to be ranked from Low Risk (Risk 1) to High Risk (Risk 3). Project risks are to be calculated based on the potential for erosion from the site and the sensitivity of the receiving water body. Receiving water bodies that are listed on the Clean Water Act (CWA) Section 303(d) list for sediment or siltation are considered High Risk. Likewise, water bodies with designated beneficial uses of SPWN, COLD, and MIGR are also considered to be High Risk. The combined (sediment/receiving water) site risk shall be calculated using the methods provided in Appendix 1 of the Construction General Permit. At a minimum, the BMP technical standards shall include requirements for High Risk sites as defined in Table 15.

(2) The use of BMPs for all construction sites, sites equal or greater to 1 acre, and for paving projects per Tables 14 and 16 of this Order.

(3) Detailed installation designs and cut sheets for use within ESCPs.

(4) Maintenance expectations for each BMP, or category of BMPs, as appropriate.

iii. Permittees are encouraged to adopt respective BMPs from latest versions of the *California BMP Handbook, Construction* or *Caltrans Stormwater Quality Handbooks, Construction Site Best Management Practices (BMPs) Manual* and addenda. Alternatively, Permittees are authorized to develop or adopt equivalent BMP standards consistent for Southern California and for the range of activities presented below in Tables 13 through 16.

iv. The local BMP technical standards shall be readily available to the development community and shall be clearly referenced within each Permittee's storm water or development services website, ordinance, permit approval process and/or ESCP review forms. The local BMP technical standards shall also be readily available to the Regional Water Board upon request.

v. Local BMP technical standards shall be available for the following:

Table 13. Minimum Set of BMPs for All Construction Sites

Erosion Controls	Scheduling
	Preservation of Existing Vegetation
Sediment Controls	Silt Fence
	Sand Bag Barrier
	Stabilized Construction Site Entrance/Exit
Non-Storm water Management	Water Conservation Practices
	Dewatering Operations
Waste Management	Material Delivery and Storage
	Stockpile Management
	Spill Prevention and Control
	Solid Waste Management
	Concrete Waste Management
	Sanitary/Septic Waste Management

Table 14. Additional BMPs Applicable to Construction Sites Disturbing 1 Acre or More

Erosion Controls	Hydraulic Mulch
	Hydroseeding
	Soil Binders
	Straw Mulch
	Geotextiles and Mats
	Wood Mulching
Sediment Controls	Fiber Rolls
	Gravel Bag Berm
	Street Sweeping and/ or Vacuum
	Storm Drain Inlet Protection
	Scheduling
	Check Dam
Additional Controls	Wind Erosion Controls
	Stabilized Construction Entrance/ Exit
	Stabilized Construction Roadway
	Entrance/ Exit Tire Wash
Non-Storm water Management	Vehicle and Equipment Washing
	Vehicle and Equipment Fueling
	Vehicle and Equipment Maintenance
Waste Management	Material Delivery and Storage
	Spill Prevention and Control

Table 15. Additional Enhanced BMPs for High Risk Sites

Erosion Controls	Hydraulic Mulch
	Hydroseeding
	Soil Binders
	Straw Mulch

	Geotextiles and Mats
	Wood Mulching
	Slope Drains
Sediment Controls	Silt Fence
	Fiber Rolls
	Sediment Basin
	Check Dam
	Gravel Bag Berm
	Street Sweeping and/or Vacuum
	Sand Bag Barrier
	Storm Drain Inlet Protection
Additional Controls	Wind Erosion Controls
	Stabilized Construction Entrance/Exit
	Stabilized Construction Roadway
	Entrance/Exit Tire Wash
	Advanced Treatment Systems*
Non-Storm water Management	Water Conservation Practices
	Dewatering Operations (Ground water dewatering only under NPDES Permit No. CAG994004)
	Vehicle and Equipment Washing
	Vehicle and Equipment Fueling
	Vehicle and Equipment Maintenance
Waste Management	Material Delivery and Storage
	Stockpile Management
	Spill Prevention and Control
	Solid Waste Management

* Applies to public roadway projects.

Table 16. Minimum Required BMPs for Roadway Paving or Repair Operation (For Private or Public Projects)

1.	Restrict paving and repaving activity to exclude periods of rainfall or predicted rainfall unless required by emergency conditions.
2.	Install gravel bags and filter fabric or other equivalent inlet protection at all susceptible storm drain inlets and at manholes to prevent spills of paving products and tack coat.
3.	Prevent the discharge of release agents including soybean oil, other oils, or diesel to the storm water drainage system or receiving waters.
4.	Minimize non storm water runoff from water use for the roller and for evaporative cooling of the asphalt.
5.	Clean equipment over absorbent pads, drip pans, plastic sheeting or other material to capture all spillage and dispose of properly.
6.	Collect liquid waste in a container, with a secure lid, for transport to a maintenance facility to be reused, recycled or disposed of properly.
7.	Collect solid waste by vacuuming or sweeping and securing in an

	appropriate container for transport to a maintenance facility to be reused, recycled or disposed of properly.
8.	Cover the “cold-mix” asphalt (i.e., pre-mixed aggregate and asphalt binder) with protective sheeting during a rainstorm.
9.	Cover loads with tarp before haul-off to a storage site, and do not overload trucks.
10.	Minimize airborne dust by using water spray or other approved dust suppressant during grinding.
11.	Avoid stockpiling soil, sand, sediment, asphalt material and asphalt grindings materials or rubble in or near storm water drainage system or receiving waters.
12.	Protect stockpiles with a cover or sediment barriers during a rain.

j. Construction Site Inspection

i. Each Permittee shall use its legal authority to implement procedures for inspecting public and private construction sites.

ii. The inspection procedures shall be implemented as follows:

(1) Inspect the public and private construction sites as specified in Table 17 below:

Table 17. Inspection Frequencies for Sites One Acre or Greater

Site	Inspection Frequency Shall Occur
a. All sites 1 acre or larger that discharge to a tributary listed by the state as an impaired water for sediment or turbidity under the CWA § 303(d)	(1) when two or more consecutive days with greater than 50% chance of rainfall are predicted by NOAA[29], (2) within 48 hours of a ½-inch rain event and at (3) least once every two weeks
b. Other sites 1 acre or more determined to be a significant threat to water quality[30]	
c. All other construction sites with 1 acre or more of soil disturbance not meeting the criteria above	At least monthly

(2) Each Permittee shall inspect all phases of construction as follows:

(a) Prior to Land Disturbance

Prior to allowing an operator to commence land disturbance, each Permittee shall perform an inspection to ensure all necessary erosion

[29] www.srh.noaa.gov/forecast

[30] In evaluating the threat to water quality, the following factors shall be considered: soil erosion potential; site slope; project size and type; sensitivity of receiving water bodies; proximity to receiving water bodies; non-storm water discharges; past record of non-compliance by the operators of the construction site; and any water quality issues relevant to the particular MS4.

and sediment structural and non-structural BMP materials and procedures are available per the erosion and sediment control plan.

(b) During Active Construction, including Land Development[31] and Vertical Construction[32]

In accordance with the frequencies specified in Part VI.D.8.j and Table 17 of this Order, each Permittee shall perform an inspection to ensure all necessary erosion and sediment structural and non-structural BMP materials and procedures are available per the erosion and sediment control plan throughout the construction process.

(c) Final Landscaping / Site Stabilization[33]

At the conclusion of the project and as a condition of approving and/or issuing a Certificate of Occupancy, each Permittee shall inspect the constructed site to ensure that all graded areas have reached final stabilization and that all trash, debris, and construction materials, and temporary erosion and sediment BMPs are removed.

(3) Based on the required frequencies above, each construction project shall be inspected a minimum of three times.

(4) Inspection Standard Operating Procedures

Each Permittee shall develop, implement, and revise as necessary, standard operating procedures that identify the inspection procedures each Permittee will follow. Inspections of construction sites, and the standard operating procedures, shall include, but are not limited to:

(a) Verification of active coverage under the Construction General Permit for sites disturbing 1 acre or more, or that are part of a planned development that will disturb 1 acre or more and a process for referring non-filers to the Regional Water Board.

(b) Review of the applicable ESCP and inspection of the construction site to determine whether all BMPs have been selected, installed, implemented, and maintained according to the approved plan and subsequent approved revisions.

(c) Assessment of the appropriateness of the planned and installed BMPs and their effectiveness.

(d) Visual observation and record keeping of non-storm water discharges, potential illicit discharges and connections, and potential discharge of pollutants in storm water runoff.

(e) Development of a written or electronic inspection report generated from an inspection checklist used in the field.

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[31] Activities include cuts and fills, rough and finished grading; alluvium removals; canyon cleanouts; rock undercuts; keyway excavations; stockpiling of select material for capping operations; and excavation and street paving, lot grading, curbs, gutters and sidewalks, public utilities, public water facilities including fire hydrants, public sanitary sewer systems, storm sewer system and/or other drainage improvement.

[32] The build out of structures from foundations to roofing, including rough landscaping.

[33] All soil disturbing activities at each individual parcel within the site have been completed.

(f) Tracking of the number of inspections for the inventoried construction sites throughout the reporting period to verify that the sites are inspected at the minimum frequencies required in Table 17 of this Order.

k. Enforcement

Each Permittee shall implement its Progressive Enforcement Policy to ensure that construction sites are brought into compliance with all storm water requirements within a reasonable time period. See Part VI.D.2 for requirements for the development and implementation of a Progressive Enforcement Policy.

l. Permittee Staff Training

i. Each Permittee shall ensure that all staff whose primary job duties are related to implementing the construction storm water program are adequately trained.

ii. Each Permittee may conduct in-house training or contract with consultants. Training shall be provided to the following staff positions of the MS4:

(1) Plan Reviewers and Permitting Staff

Ensure staff and consultants are trained as qualified individuals, knowledgeable in the technical review of local erosion and sediment control ordinance, local BMP technical standards, ESCP requirements, and the key objectives of the State Water Board QSD program. Permittees may provide internal training to staff or require staff to obtain QSD certification.

(2) Erosion Sediment Control/Storm Water Inspectors

Each Permittee shall ensure that its inspectors are knowledgeable in inspection procedures consistent with the State Water Board sponsored program QSD or a Qualified SWPPP Practitioner (QSP) or that a designated person on staff who has been trained in the key objectives of the QSD/QSP programs supervises inspection operations. Each Permittee may provide internal training to staff or require staff to obtain QSD/QSP certification. Each inspector must be knowledgeable of the local BMP technical standards and ESCP requirements.

(3) Third-Party Plan Reviewers, Permitting Staff, and Inspectors

If the Permittee utilizes outside parties to conduct inspections and/or review plans, each Permittee shall ensure these staff are trained per the requirements listed above. Outside contractors can self-certify, providing they certify they have received all applicable training required in the Permit and have documentation to that effect.

9. Public Agency Activities Program

a. Each Permittee shall implement a Public Agency Activities Program to minimize storm water pollution impacts from Permittee-owned or operated facilities and activities and to identify opportunities to reduce storm water pollution impacts from areas of existing development. Requirements for Public Agency Facilities and Activities consist of the following components:

i. Public Construction Activities Management

ii. Public Facility Inventory

iii. Inventory of Existing Development for Retrofitting Opportunities

iv. Public Facility and Activity Management

v. Vehicle and Equipment Wash Areas

vi. Landscape, Park, and Recreational Facilities Management

vii. Storm Drain Operation and Maintenance

viii. Streets, Roads, and Parking Facilities Maintenance

ix. Emergency Procedures

x. Municipal Employee and Contractor Training

b. Public Construction Activities Management

i. Each Permittee shall implement and comply with the Planning and Land Development Program requirements in Part VI.D.7 of this Order at Permittee-owned or operated (i.e., public or Permittee sponsored) construction projects that are categorized under the project types identified in Part VI.D.7.b of this Order.

ii. Each Permittee shall implement and comply with the appropriate Development Construction Program requirements in Part VI.D.8 of this Order at Permittee-owned or operated construction projects as applicable.

iii. For Permittee-owned or operated projects (including those under a capital improvement project plan) that disturb less than one acre of soil, each Permittee shall require an effective combination of erosion and sediment control BMPs from Table 13 (see Construction Development Program, minimum BMPs).

iv. Each Permittee shall obtain separate coverage under the Construction General Permit for all Permittee-owned or operated construction sites that require coverage.

c. Public Facility Inventory

i. Each Permittee shall maintain an updated inventory of all Permittee-owned or operated (i.e., public) facilities within its jurisdiction that are potential sources of storm water pollution. The incorporation of facility information into a GIS is recommended. Sources to be tracked include but are not limited to the following:

(1) Animal control facilities

(2) Chemical storage facilities

(3) Composting facilities

(4) Equipment storage and maintenance facilities (including landscape maintenance-related operations)

(5) Fueling or fuel storage facilities (including municipal airports)

(6) Hazardous waste disposal facilities

(7) Hazardous waste handling and transfer facilities

(8) Incinerators

(9) Landfills

(10) Materials storage yards

(11) Pesticide storage facilities

(12) Fire stations

(13) Public restrooms

(14) Public parking lots

(15) Public golf courses

(16) Public swimming pools

(17) Public parks

(18) Public works yards

(19) Public marinas

(20) Recycling facilities

(21) Solid waste handling and transfer facilities

(22) Vehicle storage and maintenance yards

(23) Storm water management facilities (e.g., detention basins)

(24) All other Permittee-owned or operated facilities or activities that each Permittee determines may contribute a substantial pollutant load to the MS4.

ii. Each Permittee shall include the following minimum fields of information for each Permittee-owned or operated facility in its inventory.

(1) Name of facility

(2) Name of facility manager and contact information

(3) Address of facility (physical and mailing)

(4) A narrative description of activities performed and potential pollution sources.

(5) Coverage under the Industrial General Permit or other individual or general NPDES permits or any applicable waiver issued by the Regional or State Water Board pertaining to storm water discharges.

iii. Each Permittee shall update its inventory at least once during the 5-year term of the Order. The update shall be accomplished through collection of new information obtained through field activities or through other readily available inter and intra-agency informational databases (e.g., property management, land-use approvals, accounting and depreciation ledger account, and similar information).

d. Inventory of Existing Development for Retrofitting Opportunities

i. Each Permittee shall develop an inventory of retrofitting opportunities that meets the requirements of this Part VI.9.d. Retrofit opportunities shall be identified within the public right-of-way or in coordination with a TMDL implementation plan(s). The goals of the existing development retrofitting inventory are to address the impacts of existing development through regional or sub-regional retrofit projects that reduce the discharges of storm water pollutants into the MS4 and prevent discharges from the MS4 from causing or contributing to a violation of water quality standards as defined in Part V.A, Receiving Water Limitations.

ii. Each Permittee shall screen existing areas of development to identify candidate areas for retrofitting using watershed models or other screening level tools.

iii. Each Permittee shall evaluate and rank the areas of existing development identified in the screening to prioritize retrofitting candidates. Criteria for evaluation may include but are not limited to:

(1) Feasibility, including general private and public land availability;

(2) Cost effectiveness;

(3) Pollutant removal effectiveness;

(4) Tributary area potentially treated;

(5) Maintenance requirements;

(6) Landowner cooperation;

(7) Neighborhood acceptance;

(8) Aesthetic qualities;

(9) Efficacy at addressing concern; and

(10) Potential improvements to public health and safety.

iv. Each Permittee shall consider the results of the evaluation in the following programs:

(1) The Permittee's storm water management program: Highly feasible projects expected to benefit water quality should be given a high priority to implement source control and treatment control BMPs in a Permittee's SWMP.

(2) Off-site mitigation for New Development and Redevelopment: Each Permittee shall consider high priority retrofit projects as candidates for off-site mitigation projects per Part VI.D.7.c.iii.(4).(d).

(3) Where feasible, at the discretion of the Permittee, the existing development retrofitting program may be coordinated with flood control projects and other infrastructure improvement programs per Part VI.D.9.e.ii.(2) below.

v. Each Permittee shall cooperate with private landowners to encourage site specific retrofitting projects. Each Permittee shall consider the following practices in cooperating with private landowners to retrofit existing development:

(1) Demonstration retrofit projects;

(2) Retrofits on public land and easements that treat runoff from private developments;

(3) Education and outreach;

(4) Subsidies for retrofit projects;

(5) Requiring retrofit projects as enforcement, mitigation or ordinance compliance;

(6) Public and private partnerships;

(7) Fees for existing discharges to the MS4 and reduction of fees for retrofit implementation.

e. Public Agency Facility and Activity Management

i. Each Permittee shall obtain separate coverage under the Industrial General Permit for all Permittee-owned or operated facilities where industrial activities are conducted that require coverage under the Industrial General Permit.

ii. Each Permittee shall implement the following measures for Permittee- owned and operated flood management projects:

(1) Develop procedures to assess the impacts of flood management projects on the water quality of receiving water bodies; and

(2) Evaluate existing structural flood control facilities to determine if retrofitting the facility to provide additional pollutant removal from storm water is feasible.

iii. Each Permittee shall ensure the implementation and maintenance of activity specific BMPs listed in Table 18 (BMPs for Public Agency Facilities and Activities) or an equivalent set of BMPs when such activities occur at Permittee-owned or operated facilities and field activities (e.g., project sites) including but not limited to the facility types listed in Part VI.D.9.c above, and at any area that includes the activities described in Table 18, or that have the potential to discharge pollutants in storm water.

iv. Any contractors hired by the Permittee to conduct Public Agency Activities including, but not limited to, storm and/or sanitary sewer system inspection and repair, street sweeping, trash pick-up and disposal, and street and right-of-way construction and repair shall be contractually required to implement and maintain the activity specific BMPs listed in Table 18. Each Permittee shall conduct oversight of contractor activities to ensure these BMPs are implemented and maintained.

v. Permittee-owned or operated facilities that have obtained coverage under the Industrial General Permit shall implement and maintain BMPs consistent with the associated SWPPP and are therefore not required to implement and maintain the activity specific BMPs listed in Table 18.

vi. Effective source control BMPs for the activities listed in Table 18 shall be implemented at Permittee-owned or operated facilities, unless the pollutant generating activity does not occur. Each Permittee shall require implementation of additional BMPs where storm water from the MS4 discharges to a significant ecological area (SEA, see Attachment A for definition), a water body subject to TMDL provisions in Part VI.E., or a CWA § 303(d) listed water body (see Part VI.E below). Likewise, for those BMPs that are not adequately protective of water quality standards, a Permittee may require additional site-specific controls.

Table 18. BMPs for Public Agency Facilities and Activities

General and Activity Specific BMPs	
General BMPs	Scheduling and Planning
	Spill Prevention and Control
	Sanitary/Septic Waste Management
	Material Use
	Safer Alternative Products
	Vehicle/Equipment Cleaning, Fueling and Maintenance
	Illicit Connection Detection, Reporting and Removal
	Illegal Spill Discharge Control
	Maintenance Facility Housekeeping Practices
Flexible Pavement	Asphalt Cement Crack and Joint Grinding/ Sealing
	Asphalt Paving
	Structural Pavement Failure (Digouts) Pavement Grinding and Paving
	Emergency Pothole Repairs
	Sealing Operations
Rigid Pavement	Portland Cement Crack and Joint Sealing
	Mudjacking and Drilling
	Concrete Slab and Spall Repair
Slope/ Drains/ Vegetation	Shoulder Grading
	Nonlandscaped Chemical Vegetation Control
	Nonlandscaped Mechanical Vegetation Control/

General and Activity Specific BMPs	
	Mowing
	Nonlandscaped Tree and Shrub Pruning, Brush Chipping, Tree and Shrub Removal
	Fence Repair
	Drainage Ditch and Channel Maintenance
	Drain and Culvert Maintenance
	Curb and Sidewalk Repair
Litter/ Debris/ Graffiti	Sweeping Operations
	Litter and Debris Removal
	Emergency Response and Cleanup Practices
	Graffiti Removal
Landscaping	Chemical Vegetation Control
	Manual Vegetation Control
	Landscaped Mechanical Vegetation Control/ Mowing
	Landscaped Tree and Shrub Pruning, Brush Chipping, Tree and Shrub Removal
	Irrigation Line Repairs
	Irrigation (Watering), Potable and Nonpotable
Environmental	Storm Drain Stenciling
	Roadside Slope Inspection
	Roadside Stabilization
	Stormwater Treatment Devices
	Traction Sand Trap Devices
Bridges	Welding and Grinding
	Sandblasting, Wet Blast with Sand Injection and Hydroblasting
	Painting
	Bridge Repairs
Other Structures	Pump Station Cleaning
	Tube and Tunnel Maintenance and Repair
	Tow Truck Operations
	Toll Booth Lane Scrubbing Operations
Electrical	Sawcutting for Loop Installation
Traffic Guidance	Thermoplastic Striping and Marking
	Paint Striping and Marking
	Raised/ Recessed Pavement Marker Application and Removal
	Sign Repair and Maintenance
	Median Barrier and Guard Rail Repair
	Emergency Vehicle Energy Attenuation Repair
Storm Maintenance	Minor Slides and Slipouts Cleanup/ Repair
Management and Support	Building and Grounds Maintenance
	Storage of Hazardous Materials (Working Stock)
	Material Storage Control (Hazardous Waste)

General and Activity Specific BMPs	
	Outdoor Storage of Raw Materials
	Vehicle and Equipment Fueling
	Vehicle and Equipment Cleaning
	Vehicle and Equipment Maintenance and Repair
	Aboveground and Underground Tank Leak and Spill Control

f. Vehicle and Equipment Washing

i. Each Permittee shall implement and maintain the activity specific BMPs listed in Table 18 (BMPs for Public Agency Facilities and Activities) for all fixed vehicle and equipment washing; including fire fighting and emergency response vehicles.

ii. Each Permittee shall prevent discharges of wash waters from vehicle and equipment washing to the MS4 by implementing any of the following measures at existing facilities with vehicle or equipment wash areas:

(1) Self-contain, and haul off for disposal; or

(2) Equip with a clarifier or an alternative pre-treatment device and plumb to the sanitary sewer in accordance with applicable waste water provider regulations.

iii. Each Permittee shall ensure that any municipal facilities constructed, redeveloped, or replaced shall not discharge wastewater from vehicle and equipment wash areas to the MS4 by plumbing all areas to the sanitary sewer in accordance with applicable waste water provider regulations, or self-containing all waste water/ wash water and hauling to a point of legal disposal.

g. Landscape, Park, and Recreational Facilities Management

i. Each Permittee shall implement and maintain the activity specific BMPs listed in Table 18 for all public right-of-ways, flood control facilities and open channels, lakes and reservoirs, and landscape, park, and recreational facilities and activities.

ii. Each Permittee shall implement an IPM program that includes the following:

(1) Pesticides are used only if monitoring indicates they are needed, and pesticides are applied according to applicable permits and established guidelines.

(2) Treatments are made with the goal of removing only the target organism.

(3) Pest controls are selected and applied in a manner that minimizes risks to human health, beneficial non-target organisms, and the environment.

(4) The use of pesticides, including Organophosphates and Pyrethroids, does not threaten water quality.

(5) Partner with other agencies and organizations to encourage the use of IPM.

(6) Adopt and verifiably implement policies, procedures, and/ or ordinances requiring the minimization of pesticide use and encouraging the use of IPM techniques (including beneficial insects) for Public Agency Facilities and Activities.

(7) Policies, procedures, and ordinances shall include commitments and a schedule to reduce the use of pesticides that cause impairment of surface waters by implementing the following procedures:

(a) Prepare and annually update an inventory of pesticides used by all internal departments, divisions, and other operational units.

(b) Quantify pesticide use by staff and hired contractors.

(c) Demonstrate implementation of IPM alternatives where feasible to reduce pesticide use.

iii. Each Permittee shall implement the following requirements:

(1) Use a standardized protocol for the routine and non-routine application of pesticides (including pre-emergents), and fertilizers.

(2) Ensure there is no application of pesticides or fertilizers (1) when two or more consecutive days with greater than 50% chance of rainfall are predicted by NOAA[34], (2) within 48 hours of a ½-inch rain event, or (3) when water is flowing off the area where the application is to occur. This requirement does not apply to the application of aquatic pesticides described in Part VI.D.9.g.iii.(1) above or pesticides which require water for activation.

(3) Ensure that no banned or unregistered pesticides are stored or applied.

(4) Ensure that all staff applying pesticides are certified in the appropriate category by the California Department of Pesticide Regulation, or are under the direct supervision of a pesticide applicator certified in the appropriate category.

(5) Implement procedures to encourage the retention and planting of native vegetation to reduce water, pesticide and fertilizer needs; and

(6) Store pesticides and fertilizers indoors or under cover on paved surfaces, or use secondary containment.

(a) Reduce the use, storage, and handling of hazardous materials to reduce the potential for spills.

(b) Regularly inspect storage areas.

h. Storm Drain Operation and Maintenance

[34] www.srh.noaa.gov/forecast

i. Each Permittee shall implement and maintain the activity specific BMPs listed in Table 18 for storm drain operation and maintenance.

ii. Ensure that all material removed from the MS4 does not reenter the system. Solid material shall be dewatered in a contained area and liquid material shall be disposed in accordance with any of the following measures:

(1) Self-contain, and haul off for legal disposal; or

(2) Applied to the land without runoff; or

(3) Equip with a clarifier or an alternative pre-treatment device; and plumb to the sanitary sewer in accordance with applicable waste water provider regulations.

iii. Catch Basin Cleaning

(1) In areas that are not subject to a trash TMDL, each Permittee shall determine priority areas and shall update its map or list of Catch Basins with their GPS coordinates and priority:

<u>Priority A</u>: Catch basins that are designated as consistently generating the highest volumes of trash and/or debris.

<u>Priority B</u>: Catch basins that are designated as consistently generating moderate volumes of trash and/or debris.

<u>Priority C</u>: Catch basins that are designated as generating low volumes of trash and/or debris.

The map or list shall contain the rationale or data to support priority designations.

(2) In areas that are not subject to a trash TMDL, each Permittee shall inspect catch basins according to the following schedule:

<u>Priority A</u>: A minimum of 3 times during the wet season (October 1 through April 15) and once during the dry season every year.

<u>Priority B</u>: A minimum of once during the wet season and once during the dry season every year.

<u>Priority C</u>: A minimum of once per year.

Catch basins shall be cleaned as necessary on the basis of inspections. At a minimum, Permittees shall ensure that any catch basin that is determined to be at least 25% full of trash shall be cleaned out. Permittees shall maintain inspection and cleaning records for Regional Water Board review.

(3) In areas that are subject to a trash TMDL, the subject Permittees shall implement the applicable provisions in Part VI.E.

iv. Trash Management at Public Events

(1) Each Permittee shall require the following measures for any event in the public right of way or wherever it is foreseeable that substantial quantities

of trash and litter may be generated, including events located in areas that are subject to a trash TMDL:

(a) Proper management of trash and litter generated; and

(b) Arrangement for temporary screens to be placed on catch basins; or

(c) Provide clean out of catch basins, trash receptacles, and grounds in the event area within one business day subsequent to the event.

v. Trash Receptacles

(1) Each Permittee shall ensure trash receptacles, or equivalent trash capturing devices, are covered in areas newly identified as high trash generation areas within its jurisdiction.

(2) Each Permittee shall ensure that all trash receptacles are cleaned out and maintained as necessary to prevent trash overflow.

vi. Catch Basin Labels and Open Channel Signage

(1) Each Permittee shall label all storm drain inlets that they own with a legible “no dumping” message.

(2) Each Permittee shall inspect the legibility of the stencil or label nearest each inlet prior to the wet season every year.

(3) Each Permittee shall record all catch basins with illegible stencils and re-stencil or re-label within 180 days of inspection.

(4) Each Permittee shall post signs, referencing local code(s) that prohibit littering and illegal dumping, at designated public access points to open channels, creeks, urban lakes, and other relevant water bodies.

vii. Additional Trash Management Practices

(1) In areas that are not subject to a trash TMDL, each Permittee shall install trash excluders, or equivalent devices, on or in catch basins or outfalls to prevent the discharge of trash to the MS4 or receiving water no later than four years after the effective date of this Order in areas defined as Priority A (Part VI.D.9.h.iii.(1)) except at sites where the application of such BMP(s) alone will cause flooding. Lack of maintenance that causes flooding is not an acceptable exception to the requirement to install BMPs. Alternatively, each Permittee may implement alternative or enhanced BMPs beyond the provisions of this Order (such as but not limited to increased street sweeping, adding trash cans near trash generation sites, prompt enforcement of trash accumulation, increased trash collection on public property, increased litter prevention messages or trash nets within the MS4) that provide substantially equivalent removal of trash. Each Permittee shall demonstrate that BMPs, which substituted for trash excluders, provide equivalent trash removal performance as excluders. When outfall trash capture is provided, revision of the schedule for inspection and cleanout of catch basins in Part VI.D.9.h.iii.(2) shall be reported in the next year’s annual report.

viii. Storm Drain Maintenance

Each Permittee shall implement a program for Storm Drain Maintenance that includes the following:

(1) Visual monitoring of Permittee-owned open channels and other drainage structures for trash and debris at least annually.

(2) Removal of trash and debris from open channels a minimum of once per year before the wet season.

(3) Elimination of the discharge of contaminants during MS4 maintenance and clean outs.

(4) Proper disposal of debris and trash removed during storm drain maintenance.

ix. Infiltration from Sanitary Sewer to MS4/Preventive Maintenance

(1) Each Permittee shall implement controls and measures to prevent and eliminate infiltration of seepage from sanitary sewers to MS4s through thorough, routine preventive maintenance of the MS4.

(2) Each Permittee that operates both a municipal sanitary sewer system and a MS4 must implement controls and measures to prevent and eliminate infiltration of seepage from the sanitary sewers to the MS4s that must include overall sanitary sewer and MS4 surveys and thorough, routine preventive maintenance of both. Implementation of a Sewer System Management Plan in accordance with the Statewide General Waste Discharge Requirements for Sanitary Sewer Systems, may be used to fulfill this requirement.

(3) Each Permittee shall implement controls to limit infiltration of seepage from sanitary sewers to the MS4 where necessary. Such controls must include:

(a) Adequate plan checking for construction and new development;

(b) Incident response training for its municipal employees that identify sanitary sewer spills;

(c) Code enforcement inspections;

(d) MS4 maintenance and inspections;

(e) Interagency coordination with sewer agencies; and

(f) Proper education of its municipal staff and contractors conducting field operations on the MS4 or its municipal sanitary sewer (if applicable).

x. Permittee Owned Treatment Control BMPs

(1) Each Permittee shall implement an inspection and maintenance program for all Permittee owned treatment control BMPs, including post-construction treatment control BMPs.

(2) Each Permittee shall ensure proper operation of all treatment control BMPs and maintain them as necessary for proper operation, including all post-construction treatment control BMPs.

(3) Any residual water[35] produced by a treatment control BMP and not being internal to the BMP performance when being maintained shall be:

(a) Hauled away and legally disposed of; or

(b) Applied to the land without runoff; or

(c) Discharged to the sanitary sewer system (with permits or authorization); or

(d) Treated or filtered to remove bacteria, sediments, nutrients, and meet the limitations set in Table 19 (Discharge Limitations for Dewatering Treatment BMPs), prior to discharge to the MS4.

Table 19. Discharge Limitations for Dewatering Treatment BMPs[36]

Parameter	Units	Limitation
Total Suspended Solids	mg/L	100
Turbidity	NTU	50
Oil and Grease	mg/L	10

i. Streets, Roads, and Parking Facilities Maintenance

i. Each Permittee shall designate streets and/or street segments within its jurisdiction as one of the following:

Priority A: Streets and/or street segments that are designated as consistently generating the highest volumes of trash and/or debris.

Priority B: Streets and/or street segments that are designated as consistently generating moderate volumes of trash and/or debris.

Priority C: Streets and/or street segments that are designated as generating low volumes of trash and/or debris.

ii. Each Permittee shall perform street sweeping of curbed streets according to the following schedule:

Priority A: Streets and/or street segments that are designated as Priority A shall be swept at least two times per month.

Priority B: Streets and/or street segments that are designated as Priority B shall be swept at least once per month.

Priority C: Streets and/or street segments that are designated as Priority C shall be swept as necessary but in no case less than once per year.

[35] See Attachment A.
[36] Technology based effluent limitations.

iii. Road Reconstruction

Each Permittee shall require that for any project that includes roadbed or street paving, repaving, patching, digouts, or resurfacing roadbed surfaces, that the following BMPs be implemented for each project.

(1) Restrict paving and repaving activity to exclude periods of rainfall or predicted rainfall[37] unless required by emergency conditions.

(2) Install sand bags or gravel bags and filter fabric at all susceptible storm drain inlets and at manholes to prevent spills of paving products and tack coat;

(3) Prevent the discharge of release agents including soybean oil, other oils, or diesel into the MS4 or receiving waters.

(4) Prevent non-storm water runoff from water use for the roller and for evaporative cooling of the asphalt.

(5) Clean equipment over absorbent pads, drip pans, plastic sheeting or other material to capture all spillage and dispose of properly.

(6) Collect liquid waste in a container, with a secure lid, for transport to a maintenance facility to be reused, recycled or disposed of properly.

(7) Collect solid waste by vacuuming or sweeping and securing in an appropriate container for transport to a maintenance facility to be reused, recycled or disposed of properly.

(8) Cover the "cold-mix" asphalt (i.e., pre-mixed aggregate and asphalt binder) with protective sheeting during a rainstorm.

(9) Cover loads with tarp before haul-off to a storage site, and do not overload trucks.

(10) Minimize airborne dust by using water spray during grinding.

(11) Avoid stockpiling soil, sand, sediment, asphalt material and asphalt grindings materials or rubble in or near MS4 or receiving waters.

(12) Protect stockpiles with a cover or sediment barriers during a rain.

iv. Parking Facilities Maintenance

(1) Permittee-owned parking lots exposed to storm water shall be kept clear of debris and excessive oil buildup and cleaned no less than 2 times per month and/or inspected no less than 2 times per month to determine if cleaning is necessary. In no case shall a Permittee-owned parking lot be cleaned less than once a month.

j. Emergency Procedures

i. Each Permittee may conduct repairs of essential public service systems and infrastructure in emergency situations with a self-waiver of the provisions of this Order as follows:

[37] A probability of precipitation (POP) of 50% is required.

(1) The Permittee shall abide by all other regulatory requirements, including notification to other agencies as appropriate.

(2) Where the self-waiver has been invoked, the Permittee shall submit to the Regional Water Board Executive Officer a statement of the occurrence of the emergency, an explanation of the circumstances, and the measures that were implemented to reduce the threat to water quality, no later than 30 business days after the situation of emergency has passed.

(3) Minor repairs of essential public service systems and infrastructure in emergency situations (that can be completed in less than one week) are not subject to the notification provisions. Appropriate BMPs to reduce the threat to water quality shall be implemented.

k. Municipal Employee and Contractor Training

i. Each Permittee shall, no later than 1 year after Order adoption and annually thereafter before June 30, train all of their employees in targeted positions (whose interactions, jobs, and activities affect storm water quality) on the requirements of the overall storm water management program, or shall ensure contractors performing privatized/contracted municipal services are appropriately trained to:

(1) Promote a clear understanding of the potential for activities to pollute storm water.

(2) Identify opportunities to require, implement, and maintain appropriate BMPs in their line of work.

Outside contractors can self-certify, providing they certify they have received all applicable training required in the Permit and have documentation to that effect.

ii. Each Permittee shall, no later than 1 year after Order adoption and annually thereafter before June 30, train all of their employees and contractors who use or have the potential to use pesticides or fertilizers (whether or not they normally apply these as part of their work). Training programs shall address:

(1) The potential for pesticide-related surface water toxicity.

(2) Proper use, handling, and disposal of pesticides.

(3) Least toxic methods of pest prevention and control, including IPM.

(4) Reduction of pesticide use.

iii. Outside contractors can self-certify, providing they certify they have received all applicable training required in the Permit and have documentation to that effect.

10. Illicit Connections and Illicit Discharges Elimination Program

a. General

i. Each Permittee shall continue to implement an Illicit Connection and Illicit Discharge Elimination (IC/ID) Program to detect, investigate, and eliminate IC/IDs to the MS4. The IC/ID Program must be implemented in accordance with the requirements and performance measures specified in this Order.

ii. As stated in Part VI.A.2 of this Order, each Permittee must have adequate legal authority to prohibit IC/IDs to the MS4 and enable enforcement capabilities to eliminate the source of IC/IDs.

iii. Each Permittee's IC/ID Program shall consist of at least the following major program components:

(1) Procedures for conducting source investigations for IC/IDs

(2) Procedures for eliminating the source of IC/IDs

(3) Procedures for public reporting of illicit discharges

(4) Spill response plan

(5) IC/IDs education and training for Permittee staff

b. Illicit Discharge Source Investigation and Elimination

i. Each Permittee shall develop written procedures for conducting investigations to identify the source of all suspected illicit discharges, including procedures to eliminate the discharge once the source is located.

ii. At a minimum, each Permittee shall initiate an investigation(s) to identify and locate the source within 72 hours of becoming aware of the illicit discharge.

iii. When conducting investigations, each Permittee shall comply with the following:

(1) Illicit discharges suspected of being sanitary sewage and/or significantly contaminated shall be investigated first.

(2) Each Permittee shall track all investigations to document at a minimum the date(s) the illicit discharge was observed; the results of the investigation; any follow-up of the investigation; and the date the investigation was closed.

(3) Each Permittee shall investigate the source of all observed illicit discharges.

iv. When taking corrective action to eliminate illicit discharges, each Permittee shall comply with the following:

(1) If the source of the illicit discharge has been determined to originate within the Permittee's jurisdiction, the Permittee shall immediately notify the responsible party/parties of the problem, and require the responsible party to initiate all necessary corrective actions to eliminate the illicit discharge.

Upon being notified that the discharge has been eliminated, the Permittee shall conduct a follow-up investigation to verify that the discharge has been eliminated and cleaned-up to the satisfaction of the Permittee(s). Each Permittee shall document its follow-up investigation. Each Permittee may seek recovery and remediation costs from responsible parties or require compensation for the cost of all inspection, investigation, cleanup and oversight activities. Resulting enforcement actions shall follow the program's Progressive Enforcement Policy, per Part VI.D.2.

(2) If the source of the illicit discharge has been determined to originate within an upstream jurisdiction, the Permittee shall notify the upstream jurisdiction and the Regional Water Board within 30 days of such determination and provide all of the information collected regarding efforts to identify its source. Each Permittee may seek recovery and remediation costs from responsible parties or require compensation for the cost of all inspection, investigation, cleanup and oversight activities. Resulting enforcement actions shall follow the program's Progressive Enforcement Policy, per Part VI.D.2.

(3) If the source of the illicit discharge cannot be traced to a suspected responsible party, affected Permittees shall implement its spill response plan and then initiate a permanent solution as described in section 10.b.v below.

v. In the event the Permittee is unable to eliminate an ongoing illicit discharge following full execution of its legal authority and in accordance with its Progressive Enforcement Policy, or other circumstances prevent the full elimination of an ongoing illicit discharge, including the inability to find the responsible party/parties, the Permittee shall provide for diversion of the entire flow to the sanitary sewer or provide treatment. In either instance, the Permittee shall notify the Regional Water Board in writing within 30 days of such determination and shall provide a written plan for review and comment that describes the efforts that have been undertaken to eliminate the illicit discharge, a description of the actions to be undertaken, anticipated costs, and a schedule for completion.

c. Identification and Response to Illicit Connections

i. Investigation

Each Permittee, upon discovery or upon receiving a report of a suspected illicit connection, shall initiate an investigation within 21 days, to determine the following: (1) source of the connection, (2) nature and volume of discharge through the connection, and (3) responsible party for the connection.

ii. Elimination

Each Permittee, upon confirmation of an illicit MS4 connection, shall ensure that the connection is:

(1) Permitted or documented, provided the connection will only discharge storm water and non-storm water allowed under this Order or other individual or general NPDES Permits/WDRs, or

(2) Eliminated within 180 days of completion of the investigation, using its formal enforcement authority, if necessary, to eliminate the illicit connection.

iii. Documentation

Formal records must be maintained for all illicit connection investigations and the formal enforcement taken to eliminate illicit connections.

d. Public Reporting of Non-Storm Water Discharges and Spills

i. Each Permittee shall promote, publicize, and facilitate public reporting of illicit discharges or water quality impacts associated with discharges into or from MS4s through a central contact point, including phone numbers and an internet site for complaints and spill reporting. Each Permittee shall also provide the reporting hotline to Permittee staff to leverage the field staff that has direct contact with the MS4 in detecting and eliminating illicit discharges.

ii. Each Permittee shall implement the central point of contact and reporting hotline requirements listed in this part in one or more of the following methods:

(1) By participating in a County-wide sponsored hotline

(2) By participating in one or more Watershed Group sponsored hotlines

(3) Or individually within its own jurisdiction

(4) The LACFCD shall, in collaboration with the County, continue to maintain the 888-CLEAN-LA hotline and internet site to promote, publicize, and facilitate public reporting of illicit discharges or water quality impacts associated with discharges into or from MS4s.

iii. Each Permittee shall ensure that signage adjacent to open channels, as required in Part F.8.h.vi, include information regarding dumping prohibitions and public reporting of illicit discharges.

iv. Each Permittee shall develop and maintain written procedures that document how complaint calls are received, documented, and tracked to ensure that all complaints are adequately addressed. The procedures shall be evaluated to determine whether changes or updates are needed to ensure that the procedures accurately document the methods employed by the Permittee. Any identified changes shall be made to the procedures subsequent to the evaluation.

v. Each Permittee shall maintain documentation of the complaint calls and record the location of the reported spill or IC/ ID and the actions undertaken in response to all IC/ID complaints, including referrals to other agencies.

e. Spill Response Plan

i. Each Permittee shall implement a spill response plan for all sewage and other spills that may discharge into its MS4. The spill response plan shall clearly identify agencies responsible for spill response and cleanup, telephone numbers and e-mail address for contacts, and shall contain at a minimum the following requirements:

(1) Coordination with spill response teams throughout all appropriate departments, programs and agencies so that maximum water quality protection is provided.

(2) Initiate investigation of all public and employee spill complaints within one business day of receiving the complaint to assess validity.

(3) Response to spills for containment within 4 hours of becoming aware of the spill, except where such spills occur on private property, in which case the response should be within 2 hours of gaining legal access to the property.

(4) Spills that may endanger health or the environment shall be reported to appropriate public health agencies and the Office of Emergency Services (OES).

f. Illicit Connection and Illicit Discharge Education and Training

i. Each Permittee must continue to implement a training program regarding the identification of IC/IDs for all municipal field staff, who, as part of their normal job responsibilities (e.g., street sweeping, storm drain maintenance, collection system maintenance, road maintenance), may come into contact with or otherwise observe an illicit discharge or illicit connection to the MS4. Contact information, including the procedure for reporting an illicit discharge, must be readily available to field staff. Training program documents must be available for review by the permitting authority.

ii. Each Permittee shall ensure contractors performing privatized/contracted municipal services such as, but not limited to, storm and/or sanitary sewer system inspection and repair, street sweeping, trash pick-up and disposal, and street and right-of-way construction and repair are trained regarding IC/ID identification and reporting. Permittees may provide training or include contractual requirements for IC/ID identification and reporting training. Outside contractors can self-certify, providing they certify they have received all applicable training required in the Permit and have documentation to that effect.

iii. Each Permittee's training program should address, at a minimum, the following:

(1) IC/ID identification, including definitions and examples,

(2) investigation,

(3) elimination,

(4) cleanup,

(5) reporting, and

(6) documentation.

iv. Each Permittee must create a list of applicable positions and contractors which require IC/ID training and ensure that training is provided at least twice during the term of the Order. Each Permittee must maintain documentation of the training activities.

v. New Permittee staff members must be provided with IC/ID training within 180 days of starting employment.

E. Total Maximum Daily Load Provisions

1. The provisions of this Part VI.E. implement and are consistent with the assumptions and requirements of all waste load allocations (WLAs) established in TMDLs for which some or all of the Permittees in this Order are responsible.

a. Part VI.E of this Order includes provisions that are designed to assure that Permittees achieve WLAs and meet other requirements of TMDLs covering receiving waters impacted by the Permittees' MS4 discharges. TMDL provisions are grouped by WMA (WMA) in Attachments L through R.

b. The Permittees subject to each TMDL are identified in Attachment K.

c. The Permittees shall comply with the applicable water quality-based effluent limitations and/or receiving water limitations contained in Attachments L through R, consistent with the assumptions and requirements of the WLAs established in the TMDLs, including implementation plans and schedules, where provided for in the State adoption and approval of the TMDL (40 CFR §122.44(d)(1)(vii)(B); Cal. Wat. Code §13263(a)).

d. A Permittee may comply with water quality-based effluent limitations and receiving water limitations in Attachments L through R using any lawful means.

2. Compliance Determination

a. General

i. A Permittee shall demonstrate compliance at compliance monitoring points established in each TMDL or, if not specified in the TMDL, at locations identified in an approved TMDL monitoring plan or in accordance with an approved integrated monitoring program per Attachment E, Part VI.C.5 (Integrated Watershed Monitoring and Assessment).

ii. Compliance with water quality-based effluent limitations shall be determined as described in Parts VI.E.2.d and VI.E.2.e, or for trash water quality-based effluent limitations as described in Part VI.E.5.b, or as otherwise set forth in TMDL specific provisions in Attachments L through R.

iii. Pursuant to Part VI.C, a Permittee may, individually or as part of a watershed-based group, develop and submit for approval by the Regional Water Board Executive Officer a Watershed Management Program that addresses all water quality-based effluent limitations and receiving water limitations to which the Permittee is subject pursuant to established TMDLs.

b. Commingled Discharges

i. A number of the TMDLs establish WLAs that are assigned jointly to a group of Permittees whose storm water and/or non-storm water discharges are or may be commingled in the MS4 prior to discharge to the receiving water subject to the TMDL.

ii. In these cases, pursuant to 40 CFR section 122.26(a)(3)(vi), each Permittee is only responsible for discharges from the MS4 for which they are owners and/or operators.

iii. Where Permittees have commingled discharges to the receiving water, compliance at the outfall to the receiving water or in the receiving water shall be determined for the group of Permittees as a whole unless an individual Permittee demonstrates that its discharge did not cause or contribute to the exceedance, pursuant to subpart v. below.

iv. For purposes of compliance determination, each Permittee is responsible for demonstrating that its discharge did not cause or contribute to an exceedance of an applicable water quality-based effluent limitation(s) at the outfall or receiving water limitation(s) in the target receiving water.

v. A Permittee may demonstrate that its discharge did not cause or contribute to an exceedance of an applicable water quality-based effluent limitation or receiving water limitation in any of the following ways:

(1) Demonstrate that there is no discharge from the Permittee's MS4 into the applicable receiving water during the time period subject to the water quality-based effluent limitation and/or receiving water limitation; or

(2) Demonstrate that the discharge from the Permittee's MS4 is controlled to a level that does not exceed the applicable water quality-based effluent limitation; or

(3) For exceedances of bacteria receiving water limitations or water quality-based effluent limitations, demonstrate through a source investigation pursuant to protocols established under California Water Code section 13178 or for exceedances of other receiving water limitations or water quality-based effluent limitations, demonstrate using other accepted source identification protocols, that pollutant sources within the jurisdiction of the Permittee or the Permittee's MS4 have not caused or contributed to the exceedance of the Receiving Water Limitation(s).

c. Receiving Water Limitations Addressed by a TMDL

i. For receiving water limitations in Part V.A. associated with water body-pollutant combinations addressed in a TMDL, Permittees shall achieve compliance with the receiving water limitations in Part V.A. as outlined in this Part VI.E. and Attachments L through R of this Order.

ii. A Permittee's full compliance with the applicable TMDL requirement(s), including compliance schedules, of this Part VI.E. and Attachments L through R constitutes compliance with Part V.A. of this Order for the specific pollutant addressed in the TMDL.

iii. As long as a Permittee is in compliance with the applicable TMDL requirements in a time schedule order (TSO) issued by the Regional Water Board pursuant to California Water Code sections 13300 and 13385(j)(3), it is not the Regional Water Board's intention to take an enforcement action for violations of Part V.A. of this Order for the specific pollutant(s) addressed in the TSO.

d. Interim Water Quality-Based Effluent Limitations and Receiving Water Limitations

i. A Permittee shall be considered in compliance with an applicable interim water quality-based effluent limitation and interim receiving water limitation for a pollutant associated with a specific TMDL if any of the following is demonstrated:

(1) There are no violations of the interim water quality-based effluent limitation for the pollutant associated with a specific TMDL at the Permittee's applicable MS4 outfall(s),[38] including an outfall to the receiving water that collects discharges from multiple Permittees' jurisdictions;

(2) There are no exceedances of the applicable receiving water limitation for the pollutant associated with a specific TMDL in the receiving water(s) at, or downstream of, the Permittee's outfall(s);

(3) There is no direct or indirect discharge from the Permittee's MS4 to the receiving water during the time period subject to the water quality-based effluent limitation and/or receiving water limitation for the pollutant associated with a specific TMDL; or

(4) The Permittee has submitted and is fully implementing an approved Watershed Management Program or EWMP pursuant to Part VI.C.

(a) To be considered fully implementing an approved Watershed Management Program or EWMP, a Permittee must be implementing

[38] An outfall may include a manhole or other point of access to the MS4 at the Permittee's jurisdictional boundary.

all actions consistent with the approved program and applicable compliance schedules, including structural BMPs.

(b) Structural storm water BMPs or systems of BMPs should be designed and maintained to treat storm water runoff from the 85th percentile, 24-hour storm, where feasible and necessary to achieve applicable WQBELs and receiving water limitations, and maintenance records must be up-to-date and available for inspection by the Regional Water Board.

(c) A Permittee that does not implement the Watershed Management Program in accordance with the milestones and compliance schedules shall demonstrate compliance with its interim water quality-based effluent limitations and/or receiving water limitations pursuant to Part VI.E.2.d.i.(1)-(3), above.

(d) Upon notification of a Permittee's intent to develop a WMP or EWMP and prior to approval of its WMP or EWMP, a Permittee's full compliance with all of the following requirements shall constitute a Permittee's compliance with provisions pertaining to interim WQBELs with compliance deadlines occurring prior to approval of a WMP or EWMP. This subdivision (d) shall not apply to interim trash WQBELs.

(1) Provides timely notice of its intent to develop a WMP or EWMP,

(2) Meets all interim and final deadlines for development of a WMP or EWMP,

(3) For the area to be covered by the WMP or EWMP, targets implementation of watershed control measures in its existing storm water management program, including watershed control measures to eliminate non-storm water discharges of pollutants through the MS4 to receiving waters, to address known contributions of pollutants from MS4 discharges that cause or contribute to the impairment(s) addressed by the TMDL(s), and

(4) Receives final approval of its WMP or EWMP within 28 or 40 months, respectively.

e. Final Water Quality-based Effluent Limitations and/or Receiving Water Limitations

i. A Permittee shall be deemed in compliance with an applicable final water quality-based effluent limitation and final receiving water limitation for the pollutant(s) associated with a specific TMDL if any of the following is demonstrated:

(1) There are no violations of the final water quality-based effluent limitation for the specific pollutant at the Permittee's applicable MS4 outfall(s)[39];

(2) There are no exceedances of applicable receiving water limitation for the specific pollutant in the receiving water(s) at, or downstream of, the Permittee's outfall(s);

(3) There is no direct or indirect discharge from the Permittee's MS4 to the receiving water during the time period subject to the water quality-based effluent limitation and/or receiving water limitation for the pollutant(s) associated with a specific TMDL; or

(4) In drainage areas where Permittees are implementing an EWMP, (i) all non-storm water and (ii) all storm water runoff up to and including the volume equivalent to the 85th percentile, 24-hour event is retained for the drainage area tributary to the applicable receiving water. This provision (4) shall not apply to final trash WQBELs.

3. USEPA Established TMDLs

TMDLs established by the USEPA, to which Permittees are subject, do not contain an implementation plan adopted pursuant to California Water Code section 13242. However, USEPA has included implementation recommendations as part of these TMDLs. In lieu of inclusion of numeric water quality based effluent limitations at this time, this Order requires Permittees subject to WLAs in USEPA established TMDLs to propose and implement best management practices (BMPs) that will be effective in achieving compliance with USEPA established numeric WLAs. The Regional Water Board may, at its discretion, revisit this decision within the term of this Order or in a future permit, as more information is developed to support the inclusion of numeric water quality based effluent limitations.

a. Each Permittee shall propose BMPs to achieve the WLAs contained in the applicable USEPA established TMDL(s), and a schedule for implementing the BMPs that is as short as possible, in a Watershed Management Program or EWMP.

b. Each Permittee may either individually submit a Watershed Management Program, or may jointly submit a WMP or EWMP with other Permittees subject to the WLAs contained in the USEPA established TMDL.

c. At a minimum, each Permittee shall include the following information in its Watershed Management Program or EWMP, relevant to each applicable USEPA established TMDL:

i. Available data demonstrating the current quality of the Permittee's MS4 discharge(s) in terms of concentration and/or load of the target pollutant(s) to the receiving waters subject to the TMDL;

[39] Ibid.

ii. A detailed description of BMPs that have been implemented, and/or are currently being implemented by the Permittee to achieve the WLA(s), if any;

iii. A detailed time schedule of specific actions the Permittee will take in order to achieve compliance with the applicable WLA(s);

iv. A demonstration that the time schedule requested is as short as possible, taking into account the time since USEPA establishment of the TMDL, and technological, operation, and economic factors that affect the design, development, and implementation of the control measures that are necessary to comply with the WLA(s);

(1) For the Malibu Creek Nutrient TMDL established by USEPA in 2003, in no case shall the time schedule to achieve the final numeric WLAs exceed five years from the effective date of this Order; and

v. If the requested time schedule exceeds one year, the proposed schedule shall include interim requirements and numeric milestones and the date(s) for their achievement.

d. Each Permittee subject to a WLA in a TMDL established by USEPA shall submit a draft of a Watershed Management Program or EWMP to the Regional Water Board Executive Officer for approval per the schedule Part VI.C.4.

e. If a Permittee does not submit a Watershed Management Program, or the plan is determined to be inadequate by the Regional Water Board Executive Officer and the Permittee does not make the necessary revisions within 90 days of written notification that plan is inadequate, the Permittee shall be required to demonstrate compliance with the numeric WLAs immediately based on monitoring data collected under the MRP (Attachment E) for this Order.

4. State Adopted TMDLs where Final Compliance Deadlines have Passed

a. Permittees shall comply immediately with water quality-based effluent limitations and/or receiving water limitations to implement WLAs in state-adopted TMDLs for which final compliance deadlines have passed pursuant to the TMDL implementation schedule.

b. Where a Permittee believes that additional time to comply with the final water quality-based effluent limitations and/or receiving water limitations is necessary, a Permittee may within 45 days of Order adoption request a time schedule order pursuant to California Water Code section 13300 for the Regional Water Board's consideration.

c. Permittees may either individually request a TSO, or may jointly request a TSO with all Permittees subject to the water quality-based effluent limitations and/or receiving water limitations, to implement the WLAs in the state-adopted TMDL.

d. At a minimum, a request for a time schedule order shall include the following:

i. Data demonstrating the current quality of the MS4 discharge(s) in terms of concentration and/or load of the target pollutant(s) to the receiving waters subject to the TMDL;

ii. A detailed description and chronology of structural controls and source control efforts, since the effective date of the TMDL, to reduce the pollutant load in the MS4 discharges to the receiving waters subject to the TMDL;

iii. Justification of the need for additional time to achieve the water quality-based effluent limitations and/or receiving water limitations;

iv. A detailed time schedule of specific actions the Permittee will take in order to achieve the water quality-based effluent limitations and/or receiving water limitations;

v. A demonstration that the time schedule requested is as short as possible, taking into account the technological, operation, and economic factors that affect the design, development, and implementation of the control measures that are necessary to comply with the effluent limitation(s); and

vi. If the requested time schedule exceeds one year, the proposed schedule shall include interim requirements and the date(s) for their achievement. The interim requirements shall include both of the following:

(1) Effluent limitation(s) for the pollutant(s) of concern; and

(2) Actions and milestones leading to compliance with the effluent limitation(s).

5. Water Quality-Based Effluent Limitations for Trash

Permittees assigned a Waste Load Allocation in a trash TMDL shall comply as set forth below.

a. Effluent Limitations: Permittees shall comply with the interim and final water quality-based effluent limitations for trash set forth in Attachments L through R for the following Trash TMDLs:

i. Lake Elizabeth Trash TMDL (Attachment L)

ii. Santa Monica Bay Nearshore and Offshore Debris TMDL (Attachment M)

iii. Malibu Creek Watershed Trash TMDL (Attachment M)

iv. Ballona Creek Trash TMDL (Attachment M)

v. Machado Lake Trash TMDL (Attachment N)

vi. Los Angeles River Trash TMDL (Attachment O)

vii. Peck Road Park Lake Trash TMDL (Attachment O)

viii. Echo Park Lake Trash TMDL (Attachment O)

ix. Legg Lake Trash TMDL (Attachment O)

b. Compliance

i. Pursuant to California Water Code section 13360(a), Permittees may comply with the trash effluent limitations using any lawful means. Such compliance options are broadly classified as *full capture*, *partial capture, institutional controls,* or *minimum frequency of assessment and collection,* as described below, and any combination of these may be employed to achieve compliance:

(1) Full Capture Systems:

(a) The Basin Plan authorizes the Regional Water Board Executive Officer to certify *full capture systems*, which are systems that meet the operating and performance requirements as described in this Order, and the procedures identified in "Procedures and Requirements for Certification of a Best Management Practice for Trash Control as a Full Capture System."[40]

(b) Permittees are authorized to comply with their effluent limitations through certified *full capture systems* provided the requirements of paragraph (c), immediately below, and any conditions in the certification, continue to be met.

(c) Permittees may comply with their effluent limitations through progressive installation of *full capture systems* throughout their jurisdictional areas until all areas draining to Lake Elizabeth, Santa Monica Bay, Malibu Creek, Ballona Creek, Machado Lake, the Los Angeles River system, Legg Lake, Peck Road Park Lake, and/or Echo Park Lake are addressed. For purposes of this Order, attainment of the effluent limitations shall be conclusively presumed for any drainage area to Lake Elizabeth, Santa Monica Bay, Malibu Creek (and its tributaries), Ballona Creek (and its tributaries), Machado Lake, the Los Angeles River (and its tributaries), Legg Lake, Peck Road Park Lake, and/or Echo Park Lake where certified *full capture systems* treat all drainage from the area, provided that the *full capture systems* are adequately sized and maintained, and that maintenance records are up-to-date and available for inspection by the Regional Water Board.

[40] The Regional Water Board currently recognizes eight *full capture systems*. These are: Vortex Separation Systems (VSS) and seven other Executive Officer certified *full capture systems*, including specific types or designs of trash nets; two gross solids removal devices (GSRDs); catch basin brush inserts and mesh screens; vertical and horizontal trash capture screen inserts; and a connector pipe screen device. See August 3, 2004 Los Angeles Regional Water Quality Control Board Memorandum titled "Procedures and Requirements for Certification of a Best Management Practice for Trash Control as a Full Capture System.

(i) A Permittee shall be deemed in compliance with its final effluent limitation if it demonstrates that all drainage areas under its jurisdiction and/or authority are serviced by appropriate certified *full capture systems* as described in paragraph (1)(c).

(ii) A Permittee shall be deemed in compliance with its interim effluent limitations, where applicable:

1. By demonstrating that *full capture systems* treat the percentage of drainage areas in the watershed that corresponds to the required trash abatement.
2. Alternatively, a Permittee may propose a schedule for installation of *full capture systems* in areas under its jurisdiction and/or authority within a given watershed, targeting first the areas of greatest trash generation, for the Executive Officer's approval. The Executive Officer shall not approve any such schedule that does not result in timely compliance with the final effluent limitations, consistent with the established TMDL implementation schedule and applicable State policies. A Permittee shall be deemed in compliance with its interim effluent limitations provided it is fully in compliance with any such approved schedule.

(2) Partial Capture Devices and Institutional Controls: Permittees may comply with their interim and final effluent limitations through the installation of *partial capture devices* and the application of *institutional controls*.[41]

(a) Trash discharges from areas serviced solely by *partial capture devices* may be estimated based on demonstrated performance of the device(s) in the implementing area.[42] That is, trash reduction is equivalent to the *partial capture devices'* trash removal efficiency multiplied by the percentage of drainage area serviced by the devices.

(b) Except as provided in subdivision (c), immediately below, trash discharges from areas addressed by *institutional controls* and/or *partial capture devices* (where site-specific performance data is not available) shall be calculated using a mass balance approach, based on the daily generation rate (DGR) for a representative area.[43] The DGR shall be determined from direct measurement of trash deposited in the drainage area during any thirty-day period between June 22nd and September 22nd exclusive of rain events[44], and shall be re-calculated every year thereafter unless a less frequent period for recalculation is approved by the Regional Water Board Executive Officer. The DGR

[41] While interim effluent limitations may be complied with using *partial capture devices*, compliance with final effluent limitations cannot be achieved with the exclusive use of *partial capture devices*.
[42] Performance shall be demonstrated under different conditions (e.g. low to high trash loading).
[43] The area(s) should be representative of the land uses and activities within the Permittees' authority and shall be approved by the Executive Officer prior to the 30-day collection period.
[44] Provided no special events are scheduled that may affect the representative nature of that collection period.

shall be calculated as the total amount of trash collected during this period divided by the length of the collection period.

DGR = (Amount of trash collected during a 30-day collection period[45] ***/ (30 days)***

The DGR for the applicable area under the Permittees' jurisdiction and/or authority shall be extrapolated from that of the representative drainage area(s). A mass balance equation shall be used to estimate the amount of trash discharged during a storm event.[46] The *Storm Event Trash Discharge* for a given rain event in the Permittee's drainage area shall be calculated by multiplying the number of days since the last street sweeping by the DGR and subtracting the amount of any trash recovered in the catch basins.[47] For each day of a storm event that generates precipitation greater than 0.25 inch, the Permittee shall calculate a *Storm Event Trash Discharge*.

Storm Event Trash Discharge = [(Days since last street sweeping*DGR)] – [Amount of trash recovered from catch basins][48]

The sum of the *Storm Event Trash Discharges* for the storm year shall be the Permittee's calculated annual trash discharge.

Total Storm Year Trash Discharge = ∑Storm Event Trash Discharges from Drainage Area

(c) The Executive Officer may approve alternative compliance monitoring approaches for calculating total storm year trash discharge, upon finding that the program will provide a scientifically-based estimate of the amount of trash discharged from the Permittee's MS4.

(3) Combined Compliance Approaches:

Permittees may comply with their interim and final effluent limitations through a combination of *full capture systems*, *partial capture devices*, and *institutional controls*. Where a Permittee relies on a combination of approaches, it shall demonstrate compliance with the interim and final effluent limitations as specified in (1)(c) in areas where *full capture systems* are installed and as specified in (2)(a) or (2)(b), as appropriate, in areas where *partial capture devices* and *institutional controls* are applied.

(4) Minimum Frequency of Assessment and Collection Approach:

If allowed in a trash TMDL and approved by the Executive Officer, a Permittee may alternatively comply with its final effluent limitations by

[45] Between June 22nd and September 22nd
[46] Amount of trash shall refer to the uncompressed volume (in gallons) or drip-dry weight (in pounds) of trash collected.
[47] Any negative values shall be considered to represent a zero discharge.
[48] When more than one storm event occurs prior to the next street sweeping the discharge shall be calculated from the date of the last assessment.

implementing a program for *minimum frequency of assessment and collection* (MFAC) in conjunction with BMPs. To the satisfaction of the Executive Officer, the MFAC/BMP program must meet the following criteria:

(a) The MFAC/BMP Program includes an initial minimum frequency of trash assessment and collection and suite of structural and/or nonstructural BMPs. The MFAC/BMP program shall include collection and disposal of all trash found in the receiving water and shoreline. Permittees shall implement an initial suite of BMPs based on current trash management practices in land areas that are found to be sources of trash to the water body. The initial minimum frequency of trash assessment and collection shall be set as specified in the following TMDLs:

  (i) Malibu Creek Watershed Trash TMDL

  (ii) Machado Lake Trash TMDL

  (iii) Legg Lake Trash TMDL

(b) The MFAC/BMP Program includes reasonable assurances that it will be implemented by the responsible Permittees.

(c) MFAC protocols may be based on SWAMP protocols for rapid trash assessment, or alternative protocols proposed by Permittees and approved by the Regional Water Board Executive Officer.

(d) Implementation of the MFAC/BMP program should include a Health and Safety Program to protect personnel. The MFAC/BMP program shall not require Permittees to access and collect trash from areas where personnel are prohibited.

(e) The Regional Water Board Executive Officer may approve or require a revised assessment and collection frequency and definition of the critical conditions under the MFAC:

  (i) To prevent trash from accumulating in deleterious amounts that cause nuisance or adversely affect beneficial uses between collections;

  (ii) To reflect the results of trash assessment and collection;

  (iii) If the amount of trash collected does not show a decreasing trend, where necessary, such that a shorter interval between collections is warranted; or

  (iv) If the amount of trash collected is decreasing such that a longer interval between collections is warranted.

(f) At the end of the implementation period, a revised MFAC/BMP program may be required if the Regional Water Board Executive Officer determines that the amount of trash accumulating between collections is causing nuisance or otherwise adversely affecting beneficial uses.

(g) With regard to (4)(e)(i), (4)(e)(ii), or (4)(e)(iii), above, the Regional Water Board Executive Officer is authorized to allow responsible Permittees to implement additional structural or non-structural BMPs in lieu of modifying the monitoring frequency.

ii. If a Permittee is not in compliance with its applicable interim and/or final effluent limitation as identified in Attachments L through R, then it shall be in violation of this Order.

(1) A Permittee relying on *partial capture devices* and/or *institutional controls* that has violated its interim and/or final effluent limitation(s) shall be presumed to have violated the applicable limitation for each day of each storm event that generated precipitation greater than 0.25 inch during the applicable storm year, except those storm days on which it establishes that its cumulative Storm Event Trash Discharges has not exceeded the applicable effluent limitation.

(2) If a Permittee relying on *full capture systems* has failed to demonstrate that the *full capture systems* for any drainage area are adequately sized and maintained, and that maintenance records are up-to-date and available for inspection by the Regional Water Board, and that it is in compliance with any conditions of its certification, shall be presumed to have discharged trash in an amount that corresponds to the percentage of the baseline waste load allocation represented by the drainage area in question.

(a) A Permittee may overcome this presumption by demonstrating (using any of the methods authorized in Part VI.E.5.b) that the actual or calculated discharge for that drainage area is in compliance with the applicable interim or final effluent limitation.

iii. Each Permittee shall be held liable for violations of the effluent limitations assigned to their area. If a Permittee's compliance strategy includes *full* or *partial capture devices* and it chooses to install a full or partial capture device in the MS4 physical infrastructure of another public entity, it is responsible for obtaining all necessary permits to do so. If a Permittee believes it is unable to obtain the permits needed to install a full capture or partial capture device within another Permittee's MS4 physical infrastructure, either Permittee may request the Executive Officer to hold a conference with the Permittees. Nothing in this Order shall affect the right of that public entity or a Permittee to seek indemnity or other recourse from the other as they deem appropriate. Nothing in this subsection shall be construed as relieving a Permittee of any liability that the Permittee would otherwise have under this Order.

c. Monitoring and Reporting Requirements (pursuant to California Water Code section 13383)

i. Each Permittee shall submit a TMDL Compliance Report as part of its Annual Report detailing compliance with the applicable interim and/or final effluent limitations. Reporting shall include the information specified below. The report shall be submitted on the reporting form specified by the Regional Water Board Executive Officer. The report shall be signed under penalty of perjury by the Permittee's principal executive officer or ranking elected official or duly authorized representative of the officer, consistent with Part V.B of Attachment D (Standard Provisions), who is responsible for ensuring compliance with this Order. Each Permittee shall be charged with and shall demonstrate compliance with its applicable effluent limitations beginning with its December 15, 2013, TMDL Compliance Report.

(1) <u>Reporting Compliance based on Full Capture Systems</u>: Permittees shall provide information on the number and location of full capture installations, the sizing of each full capture installation, the drainage areas addressed by these installations, and compliance with the applicable interim or final effluent limitation, in its TMDL Compliance Report. The Los Angeles Water Board will periodically audit sizing, performance, and other data to validate that a system satisfies the criteria established for a *full capture system* and any conditions established by the Regional Water Board Executive Officer in the certification.

(2) <u>Reporting Compliance based on Partial Capture Systems and/or Institutional Controls</u>:

(a) Using Performance Data Specific to the Permittee's Area: In its TMDL Compliance Report, a Permittee shall provide: (i) site-specific performance data for the applicable device(s); (ii) information on the number and location of such installations, and the drainage areas addressed by these installations; and (iii) calculated compliance with the applicable effluent limitations.

(b) Using Direct Measurement of Trash Discharge: Permittees shall provide an accounting of DGR and trash removal via street sweeping, catch basin clean outs, etc., in a database to facilitate the calculation of discharge for each rain event. The database shall be maintained and provided to the Regional Water Board for inspection upon request. In its TMDL Compliance Report, a Permittee shall provide information on its annual DGR, calculated storm year discharge, and compliance with the applicable effluent limitation.

(3) <u>Reporting Compliance based on Combined Compliance Approaches</u>:

Permittees shall provide the information specified in Part VI.E.5.c.i(1) for areas where *full capture systems* are installed and that are specified in Part VI.E.5.c.i(2)(a) or (b), as appropriate, for areas where *partial capture devices* and *institutional controls* are applied. In its TMDL Compliance Report, a Permittee shall also provide information on compliance with the applicable effluent limitation based on the combined compliance approaches.

(4) Reporting Compliance based on an MFAC/BMP Approach:

The MFAC/BMP Program includes a Trash Monitoring and Reporting Plan, and a requirement that the responsible Permittees will self-report any non-compliance with its provisions. The results and report of the Trash Monitoring and Reporting Plan must be submitted to Regional Water Board with the Permittee's Annual Report.

ii. Violation of the reporting requirements of this Part shall be punishable pursuant to, inter alia, California Water Code section 13385, subdivisions (a)(3) and (h)(1), and/or section 13385.1.

Green Infrastructure for Los Angeles:

Addressing Urban Runoff and Water Supply Through **Low Impact Development**

In memory of Dorothy Green,

whose dedication to creating healthy, sustainable waters for
Los Angeles and the state of California was an inspiration to us all.

Table of Contents

Part II:
Making LID Work for Los Angeles

Appendices

[1] Executive Summary

The purpose of this report is to examine low impact development (LID) for the City of Los Angeles and potential steps for instituting city-wide low impact development programs or projects. It also gathers policy strategies and technical information that could be pertinent to the City's LID efforts.

Part I (Chapters 2–5) describes the importance of low impact development and green infrastructure and highlights existing LID programs throughout the nation and here in Southern California. Part II (Chapters 6–11) explores potential ways to implement LID in Los Angeles and some of the issues that should be considered. It also reviews current policies and regulations (such as stormwater management laws and the City's recent Green Building Ordinance) that intersect with local LID programs. Finally, the appendices contain additional information and resources that may be helpful for developing comprehensive green infrastructure programs and projects for the City of Los Angeles.

Rio Hondo Golf Course parking lot in Downey, CA

What is Low Impact Development?

Stormwater pollution, water shortages, flood control, climate change and the availability of natural green space have all become pressing environmental issues for cities around the nation, including the City of Los Angeles. Fortunately, new strategies for runoff management using low impact development and green infrastructure offer promising solutions to many of these concerns.

Low impact development (LID) is an approach to stormwater management that emphasizes the use of small-scale, natural drainage features integrated throughout the city to slow, clean, infiltrate and capture urban runoff and precipitation, thus reducing water pollution, replenishing local aquifers and increasing water reuse.[1]

Key Principles of Low Impact Development

- Decentralize □ manage urban runoff to integrate water management throughout the watershed.
- Preserve or restore the ecosystem's natural hydrological functions and cycles.
- Account for a site's topographic features in its design.
- Reduce impervious ground cover and building footprint.
- Maximize infiltration on-site.
- If infiltration is not possible, then capture water for filtration and/or reuse.

While conventional stormwater controls aim to move water off-site and into the storm drains as quickly as possible, LID seeks to do just the opposite—to keep as much water on-site as possible for absorption and infiltration in order to clean it naturally. LID focuses on controlling urban runoff and pollution at the source of the problem, rather than at the end of the storm drain outlet. A comprehensive approach to LID should include city-wide land development strategies and planning along with the creation of infrastructure for stormwater management.

Green Infrastructure

Green infrastructure refers to an interconnected network of natural features (vegetation, parks, wetlands, etc.) that provide beneficial "ecosystem services" for human populations. The benefits can include functions such as pollution removal, carbon sequestration and groundwater recharge.[2 3] Low impact development and green infrastructure are often used interchangeably because the terms overlap, but it should be noted that LID focuses specifically on water management issues, while green infrastructure's scope can be broader. Green infrastructure is often used to refer to networks of parks and open lands that preserve habitats and ecosystem functions (usually created or protected by managing land uses), but the term can also encompass small-scale natural features such as trees planted along a city sidewalk. While green infrastructure is often used for water management purposes, it can also be used to tackle other issues such as air pollution, urban heat island effects, wildlife conservation and recreational needs.

Common LID Best Management Practices

A **best management practice (BMP)**[4] is a device or technique used to remove or reduce pollutants found in stormwater runoff, preventing the contamination of receiving waters.[a] It is important to note that LID primarily employs *natural* structural best management practices (such as vegetated swales, retention ponds and green roofs), not mechanical best management practices (such as water treatment facilities and manufactured filtration units). Examples of some of the most common LID best management practices are depicted on the next page; a more extensive selection can be found in Chapter 3. The best management practices generally fall into four categories: landscape BMPs, building BMPs, street and alley BMPs, and site planning BMPs.

Seattle's SEA Street (Street Edge Alternatives) project includes bioswales and permeable pavement.

[a] Receiving waters are lakes, rivers, oceans, and other types of waterways into which stormwater can flow.

Some Common LID Best Management Practices [5]

			
Vegetated Swales □Bioswales	Rain Gardens	Rain Cisterns	Green Roofs

			
Permeable Pavers	Porous Pavement	Curb Bump-Outs	Curb Cuts

The Benefits of LID for Los Angeles

Low impact development offers a wide range of community benefits. It improves flood control, relieves pressure on the sewage treatment system, prevents river and ocean pollution, reduces the demand for water use, augments groundwater aquifers, mitigates climate change, provides natural green space, increases the availability of green jobs, and saves money on the capital costs for stormwater management infrastructure.

The potential benefits of low impact development to help water pollution, water supply and energy usage in Los Angeles County are compelling. A study done by Community Conservancy International in March 2008 found that **nearly 40% of L.A. County's needs for cleaning polluted runoff could be met by implementing low impact development projects on existing public lands.** A net average of 15,000 acres of existing public lands in the county are suitable for LID projects.[6]

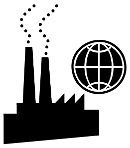
In addition, each ¼-acre of hardscape in Los Angeles has the potential to collect 100,000 gallons of rainwater per year.[7] A separate study by the Natural Resource Defense Council from January 2009[8] found that an increased use of LID practices throughout residential and commercial properties in L.A. County would promote groundwater recharge and water capture and reuse, reducing the county's dependence on distant sources of water. This increased use of LID would result in the **savings of 74,600–152,500 acre-feet of imported water** per year by 2030. Based on current per capita water usage in the City of Los Angeles, this is equivalent to the water consumption of 456,300–929,700 people.[9] Moreover, since L.A. County would be pumping less water from distant locations, **131,700–428,000 MWH of energy would be saved** per year by 2030, which is equivalent to the electricity used by 20,000–64,800 households.[10] Therefore, LID could also mitigate climate change by reducing greenhouse gases.

The following tables highlight some of the advantages that LID has to offer and provide interesting facts about the effectiveness of LID. Additional tables about flood control, wastewater management, water pollution, community improvements, and construction and building costs can be found in Chapter 4.

Bioswales at 1100 S. Hope Street in downtown L.A.

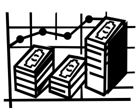
Water Supply & Demand

Issues	How LID Helps	Supporting Facts
• The L.A. area regularly faces water shortages and does not generate enough water to sustain itself. • Only 13□ of L.A. City□s water supply comes from local groundwater.[11] • 48□ of L.A. City□s water supply originates from the Mono Basin and Owens Valley aqueducts. • At least 30□ of all the water used in the City of Los Angeles is used outdoors.[12]	• Decreases Los Angeles□ dependence on outside sources of water. • Reduces the demand for irrigation water because rainwater is slowed and captured for infiltration into the ground. Some methods also capture water for reuse. • Increases the supply in the local water table. • Promotes or requires the use of drought-tolerant plants.	• Widespread use of water infiltration, capture and reuse in L.A. County would result in the savings of 74,600□152,500 acre-feet of imported water per year by 2030.[13] (Equivalent to the water consumption of 456,300□929,700 people.) • Each □-acre lot in L.A. has the potential to generate100,000 gallons of stormwater annually.[14] • By disconnecting 60,000 gutter downspouts, Portland diverted 1.5 billion gallons of stormwater per year. [15]



Climate Change

Issues	How LID Helps	Supporting Facts
• Fossil fuels are the #1 source of the greenhouse gases that cause climate change. • World temperatures could rise by between 2.0 and 11.5 °F during the 21st century.[16] • Blacktop surfaces can elevate surrounding city temperatures as much as 10°F.[17] • In the summer, central Los Angeles is typically 5°F warmer than surrounding suburban and rural areas due to the heat island effect.[18]	• Increasing the local water supply means that Los Angeles will use less energy pumping water from distant locations. • Trees and landscaping counteract climate change by absorbing excess carbon dioxide. • Shade from trees and evapotranspiration by plants reduce the heat island effect.	• Water systems account for 19% of the electricity used in the state of California.[19] • L.A. County could save 131,700–428,000 mWh of energy per year if less water was transported from Northern California.[20] (Equivalent to electricity use of 20,000–64,800 households.) • Each shade tree in L.A. prevents the combustion of 18kg of carbon annually and sequesters an additional 4.5–11kg of carbon per year.[21]



Green Jobs & Economy

Issues	How LID Helps	Supporting Facts
• The City of Los Angeles would like to encourage the development of "green-collar" jobs.[22] • The current economic recession has resulted in city budget cuts. More revenues are needed to fill the gaps.	• Encourages the growth of the green building industry. • Encourages the landscaping and gardening industry to shift to eco-friendly practices that emphasize native, drought-tolerant plants and rainwater harvesting. • Property drainage evaluations could increase the demand for "green industry" jobs in environmental assessment. • Trees and landscaping and reduced neighborhood flooding can enhance neighborhood property values, thus increasing tax revenues.	• L.A.'s Green Building Ordinance will create an anticipated 500 green-collar, union jobs.[23] • L.A.'s growing green building industry presents workforce development opportunities for auditors and landscapers and gardeners.[24] • Trees in Portland, OR generate approx. $13 million per year in property tax revenues by increasing real estate values.[25]

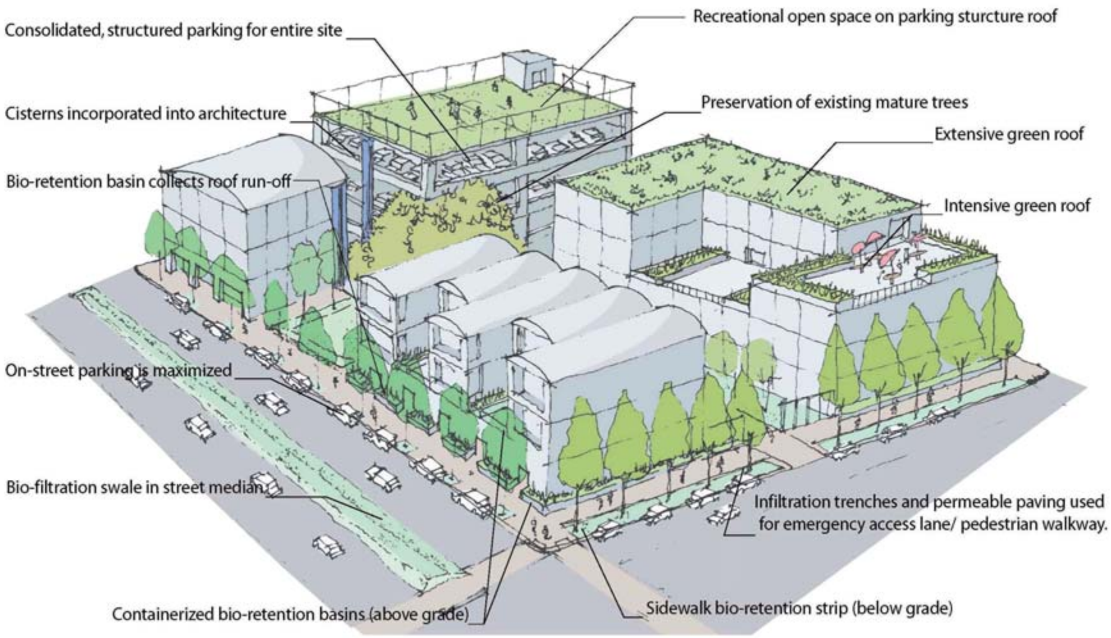


Illustration from the City of Emeryville's *"Stormwater Guidelines for Green, Dense Redevelopment"* manual depicting what LID might look like for a commercial development. *Credit: City of Emeryville / Community, Design + Architecture*

Examples of LID Programs, Projects and Regulations [26]

Many cities and counties across the country already have low impact development regulations, programs and projects underway, often pursued as an extension of a greater stormwater management, landscaping or sustainability program. Some particularly notable examples include the nation's first official LID program in Prince George's County (MD), Seattle's "Street Edge Alternatives" retrofit projects and their Green Factor building code (which requires properties to attain a certain level of permeability), numerous Green Streets projects in Portland (OR), Chicago's Green Alleys program, and Emeryville's program that promotes green, dense redevelopment.

The County of Los Angeles passed its Low Impact Development Ordinance in October 2008, which could offer a template for future LID efforts in the City of Los Angeles. The City of Los Angeles does not yet have a LID ordinance of its own, but it does have a number of pilot programs in place such as the Oros Street stormwater retrofit, Bimini Slough Ecology Park, the Green Streets LA program, and the Downspout Disconnect program. Other examples of LID in Southern California include the City of Ventura's Green Street policy, the City of San Diego's low impact development program, and Santa Monica's green building program.

Oros Street after its "green street" reconstruction (Los Angeles)

Existing Stormwater Regulations & Programs in Los Angeles

There are a number of stormwater regulations and green infrastructure programs originating from the federal, state, county and city levels of government that apply to the City of Los Angeles, providing a solid foundation for future LID efforts. Four key regulations and programs in the City of Los Angeles are the Standard Urban Stormwater Mitigation Plan, the Green Building Ordinance, the Landscape Ordinance and the Green Streets LA program.

The **Standard Urban Stormwater Mitigation Plan (SUSMP)** is part of L.A. County's Municipal Stormwater Permit, which applies to the City and addresses federal water pollution regulations by setting stormwater management requirements. In general, SUSMP applies to new developments and redevelopments of a certain minimum size.[27] It therefore does not apply to a large amount of existing development in Los Angeles. SUSMP best management practices must be able to infiltrate, capture and reuse, or treat all of the runoff from a site during an 85th percentile storm, which is equivalent to a ¾" storm. Although many of Los Angeles' existing low impact development BMPs were installed due to SUSMP requirements, SUSMP's primary goal is to reduce pollution levels; it only incidentally diverts stormwater to groundwater recharge areas. Additionally, the L.A. County Stormwater Permit must be reissued every five years, and its requirements can vary from permit to permit.

A vegetated swale with curb cuts in the parking lot of a shopping center at 8500 Firestone Blvd., Downey, CA.

The City of Los Angeles' **Green Building Ordinance** and **Landscape Ordinance** both have some LID features, but at this time neither addresses low impact development principles.[28 29] Like SUSMP, they do not deal with existing development, and they do not specifically require significant use of green infrastructure BMPs.

The **Green Streets LA** program was initiated by the City Board of Public Works with the idea that Los Angeles' extensive street network offers an important opportunity to absorb, capture and filter urban runoff, which addresses pollution and groundwater recharge issues.[30] The Green Streets LA program has expanded the City's focus to include a broader array of LID practices. A preliminary set of Green Streets design guidelines were developed in 2008 and other measures are being planned to institutionalize low impact development.

How Much Does Low Impact Development Cost?

Pilot projects have shown that using low impact development techniques instead of conventional stormwater controls can result in considerable capital cost savings. **An analysis of LID projects from across the nation conducted by the U.S. Environmental Protection Agency (EPA) in 2007 found that with just a few exceptions, the capital costs of LID projects were less than conventional water management controls.** As shown in the table below, savings ranged from 15–80%.[31] (Please see Appendix III for a fact sheet about the report.) It is important to note that the EPA's analysis did not account for the value of the environmental, social and community benefits created by the projects.

Project [a]	Estimated Conventional Development Cost	Actual LID Cost	Cost Savings[b]	Percent Savings[b]
2nd Avenue SEA Street (Washington)	$868,803	$651,548	$217,255	25□
Auburn Hills (Wisconsin)	$2,360,385	$1,598,989	$761,396	32□
Bellingham City Hall (Washington)	$27,600	$5,600	$22,000	80□
Bellingham Park (Washington)	$52,800	$12,800	$40,000	76□
Gap Creek (Arkansas)	$4,620,600	$3,942,100	$678,500	15□
Garden Valley (Washington)	$324,400	$260,700	$63,700	20□
Kensington Estates (Washington)	$765,700	$1,502,900	□$737,200	□96□
Laurel Springs (Wisconsin)	$1,654,021	$1,149,552	$504,469	30□
Mill Creek[c] (Illinois)	$12,510	$9,099	$3,411	27□
Prairie Glen (Wisconsin)	$1,004,848	$599,536	$405,312	40□
Somerset (Maryland)	$2,456,843	$1,671,461	$785,382	32□
Tellabs Corporate Campus (Illinois)	$3,162,160	$2,700,650	$461,510	15□

EPA Report:

Cost Comparisons Between Conventional and LID Approaches

Notes:

[a] Some of the case study results do not lend themselves to display in the format of this table (Central Park Commercial Redesigns, Crown St., Poplar Street Apartments, Prairie Crossing, Portland Downspout Disconnection, and Toronto Green Roofs).
[b] Negative values denote increased cost for the LID design over conventional development costs.
[c] Mill Creek costs are reported on a per-lot basis.

Source: "Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices." USEPA, 2007.

Research conducted by the City of Ventura may be helpful in determining the potential costs of implementing low impact development in Los Angeles, as Ventura is also located in Southern California and has a similar climate. A copy of Ventura's "Green Streets Matrix" is included in Appendix II. It contains an analysis of the costs, benefits, challenges and drawbacks for 17 different kinds of LID best management practices. The City of Los Angeles' Green Streets LA program is also in the process of developing its own cost estimates.

Low Impact Development for Los Angeles

Funding and Maintaining a LID Program

In a time of government budget cuts, searching for steady funding to support new public works projects and regular maintenance services has never been more important. Consistent maintenance of low impact development best management practices will ensure that they continuously perform at a high standard. Chapter 6 highlights more than a dozen strategies that could help secure a steady revenue stream for city projects and services. Ideas include municipal bonds, LID in-lieu fees, individualized parcel drainage fees with a rebate program, parking increment financing, using Quimby Fees for LID parks, public-private partnerships, and sales of L.A. City carbon offsets.

Strategies to Codify Low Impact Development

While a number of existing regulations and programs in Los Angeles touch on low impact development principles, the City could benefit from a comprehensive, enforceable ordinance that makes LID a common practice. **The two greatest advantages to enacting a LID ordinance—as opposed to relying exclusively on LID policies—are (1) enforcement, and (2) long-term reliability.** Nonetheless, a few alternative methods for implementing low impact development on a smaller scale include meeting SUSMP requirements using low impact development standards, revising the Landscape Ordinance to include LID standards, or enacting a LID ordinance after a voluntary pilot phase. These alternatives are further described in Chapter 8.

Defining the Scope of a LID Strategy for Los Angeles

Chapter 9 discusses issues that must be considered in order to define the appropriate scope and standards for a low impact development strategy in Los Angeles:

- Determining to whom LID should apply—government buildings, public infrastructure, private residences, commercial properties, industrial land, etc.
- Encompassing new and existing development to ensure that LID is implemented throughout the watershed for maximum results, possibly using a rebate program to encourage existing properties to install LID best management practices.
- Deciding how to safely include brownfields in a LID program.
- Setting new performance standards—should LID vary with soil type and the character of the local water table? Would it benefit L.A. to exceed current SUSMP standards?
- Suggestions for the potential contents of a comprehensive LID ordinance, program and standards manual.

A curb cut that directs water from the street into a bioswale. 1100 S. Hope Street in downtown Los Angeles.

Considerations for LID Implementation

Low impact development offers promising strategies for the City of Los Angeles to significantly improve stormwater management and increase water supply and green space while simultaneously reducing its impact on climate change and the environment in general. However, the city should consider a number of challenges before developing and implementing a comprehensive LID program. Chapter 10 explores the following issues:

- Defining LID goals and standards that are appropriate for Los Angeles.
- Balancing the City's smart growth and infiltration goals.
- Administrative challenges—which departments will administer LID? Are there any existing regulations that conflict with LID?
- LID readiness and education—do city employees, architects, landscape designers and professional gardeners have the knowledge to properly implement LID techniques?
- LID knowledge, data and evaluation—need to gather more information about the costs and effectiveness of using LID in dry climates.
- Equity issues—how can we ensure that implementing low impact development will not unfairly burden low income communities with a financial obligation that might be difficult to bear without a subsidy?

Recommended Next Steps

Chapter 11 recommends a number of steps that the City of Los Angeles can pursue to implement a more comprehensive low impact development (LID) and green infrastructure program. These recommendations can be summarized as:

1. Internal Review: review low impact development strategy with the City's Green Team, Green Streets Committee and City Council committees.
2. Survey and analyze current policies, ordinances and standards to identify potential conflicts with LID and green infrastructure. Make recommendations for necessary changes. (See Chapters 7 & 10.) Engineering and building & safety standard plans, practices, and ordinances should be a top priority. Also check fire and flood ordinances and insurance maps for conflicts with LID.
3. Integrate LID principles into the Conservation Element of the General Plan.
4. Integrate LID principles into a revised Landscape Ordinance, which the state requires every city to adopt by 2010. (See Chapter 7.)
5. Determine which groups need to be involved with LID brainstorming, review and feedback: environmental groups, developers, architects, landscape architects, planners, civil engineers, community organizations, gardening industry, etc.
6. Develop a working group to draft a LID ordinance.

Conclusion

Southern California was designed and built mostly in the 20th Century, and the prevailing idea at the time was to move water quickly and directly to the ocean. In the 21st Century, we have learned how to design our streets, sidewalks, and landscaping to soak up runoff through a more natural process, weaving the textures of nature into the fabric of the city. Low impact development is an emerging and important international stormwater management trend. We have begun to capitalize on the valuable services that nature can offer us: capturing, cleaning, and storing stormwater.

Nationwide research has proven that low impact development can be a cost effective solution to pressing problems pertaining to water quality and water supply, as well the other benefits noted in this paper, such as flood control, mitigation of climate change, and creation of more natural spaces. For instance, research conducted in Los Angeles has found that the City can significantly increase its water supply, ameliorate climate change issues, and address of much of the pollution found in urban runoff by converting its paved areas from gray to green. Moreover, implementing low impact development will create new, local "green-collar" jobs through the development of a workforce trained to install and maintain green infrastructure features.

The LID principles become particularly crucial as climate change impacts to our environment produce changing weather patterns that are currently predicted to result in longer term drought conditions throughout California. Harvesting all available rainwater by the various methods shown in this paper is an important means of addressing this looming problem.

The City of Los Angeles is well underway toward implementing the principles of low impact development into its designs for streets, sidewalks and alleys, through its Green Streets and Green Alleys program. With over 6,500 miles of streets and 900 miles of alleys, much could be accomplished by incorporating LID principles into new construction and by phasing in LID conversions for existing infrastructure. However, these paved areas only account for a portion of the hardscape found in Los Angeles, and thus only a portion of the stormwater burden. Implementation of low impact development on a wider and more intensive scale throughout the city is worth consideration, both on public and private property.

Endnotes

1 Puget Sound Action Team, Washington State University Pierce County Extension. "Low Impact Development: Technical Guidance Manual for Puget Sound," p.1. January 2005. Accessed on 8/5/08, www.psp.wa.gov/downloads/LID/LID_manual2005.pdf

2 Benedict, Mark A. and Edward T. McMahon. The Conservation Fund. Sprawlwatch Clearinghouse Monograph Series, "Green Infrastructure: Smart Conservation for the 21st Century," p.5. Accessed on 8/10/08, http://www.sprawlwatch.org/greeninfrastructure.pdf

3 U.S. Environmental Protection Agency. *Managing Wet Weather with Green Infrastructure.* Accessed on 8/10/08, http://cfpub.epa.gov/npdes/home.cfm?program_id=298

4 U.S. Environmental Protection Agency. "Urban Stormwater BMP Performance Monitoring: A Guidance Manual for Meeting the National Stormwater BMP Database Requirements," p.10. April 25, 2002. Accessed on 8/10/08, http://www.epa.gov/guide/stormwater/files/montch1and2.pdf

5 *Photo credits for Common LID BMPs:* Vegetated swales = Capital Region District, British Columbia. Rain garden = Iowa Natural Resources Conservation Service. Rain cistern = EPA / Abby Hall. Green roof = City of Los Angeles Bureau of Sanitation. Permeable pavers = EPA / Abby Hall. Porous pavement = City of Los Angeles Watershed Protection Division, Planning and Engineering Section. Curb bump-out = EPA / Abby Hall. Curb cuts = Haan-Fawn Chau.

6 Community Conservancy International. "The Green Solutions Project" report, March 2008. Executive Summary, p.ES-3. The report can be viewed at http://www.ccint.org/greensolution.html

7 Estimates of potential stormwater runoff assuming an average yearly rainfall in Los Angeles of 15-inches on impervious surfaces. {Potential stormwater from a ¼-acre lot} = (0.25 x 43,560 sq.ft. per acre) x (15" rain per year) / (12" per ft.) x (7.481 gal. per cu.ft.) = 101,835 gallons. An ordinary, 2-lane street is 30 feet wide. {Potential stormwater from a city street, not including sidewalks} = (500 ft. long) x (30 ft. wide) x (15" rain per year) / (12" per ft.) x (7.481 gal. per cu.ft.) = 140,269 gallons. Calculation by the City of Los Angeles Bureau of Sanitation, November 2008.

8 *First source of information:* Beckman, David S. and Noah Garrison. "NRDC Comment on AB32 Scoping Plan Appendices—Water Sector," August 11, 2008. Natural Resources Defense Council comments sent to the California Air Resources Board. *Second source of information:* Email message from Noah Garrison, Project Attorney at NRDC, on January 21, 2009. "LID Numbers for L.A. County."

9 This calculation is based on the average daily per capita water use of Los Angeles residents from 2006-2007, which was 146 gallons per person per day. (According to the City of Los Angeles Department of Environmental Affairs website, http://www.lacity.org/EAD/2007environmental%20facts.htm, accessed on 2/22/09.) 146 gallons per day x 365 days per year = 53,290 gallons per person per year = .1635 AF/person/year. Conversion factor: 1 acre foot = 325,851 gallons. 74,600 AF per year saved / .1635 AF per person per year = the water used by 456,269 people. 152,000 AF per year saved / .1635 AF per person per year = the water used by 929,664 people.

10 This calculation is based on the average monthly electricity use per household in the City of Los Angeles, which is 550 kWh. (According to the C40 Cities website, http://www.c40cities.org/bestpractices/renewables/la_renewable.jsp, accessed on 2/22/09.) 550 kWh per household per month x 12 months = 6,600 kWh = 6.6 mWh per household per year. 131,700 mWh saved per year / 6.6 mWh per household per year = 19,955 households per year. 428,000 mWh saved per year / 6.6 mWh per household per year = 64,848 households per year.

11 *See Endnote #8.*

12 Los Angeles Department of Water & Power. "City of Los Angeles Water Supply Action Plan," p.4. May 2008.

13 *See Endnote #8.*

14 Estimates of potential stormwater runoff assuming an average yearly rainfall in Los Angeles of 15-inches on impervious surfaces. {Potential stormwater from a ¼-acre lot} = (0.25 x 43,560 sq.ft. per acre) x (15" rain per year) / (12" per ft.) x (7.481 gal. per cu.ft.) = 101,835 gallons. An ordinary, 2-lane street is 30 feet wide. {Potential stormwater from a city street, not including sidewalks} = (500 ft. long) x (30 ft. wide) x (15" rain per year) / (12" per ft.) x (7.481 gal. per cu.ft.) = 140,269 gallons. Calculation by the City of Los Angeles Bureau of Sanitation, November 2008.

[15] Wise, Steve. "Green Infrastructure Rising: Best Practices in Stormwater Management." *Planning*, the magazine of the American Planning Association. August/September 2008. Pages 14-19.

[16] Intergovernmental Panel on Climate Change. "Climate Change 2007: Synthesis Report. Summary for Policy Makers." IPCC Fourth Assesment Report (AR4); Summary for Policy Makers. Accessed on 1/2/09, http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

[17] Brasuell, James. *TreePeople Advocates for Practical and Holistic Solutions to Los Angeles' Environmental Crisis*, interview with Andy Lipkis. VerdeXchange News, Vol. 01: No. 03: June 2007. Accessed on 1/10/09, http://www.verdexchange.org/node/87

[18] Rosenfeld, Arthur H, Joseph J. Romm, Hashem Akbari, and Alan C. Lloyd. *"Painting the Town White—and Green."* Originally published in the February/March 1997 issue of MIT's Technology Review. Accessed on 1/5/09 from the Heat Island Group website: http://heatisland.lbl.gov/PUBS/PAINTING/

[19] *See Endnote #8*

[20] *See Endnote #8*

[21] Akbari, H. "Shade Trees Reduce Building Energy Use and CO_2 Emissions From Power Plants." *Environmental Pollution* 116 (2002) S119–S126. Accessed on 1/4/09, http://www.fs.fed.us/psw/programs/cufr/products/12/psw_cufr703_Akbari_Reduce_Energy_Use.pdf

[22] City of Los Angeles, Office of Mayor Antonio Villaraigosa. *Energy & Environment: Green LA.* Accessed on 2/3/09, http://mayor.lacity.org/villaraigosaplan/EnergyandEnvironment/LACITY_004467.htm

[23] Schmitz, Rob. *L.A. considers green building codes.* November 28, 2008. Accessed on 1/7/09 from the American Public Media: Marketplace website: http://marketplace.publicradio.org/display/web/2008/11/28/green_jobs/

[24] Rosner, Signalle. "Job Implications in Los Angeles' Green Building Sector," May 2006. Accessed on 1/7/09 from the Green for All website: http://www.greenforall.org/resources/job-implications-in-los-angeles-green-building

[25] USDA Forest Service, Pacific Northwest Research Station. *Study shows that street trees increase the value of Portland homes by more than $1 billion*, March 10, 2008. Accessed on 1/3/09, http://www.fs.fed.us/pnw/news/2008/03/trees.shtml

[26] Please see the source citations in Chapter 5 for more information about this section.

[27] State of California, California Regional Water Quality Control Board, Los Angeles Region. "Waste Discharge Requirements for Municipal Storm Water and Urban Runoff Discharges Within the County of Los Angeles, and the Incorporated Cities Therein, Except the City of Long Beach." Order No. 01-182, NPDES Permit No. CAS004001. December 13, 2001.

[28] City of Los Angeles, Department of City Planning. "Building a Green Los Angeles: Framework for the City's Green Building Program," May 2008. Accessed on 8/13/08, http://cityplanning.lacity.org/code_studies/GreenLa/Brochure.pdf

[29] City of Los Angeles, Department of City Planning. "Los Angeles City Planning Department Recommendation Report." Report to the City Planning Commission, February 10, 2005. Case No: CPC-1992-0043-CA, CEQA: ENV-2003-7106-CE. Accessed on 8/6/08, http://cityplanning.lacity.org/Code_Studies/Other/landscape.pdf

[30] Daniels, Paula. (City of Los Angeles, Board of Public Works). "Green Streets LA" presentation. Accessed July 2008 from the Local Government Commission website, http://water.lgc.org/water-workshops/la-workshop/Green_Streets_Daniels.pdf/view

[31] U.S. Environmental Protection Agency. *Fact Sheet: Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices*, December 2007. From the Polluted Runoff (Nonpoint Source Pollution) web page. Accessed on 1/3/09, http://www.epa.gov/owow/nps/lid/costs07/factsheet.html

Part I:
Understanding
Low Impact Development

A multi-family home in Santa Monica that utilizes drought-tolerant landscaping and a rain barrel to capture water for reuse.

[2] What is Low Impact Development?

Introduction

Stormwater pollution, water shortages, flood control, climate change and the availability of natural green space have all become pressing environmental issues for cities around the nation, including the City of Los Angeles. These concerns affect not only the city's environmental quality, but also our long-term quality of life. **This report takes a look at how a low impact development program in the City of Los Angeles could offer promising solutions to many of the city's environmental concerns, especially those related to water management.**

Rio Hondo Golf Course parking lot in Downey, CA

Low impact development (LID), as defined by Washington State University's Puget Sound Action Team, "is a stormwater management strategy that emphasizes conservation and the use of existing natural site features integrated with distributed, small-scale stormwater controls to more closely mimic natural hydrologic patterns in residential, commercial and industrial settings."[1]

Low impact development takes a very different approach to water management as compared to conventional stormwater strategies. Conventional methods aim to move water off-site and into the storm drains as quickly as possible, while LID seeks to do just the opposite—keep as much water on-site as possible for absorption and infiltration. Instead of large, centralized treatment plants and water storage facilities, LID emphasizes local, decentralized solutions that capitalize on the beneficial services that natural ecosystem functions can provide. LID also focuses on controlling urban runoff and pollution right at the source, rather than at the end of the storm drain outlet. For example, a landscaped area may rely on natural soils to simultaneously absorb stormwater, filter out contaminants, and recharge the groundwater supply.

A comprehensive approach to LID should include city-wide land development strategies and planning along with the creation of infrastructure for stormwater management. As discussed in greater detail in Chapter 4, low impact development is most effective when it is applied on a wide scale. Additionally, it is important to note that LID encompasses much more than just water infiltration—it slows down water velocities (preventing floods downstream), filters out pollutants, and captures and stores water for later reuse.

Key Principles of Low Impact Development

A number of key principles characterize the goals of low impact development: [2,3]

- Decentralize and micromanage urban runoff to integrate water management throughout the watershed.
- Preserve or restore the ecosystem's natural hydrological functions and cycles.
- Emphasize a distributed (not concentrated) control of stormwater.
- Account for a site's topographic features in its design.
- Reduce impervious ground cover and building footprint.
- Maximize infiltration on-site.
- If infiltration is not possible, then capture water for filtration and/or reuse.

At its most basic level, low impact development strives to slow, clean, infiltrate and capture urban runoff and precipitation through natural processes in order to increase groundwater recharge and water reuse.

Best Management Practices & Green Infrastructure

Best Management Practices (BMPs)

A wide array of techniques and features can be used to design a low impact development project. LID sites rely heavily on natural, small-scale structural best management practices to achieve their water management goals. According to the U.S. Environmental Protection Agency, a **best management practice (BMP)** is a device or technique used to remove or reduce pollutants found in stormwater runoff, preventing the contamination of receiving waters.[4] It is important to note that LID primarily employs *natural* structural BMPs (such as vegetated swales, retention ponds, green roofs), not mechanical BMPs (such as water treatment facilities and manufactured filtration units).

Key Terms

Low Impact Development (LID)

"A stormwater management strategy that emphasizes conservation and the use of existing natural site features integrated with small-scale stormwater controls to mimic natural hydrologic patterns." *(Puget Sound Action Team 2005)*

Best Management Practice (BMP)

A device or technique used to remove or reduce pollutants found in stormwater runoff, preventing the contamination of receiving waters. *(EPA 2002)*

Green Infrastructure

[1] "An interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations." *(The Conservation Fund)*

[2] Large scale and small-scale stormwater "management approaches and technologies that infiltrate, evapotranspire, capture and reuse stormwater to maintain or restore natural hydrologies." *(EPA)*

LID is Not LEED

Low impact development (LID) should not be confused with LEED, which stands for "Leadership in Energy and Environmental Design." LEED is a program run by the U.S. Green Building Council and is used to certify eco-friendly buildings and construction practices. While some features of LEED green buildings (green roofs, pervious pavement, etc.) fulfill the goals of low impact development, the two terms are not synonymous.

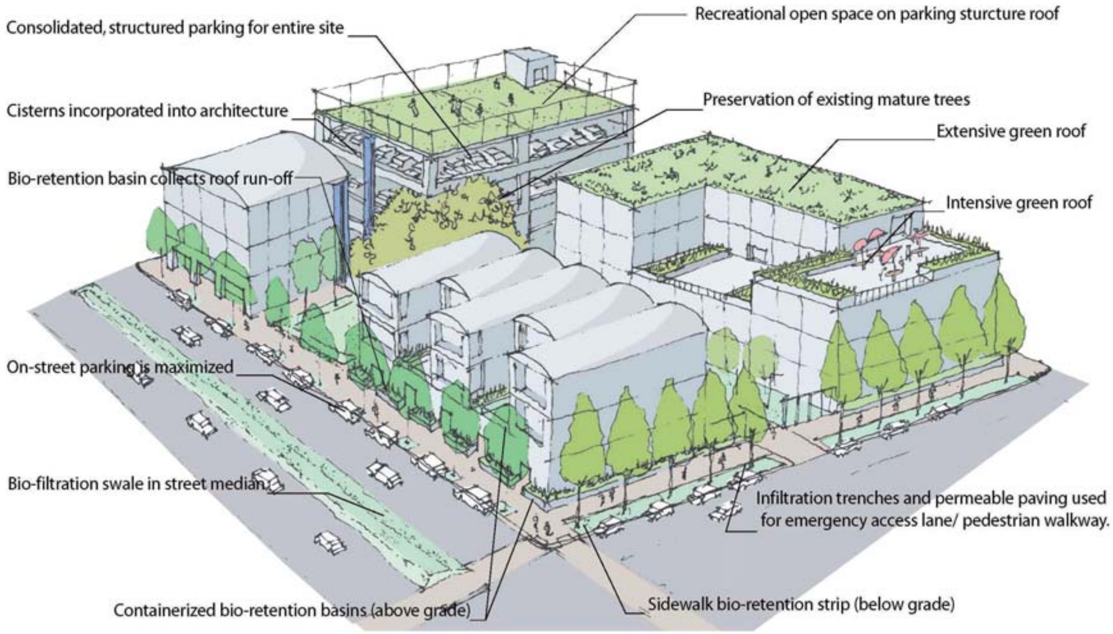


Illustration from the City of Emeryville's *"Stormwater Guidelines for Green, Dense Redevelopment"* manual depicting what LID might look like for a commercial development. *Credit: City of Emeryville / Community, Design + Architecture*

Green Infrastructure

In recent years, "green infrastructure" has become an important concept in the field of urban sustainability. Like many new terms, there is not yet one standard definition, but there is agreement on the principles. The Conservation Fund in Washington, DC states that "green infrastructure is defined as an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations."[5]

The EPA defines green infrastructure as a stormwater management strategy that is closely intertwined with natural BMPs. The EPA website says that green infrastructure uses stormwater "management approaches and technologies to infiltrate, evapotranspire,[a] capture and reuse stormwater to maintain or restore natural hydrologies. At the largest scale, the preservation and restoration of natural landscape features (such as forests, floodplains and wetlands) are critical components of green stormwater infrastructure. On a smaller scale, green infrastructure practices include rain gardens, porous pavements, green roofs, infiltration planters, trees and tree boxes, and rainwater harvesting for non-potable uses such as toilet flushing and landscape irrigation." [6]

In either case, a city with a robust green infrastructure system can reap multiple benefits from the increased services that nature provides, especially with regards to stormwater management, increased

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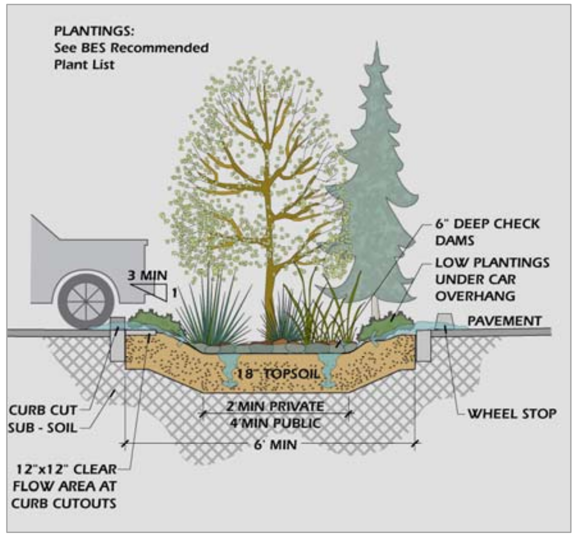
[a] Evapotranspire refers to the processes of evaporation and transpiration carried out by plants and trees.

local water supply, and pollution control. It should be noted that "low impact development" and "green infrastructure" are often used interchangeably because the terms overlap, but LID focuses specifically on water management issues, while green infrastructure's scope is broader. Green infrastructure can be used to tackle other issues besides stormwater management, such as air pollution, urban heat island effects, wildlife conservation and recreational needs.

Low Impact Development for Los Angeles

Many other municipalities have already embarked on the road to implementing low impact development and have found that stormwater improvements can even be made to large, built-out cities like Los Angeles. A number of cities, counties, federal agencies, and national and local nonprofit organizations have conducted research and published documents on LID and green infrastructure. Additionally, there are existing local LID pilot projects such as Oros Street and Elmer Avenue along the Los Angeles River. **Together, these regulations, programs, technical manuals, pilot projects and research reports offer a wealth of existing information and resources from which the City of Los Angeles could model its own low impact development ordinance and programs.**



Cross section design for a vegetated swale in a parking lot.
Bureau of Environmental Services, Portland, OR / Tom Liptan

Because Los Angeles has significant amounts of water runoff even during dry weather, low impact development can benefit the city year-round, not just during the rainy season. However, not all sites will be able to achieve every goal that LID sets forth for water management (slowing, cleaning, infiltration, capture, groundwater recharge, and reuse). Some sites may only achieve one outcome, while others may fulfill all six. For instance, near the Los Angeles River, infiltration and groundwater recharge can be difficult because the ground is composed of impenetrable clay. There, it would be best to place emphasis on slowing and cleaning water flows before they reach the river.

A curb cut and bioswale at 1100 S. Hope Street
in downtown Los Angeles.

The Purpose of This Report

The purpose of this report is to examine low impact development (LID) for the City of Los Angeles and potential steps for instituting city-wide low impact development programs or projects. It also gathers policy strategies and technical information that could be pertinent to the City's LID efforts. Part I (Chapters 2–5) describes the importance of low impact development and green infrastructure and highlights existing LID programs throughout the nation and here in Southern California. Part II (Chapters 6–11) explores potential ways to implement LID in Los Angeles and some of the issues that should be considered. It also reviews current policies and regulations (such as stormwater management laws and the City's recent Green Building Ordinance) that intersect with local LID programs. Finally, the appendices contain additional information and resources that may be helpful for developing comprehensive green infrastructure programs and projects for the City of Los Angeles.

Green roof on top of Chicago City Hall.
Dept. of Energy, NREL / Katrin Scholz-Barth

Endnotes

[1] Puget Sound Action Team, Washington State University Pierce County Extension. "Low Impact Development: Technical Guidance Manual for Puget Sound," p.1. January 2005. Accessed on 8/5/08, www.psp.wa.gov/downloads/LID/LID_manual2005.pdf

[2] Prince George's County (Maryland), Department of Environmental Resource, Programs and Planning Division. "Low Impact Development Design Strategies: An Integrated Approach," p. 1.2--1.6. June 1999. Accessed on 8/6/08, www.lowimpactdevelopment.org/pubs/LID_National_Manual.pdf

[3] Puget Sound Action Team, Washington State University Pierce County Extension. "Low Impact Development: Technical Guidance Manual for Puget Sound," chapter 1. January 2005. Accessed on 8/5/08, www.psp.wa.gov/downloads/LID/LID_manual2005.pdf

[4] U.S. Environmental Protection Agency. "Urban Stormwater BMP Performance Monitoring: A Guidance Manual for Meeting the National Stormwater BMP Database Requirements," p.10. April 25, 2002. Accessed on 8/10/08, http://www.epa.gov/guide/stormwater/files/montch1and2.pdf

[5] Benedict, Mark A. and Edward T. McMahon. The Conservation Fund. Sprawlwatch Clearinghouse Monograph Series, "Green Infrastructure: Smart Conservation for the 21st Century," p.5. Accessed on 8/10/08, http://www.sprawlwatch.org/greeninfrastructure.pdf

[6] U.S. Environmental Protection Agency. *Managing Wet Weather with Green Infrastructure.* Accessed on 8/10/08, http://cfpub.epa.gov/npdes/home.cfm?program_id=298

[3] Common LID
Best Management Practices

Despite its semi-arid climate, the City of Los Angeles has the potential to generate a remarkable amount of stormwater over the course of a year. **Each ¼-acre of hardscape has the potential to generate 100,000 gallons of stormwater runoff annually, and a 500-foot long residential street in Los Angeles could generate 140,000 gallons of stormwater.**[a] This chapter highlights a wide array of low impact development (LID) best management practices (BMPs) that are available to capture, treat, infiltrate and reuse potential water resources. Many BMPs, such as bioswales, can be applied to streets, houses, commercial development, and even industrial sites, while other BMPs (such as rain barrels for single-family homes) tend to have a narrower range of use. Projects may combine several BMPs that work together to slow down stormwater flow and infiltrate it into the ground. For instance, a single "green street" can utilize porous pavement, bioswales, bump-outs, and curb cuts all together.

Property owners can select the most appropriate BMPs to accomplish infiltration, water reuse or runoff control at their particular location. In keeping with LID principles, it is important to evaluate what existing resources on-site can be retained and reused to promote groundwater infiltration, such as top soil, established trees or natural topographic features. The suitability of soil conditions to support vegetation or infiltration can help narrow the number of BMPs to be considered. The long-term maintainability of any BMP must be factored into all decisions as an underlying driver for sustainability. Consideration of all these factors can reduce monetary costs for the owner as well as reduce "external" costs for the city overall (conserving water, reducing amount of soil sent to landfills, etc.).

Fundamental LID Objectives

Low impact development strives to **slow, clean, infiltrate and capture** urban runoff and precipitation in order to increase groundwater recharge and water reuse.

Types of LID Best Management Practices

1. Landscape BMPs
2. Building BMPs
3. Street and Alley BMPs
4. Site Planning BMPs

Capital Region District, BC

[a] Estimates of potential stormwater runoff assuming an average yearly rainfall in Los Angeles of 15-inches on impervious surfaces. {Potential stormwater from a ¼-acre lot} = (0.25 x 43,560 sq.ft. per acre) x (15" rain per year) / (12" per ft.) x (7.481 gal. per cu.ft.) = 101,835 gallons. An ordinary, 2-lane street is 30 feet wide. {Potential stormwater from a city street, not including sidewalks} = (500 ft. long) x (30 ft. wide) x (15" rain per year) / (12" per ft.) x (7.481 gal. per cu.ft.) = 140,269 gallons. Calculation by the City of Los Angeles Bureau of Sanitation, November 2008.

Landscape BMPs

Landscape-based BMPs that use runoff to support vegetation are particularly effective in satisfying the City's LID goals. For instance, the City's million trees initiative (Million Trees LA) directly recognizes the important role of trees in the capture and reuse of water, plus the additional benefits they provide by absorbing CO_2 (a greenhouse gas) and shading city streets to reduce the urban "heat island effect." Native trees are well-suited as landscape BMPs because of their ability to use large amounts of water when available, but can still withstand long periods of reduced soil moisture. Overall, integrating trees throughout the city could result in cooler temperatures, improved aesthetics, improved water quality, and enhanced property values.

Past development practices often employed engineered solutions to stormwater management instead of preserving a site's original soil conditions and natural drainage patterns. Unfortunately, the impact of these many small decisions has resulted in the loss of the Los Angeles region's ability to infiltrate groundwater, an increase in local temperatures and a negative impact to water quality. Over time, landscape practices based on low impact development can mitigate many of the unfavorable impacts of prior development and change Los Angeles into a city that
has more sustainable water management practices.

	**Vegetated Swales** A vegetated swale is a broad, shallow channel with a dense stand of vegetation covering the side slopes and the bottom. Swales can be natural or manmade, and are designed to trap particulate pollutants (suspended solids, trace metals), promote infiltration, and reduce flow velocity from stormwater runoff.[1] *Photo credit: Capital Region District, British Columbia*
	**Bioswales** Bioswales are landscape elements, very similar to vegetated swales, designed to remove silt and pollution from surface runoff water. They direct drainage with gently sloped sides (less than 6□) and are filled with vegetation, compost and□or rip rap. The water's flow path is designed to maximize the time water spends in the swale.[2] *Photo: Westchester/Imperial Highway Infiltration Swale Project* *Credit: LA BOS*

	**Rain Gardens** A rain garden, created in a low spot on a property, captures rain and excess irrigation water from roofs, driveways and yards. Runoff is directed into the rain garden to support landscapes and for infiltration to ground water. In a sense, a rain garden is a “mini-bioretention” swale that can be particularly well-suited for residential properties. Supplemental irrigation may be required during the dry season in Los Angeles. *Photo credit: Iowa Natural Resources Conservation Service, http://www.ia.nrcs.usda.gov/features/raingardens.html*
	**Infiltration Swales / Basins / Trenches** Infiltration swales are designed for conveyance and infiltration, with less emphasis on growing vegetation.[3] They are depressions created by excavation, berms, or small dams placed in a channel intended to infiltrate the storm runoff from impervious surfaces. Infiltration basins and trenches serve similar purposes as swales, but the tops may be hidden with covers that could range from landscaping to a porous material, such as decomposed granite. *Photo: Pavers and infiltration swale at Taylor Yard near Elysian Valley* *Credit: LA BOS*
	**Riparian Buffers** Riparian buffers are strips of vegetated land adjacent to a river or stream. In addition to providing wildlife habitat, the grasses, shrubs and trees along stream banks capture sediments and pollutants and prevent erosion. They also slow down flow velocities, allowing more water to percolate into the ground.[4] *Photo: Los Angeles River near Atwater Village* *Credit: LA BOS*
	**Open Space & Parks** Open space and parks provide large, vegetated areas especially well suited for infiltrating runoff on a regional scale. Additional benefits include increased wildlife habitat and recreation opportunities. *Photo: Sepulveda Basin Wildlife Refuge in the Encino area of L.A* *Credit: LA BOS*

Building BMPs

Building-based low impact development BMPs often focus on directly capturing and storing stormwater, but they can also be designed to slow and filter runoff, and reduce the sediments flowing into various water bodies. Building BMPs also improve water quality, reduce the heating and cooling requirements of buildings, and improve aesthetics. Capturing runoff from buildings or other impermeable surfaces for reuse can be done on different scales, ranging from small rain barrels to the construction of large underground cisterns. Even though Los Angeles is considered a dry climate because rainfall occurs during a relatively short season, there is still considerable potential to capture significant amounts of water.

Green roofs are especially innovative building BMPs. Both locally and around the country, green roofs (sometimes called "living roofs") have been installed to reduce runoff and provide attractive open spaces in unexpected locations. Green roof BMPs have most often been used in areas where rainfall is distributed more evenly throughout the year when compared to Los Angeles. However, in combination with other collection-oriented BMPs, green roofs cannot be ruled out for Los Angeles, especially when value is placed on potential energy savings and microclimate improvements. Green roof concepts will need to be adapted to the unique microclimates found in Los Angeles.

	**Green Roofs** Placement of rooftop planting system that allows for sustained presence of live plants covering a significant portion of a building's roof. Green roofs can provide a range of environmental (stormwater runoff reduction, energy savings), economic, and social benefits.[5] *Photo: Vista Hermosa Park, Santa Monica Mountains Conservatory, Los Angeles* *Credit: LABOS*
	**Cisterns** Reservoirs, tanks, or containers can be used to store stormwater for non-potable reuse (such as landscape irrigation). Cisterns are usually placed underground, but can also sit above ground. The cistern system on the left directs rainfall from the roof through a sand pit to filter out impurities; it then collects the water in an underground cistern. Cisterns can vary in size from smaller household units to large underground storage areas beneath outdoor playing fields. These features can also be made into attractive architectural elements. A pump may be required to harvest the water for reuse. *Photo: Cistern in Chicago. Credit: EPA / Abby Hall*

	**Rain Barrels** Rain barrels are used to store rainwater for later reuse. Gutters and downspouts direct rainfall from rooftops into the barrels. Rain barrels are smaller and less expensive than cisterns, making them more appropriate for residential buildings. Most barrels have spigots so that the water can be easily accessed for irrigation. Rain barrels are made from a variety of materials and can be an attractive landscape feature. They commonly have provisions to prevent mosquitoes from breeding. *Photo Credit: http://www.greenerbuilding.org/*
	**Rain Chains** A rain chain is a creative and attractive form of water diversion from rain gutters to the collection system; it is an alternative to the more utilitarian downspout. Rain chains consist of metal cups or chains linked to direct and slow rooftop runoff to a desired catchment area. Architect Frank Lloyd Wright often used these as an architectural element; the concept originated in Japan centuries ago where they are known as "kusari doi."[6] *Photo: A home in West Los Angeles* *Credit: Haan-Fawn Chau*

Street and Alley BMPs

The 6,500 miles of streets[7] and 914 miles[8] of alleys in the City of Los Angeles have tremendous potential for reducing the velocity of water flows, decreasing polluted runoff and augmenting water infiltration. In general, Los Angeles is highly urbanized, and the ability to apply relevant street and alley BMPs is mostly a function of redevelopment opportunities. For instance, city roadwork projects can be used to "green" city streets and sidewalks with porous pavement, curb cuts and bioswales. The successful application of these BMPs will also depend upon the development of standards acceptable to the City (to reduce liability) and the development of financial and aesthetic incentives. Additional benefits common to most of these BMPs are aestethic improvements to the local neighborhood.

	**Porous Pavement □ Sidewalks** Porous□permeable□pervious pavement and sidewalks absorb water, allowing infiltration into the soil layer below. They are especially appropriate for highly urbanized areas where open space is scarce. Porous pavement usually needs to be vacuum swept periodically to keep pores unclogged. Side benefits: (1) reduces danger of hydroplaning for cars, (2) some porous pavements absorb and store less heat, so they can help reduce temperatures in an urban environment.[9] *Photo credit: City of Los Angeles Watershed Protection Division, Planning and Engineering Section*
	**Permeable Pavers** Permeable pavers allow water to percolate through crevices between paving blocks. They come in a variety of styles, shapes and sizes. Cobblestones are a popular example. *Photo Credit: Permeable Pavers, EPA / Abby Hall*
	**Vegetated Pavers □□Grasscrete□** This well-established BMP can be met with numerous commercial products. Vegetated pavers help natural infiltration by reducing the overall imperviousness of otherwise paved areas. They can be used for sidewalks, driveways, and parking lots. They address stormwater through small, cost-effective, attractive landscape features located at the lot level. They may be suitable for emergency access where other BMPs may not. *Photo credit: Haan-Fawn Chau*

Bump-Outs

"Bump-Outs" are small vegetated swales that can be used in well-established neighborhoods where other options for infiltration may be limited. Not only can they be functional for reducing runoff, but they can also provide an attractive focal point for a street and can be used to slow traffic to improve pedestrian safety.

Photo: Portland, OR. Credit: EPA / Abby Hall

Curb Cuts

Curb cuts can be used to direct runoff from paved areas into infiltration zones such as bioswales. They allow stormwater runoff to enter a vegetated area and infiltrate the underlying root system or soil medium.

Photo: Hope Street, downtown Los Angeles. Credit: Haan-Fawn Chau

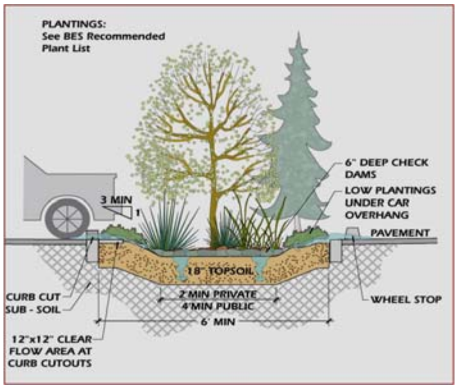
Tree Wells

Tree wells can be installed upstream of a catch basin to intercept urban runoff from a gutter (up to a certain volume). The runoff is used to irrigate the tree and local landscaping, and provides infiltration. During heavy rains, the excess water beyond the capacity of the tree well flows into the catch basin. Tree wells are placed below grade so trash is also intercepted, which is then manually removed on a periodic basis.

Photo: Hope Street, downtown Los Angeles. Credit: Haan-Fawn Chau

Site Planning BMPs

The most important low impact development BMPs often occur during a project's planning phase, well before any "green infrastructure" features are installed. Properly planning the layout of a site to enhance natural drainage patterns and developing a strategy to preserve the infiltration capacity of the existing soil during construction can make an significant difference in the success of a LID project.



Site Evaluation and Planning
During the design phase, property owners and designers should evaluate the topographic and hydrologic features of their site and minimize the amount of impervious surfaces. Soil characteristics determine whether the site is best suited for water capture or infiltration. Low impact development BMPs should be placed in locations that will maximize infiltration and minimize runoff.

Photo credit: Tom Liptan, Bureau of Engineering / Portland, OR

Retaining Existing Trees and Large Vegetation
Retaining existing trees and large vegetation that has well-developed root systems can help improve the infiltration capacity of a low impact development site.

Photo credit: Haan-Fawn Chau

Proper Site Grading
LID sites can be graded to enhance natural drainage patterns by directing water towards rain gardens and infiltration zones. Flat or shallow slopes reduce the velocity of stormwater runoff, allowing for greater infiltration. Moreover, carefully planned grading practices can help preserve valuable topsoil.

Photo credit: Haan-Fawn Chau

Preserving Top Soil and Preventing Soil Compaction
Healthy top soil can be a major asset to a LID site because it absorbs water quickly and the vegetation and microbes help filter out pollutants from urban runoff. Compaction can greatly reduce the infiltration capacity of soil. Therefore, strategies should be developed to preserve topsoil and to prevent soil compaction, especially during the construction phase of any LID project.

Photo: Compacted soil vs. healthy soil. Credit: Haan-Fawn Chau

Prioritizing LID Best Management Practices

Not all low impact development BMPs are equally effective, so municipalities could establish guidelines that place a greater priority on the installation of BMPs that fulfill goals for water infiltration, cleaning, velocity control, capture and reuse. On July 9, 2008 the City of Los Angeles adopted simple guidelines[10] to prioritize the installation of stormwater BMPs to fulfill the County's Standard Urban Stormwater Mitigation Plan (SUSMP). (Read more about SUSMP in Chapter 7.) The order of preference for the selection of appropriate BMPs is as follows: (1) infiltration systems, (2) biofiltration/retention systems, (3) stormwater capture and reuse, (4) mechanical/hydrodynamic units, and (5) a combination of any of the above.

In 2006, the County released a guidance manual called *Los Angeles County-Wide Structural BMP Prioritization Methodology*.[11] [12] The guidelines also apply to the City of Los Angeles because the City falls under the County's Standard Urban Stormwater Mitigation Plan. The County developed its Prioritization Methodology as a "systematic way of prioritizing structural BMP projects within Los Angeles County watersheds to optimize pollutant reductions in a cost-effective manner."[13] The County also notes that "the strength of the Methodology is its ability to systematically process multiple factors that affect BMP placement and effectiveness."[14]

Endnotes

[1] U.S. Environmental Protection Agency. "Storm Water Technology Fact Sheet-Vegetated Swales," September 1999. Accessed on 8/20/08, http://www.epa.gov/npdes/pubs/vegswale.pdf

[2] Fairfax County, VA. "Fairfax County – LID BMP Fact Sheet – February 28, 2005." Accessed November 2008, http://www.lowimpactdevelopment.org/ffxcty/1-4_bioswale_draft.pdf

[3] Idaho Department of Environmental Quality. "Stormwater: Catalog of Stormwater BMPs for Idaho Cities and Counties," Volume 3. Low Impact Development Techniques. September 2005. Accessed on 9/25/08, at http://www.deq.state.id.us/water/data_reports/storm_water/catalog/vol_3.pdf and http://www.deq.state.id.us/water/data_reports/storm_water/catalog/sec_3/text.pdf

[4] Connecticut River Joint Commission. "Introduction to Riparian Buffers for the Connecticut River Watershed," September 2000. Accessed on 8/25/08, www.crjc.org/buffers/Introduction.pdf

[5] "Greenroofs.com" internet-based news portal that promotes greenroofs. Accessed November 2008, www.greenroofs.com

[6] Pushard, Doug. *Rain Chains: The Art of Collecting Rainwater.* Accessed November 2008, http://www.harvesth2o.com/rainchain.shtml

[7] City of Los Angeles Bureau of Street Services, Street Maintenance Division. *Welcome to Street Maintenance Division.* Accessed November 2008, http://www.lacity.org/BOSS/StreetMaintenance/index.htm

[8] Cassidy, Arly, Josh Newell and Jennifer Wolch. "Transforming Alleys into Green Infrastructure for Los Angeles," June 2008. USC Center for Sustainable Cities. Accessed July 2008, http://college.usc.edu/geography/ESPE/documents/alleyreport_final_reduced.pdf

[9] CoolCommunities.org website. *Pervious Pavements for a More Livable Environment.* Accessed November 2008, http://www.coolcommunities.org/cool_pavements.htm

[10] City of Los Angeles Department of Public Works, Bureau of Sanitation. "City of Los Angeles – Standard Urban Stormwater Mitigation Plan (SUSMP) and Site Specific Mitigation Plan - Infiltration Requirement and Guidelines – Recommendation Report." Bureau of Sanitation Board Report No. 1. July 9, 2008. Accessed November 2008, http://eng.lacity.org/docs/dpw/agendas/2008%2F200807%2F20080709/san/20080709_ag_br_san_1.pdf

[11] Susilo, Ken J., Brandon Streets, Marc Leisenring, and Eric Strecker. County of Los Angeles Department of Public Works, Watershed Management Division. "Los Angeles County-Wide Structural BMP Prioritization Methodology: A Guidance Manual for Strategic Storm Water Quality Project Planning," 2006. Accessed on 1/15/09, http://ladpw.org/WMD/bmpmethod/assets/pdfdocs/guideancemanual.pdf

[12] County of Los Angeles Department of Public Works, Watershed Management Division. "Los Angeles County-Wide Methodology For Prioritizing Structural BMP Implementation: Guidance for Strategic Storm Water Quality Project Planning—Overview." Accessed on 1/15/09, http://ladpw.org/WMD/bmpmethod/overview.shtm

[13] Susilo, Ken J., Brandon Streets, Marc Leisenring, and Eric Strecker. County of Los Angeles Department of Public Works, Watershed Management Division. "Los Angeles County-Wide Structural BMP Prioritization Methodology: A Guidance Manual for Strategic Storm Water Quality Project Planning," 2006. Pg.7. Accessed on 1/15/09, http://ladpw.org/WMD/bmpmethod/assets/pdfdocs/guideancemanual.pdf

[14] County of Los Angeles Department of Public Works, Watershed Management Division. "Los Angeles County-Wide Methodology For Prioritizing Structural BMP Implementation: Guidance for Strategic Storm Water Quality Project Planning—Overview." Accessed on 1/15/09, http://ladpw.org/WMD/bmpmethod/overview.shtm

[4] Benefits of Low Impact Development

The potential benefits of low impact development for water pollution, water supply and energy usage in Los Angeles County are compelling. A study conducted by Community Conservancy International (CCI) in March 2008 found that **nearly 40% of L.A. County's needs for cleaning polluted runoff could be met by implementing low impact development (LID) projects on existing public lands.** CCI calculated that there is a net average of 15,000 acres of existing public lands in the county suitable for LID projects.[1]

Additionally, a study completed by the Natural Resources Defense Council (NRDC) in January 2009[2] found that an increased use of LID practices throughout residential and commercial properties in L.A. County would promote groundwater recharge and water capture and reuse, reducing the county's dependence on distant sources of water. This increased use of LID would result in the **savings of 74,600–152,500 acre-feet of imported water** per year by 2030. Based on current per capita water usage in the City of Los Angeles, this is equivalent to the water consumption of 456,300–929,700 people.[3] Moreover, since L.A. County would be pumping less water from distant locations, **131,700–428,000 MWH of energy would be saved** per year by 2030, which is equivalent to the electricity used by 20,000–64,800 households.[4] Therefore, LID could also mitigate climate change by reducing greenhouse gases.

Both the CCI and NRDC studies illustrate the significant benefits that broad implementation of low impact development strategies can have for the Los Angeles region. However, in order for Los Angeles to fully realize these benefits, LID would need to become a common, widespread practice for both new and existing land uses, not just an occasional innovation.

Quantifying LID Benefits

Quantifying the benefits of low impact development in monetary terms is dependent on the still-emerging field of placing economic

Major Benefits of LID for L.A. County

Polluted Urban Runoff

Nearly 40□ of the county□s needs for cleaning polluted runoff could be met by LID projects on existing public lands.[a]

Water Supply

By 2030, LID projects could save L.A. County 74,600–152,500 AF□yr of imported water through groundwater recharge and water capture □ reuse.[b]

Energy Use □ Climate Change

Greater reliance on local water supply instead of pumping from distant locations would save 131,700□428,000 MWH of energy per year by 2030.[c]

Additional LID Benefits

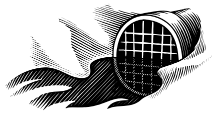
- Better flood control
- Reduced need for wastewater treatment
- Money saved on water management infrastructure
- Increased green space and wildlife habitat
- Reduced urban heat island effect
- Community beautification
- Emphasis on green jobs and economy

Sources: a) Community Conservancy International 2008, b) NRDC 2009, c) NRDC 2009 values on nature's services. While the initial efforts to determine environmental benefits may be challenging to undertake, recent studies specific to the Los Angeles area have made significant headway in providing data that can be used to calculate the benefits of LID projects. For instance, the Center for Urban Forest Research found that in Los Angeles, one million trees can remove 2.24 million pounds of air pollutants and capture 1.9 billion gallons of stormwater per year.[5] Also, the Los Angeles & San Gabriel Rivers Watershed Council has developed a Groundwater Augmentation Model that can estimate a low impact development BMP's potential for infiltration, water capture, and groundwater recharge.[6]

Low impact development is best known for helping to resolve stormwater issues, but will also have value in terms of reduction of the urban heat island effect, carbon sequestration, and groundwater recharge, as mentioned above. Further, unlike the typical mechanical methods of stormwater management (such as treatment plants) LID techniques often have significant and multiple community benefits that can simultaneously address a wide range of City concerns with one project. The following tables highlight some of the advantages that LID has to offer.

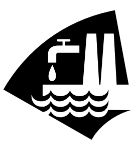
Flood Control & Wastewater Management

Issues	How LID Helps	Supporting Facts
• Heavy rains can cause flooding. "On a typical dry summer day, an average of about 24 million gallons per day (mgd) flows through the storm drain system into the Santa Monica Bay. In a heavy rain storm, this flow can increase to over one billion gallons per day."[7] • Stormwater often leaks into aging sewage pipes, straining the capacity of our treatment facilities. During a storm, the flow into the Hyperion Sewage Treatment Plant can double.[8] • The entire City of Los Angeles is approximately 47% impervious surfaces.[9]	• Reduces the quantity of urban runoff and prevents flooding. • Provides natural plants and soil which absorb excess stormwater. • Relieves pressure placed on sewage treatment plant during rain events because less stormwater seeps into the sewage system.	• Planted drainage swales in Seattle's "SEA Streets" project reduced runoff volume by 99%[10] and cost 25% less than conventional street designs.[11] • Simulated tests of curb bump-outs installed on Siskiyou Street in Portland, OR found that the vegetated swales absorbed enough water (85%) to prevent neighborhood basements from flooding.[12] • Rain gardens in Burnsville, MN retained 90% of storm runoff, even when rain was greater than the targeted 0.9-inch storm.[13]



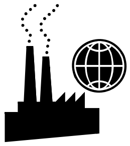
River & Ocean Pollution

Issues	How LID Helps	Supporting Facts
• In Los Angeles, the primary source of pollution in oceans and rivers is urban runoff.[14] • The City's 34,000 catch basins carry trash and contaminants from the streets straight out to the ocean, with no treatment.[15] • Five of the 10 most polluted beaches in California are in L.A. County.[16]	• Stormwater retention basins and rainwater catchment systems reduce the volume of contaminated water headed for creeks, rivers and the ocean. • Biological filtration by plants and soils can remove pollutants and sediments from urban runoff.	• Nearly 40% of polluted runoff needs in L.A. County could be met by implementing "Green Solution" projects on existing public lands.[17] • In Seattle, a green street using a series of waterfall-like bioretention features captured up to 92% of pollutants through infiltration and plant uptake.[18] • Heritage Park in Minneapolis uses filtration basins and ponds to remove 70-80% of total phosphorous and 85% of sediment from local runoff.[19]



Water Supply & Demand

Issues	How LID Helps	Supporting Facts
• The L.A. area regularly faces water shortages and does not generate enough water to sustain itself. • Only 13% of L.A. City's water supply comes from local groundwater.[20] • 48% of L.A. City's water supply originates from the Mono Basin and Owens Valley aqueducts. • At least 30% of all the water used in the City of Los Angeles is used outdoors.[21]	• Decreases Los Angeles' dependence on outside sources of water. • Reduces the demand for irrigation water because rainwater is slowed and captured for infiltration into the ground. Some methods also capture water for reuse. • Increases the supply in the local water table. • Promotes or requires the use of drought-tolerant plants.	• Widespread use of water infiltration, capture and reuse in L.A. County would result in the savings of 74,600–152,500 acre-feet of imported water per year by 2030.[22] (Equivalent to the water consumption of 456,300–929,700 people.) • Each □-acre lot in L.A. has the potential to generate 100,000 gallons of stormwater annually.[23] • By disconnecting 60,000 gutter downspouts, Portland diverted 1.5 billion gallons of stormwater per year.[24]

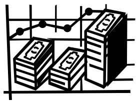


Climate Change

Issues	How LID Helps	Supporting Facts
• Fossil fuels are the #1 source of the greenhouse gases that cause climate change. • World temperatures could rise by between 2.0 and 11.5 °F during the 21st century.[25] • Blacktop surfaces can elevate surrounding city temperatures as much as 10°F.[26] • In the summer, central Los Angeles is typically 5°F warmer than surrounding suburban and rural areas due to the heat island effect.[27]	• Increasing the local water supply means that Los Angeles will use less energy pumping water from distant locations. • Trees and landscaping counteract climate change by absorbing excess carbon dioxide. • Shade from trees and evapotranspiration by plants reduce the heat island effect.	• Water systems account for 19% of the electricity used in the state of California.[28] • L.A. County could save 131,700–428,000 mWh of energy per year if less water was transported from Northern California.[29] (Equivalent to electricity use of 20,000–64,800 households.) • Each shade tree in L.A. prevents the combustion of 18kg of carbon annually and sequesters an additional 4.5–11kg of carbon per year.[30]

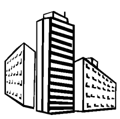
Green Space & Community Improvements

Issues	How LID Helps	Supporting Facts
• Los Angeles ranks last among major cities in per capita open space. The National Recreation and Parks Association recommends 10 acres of park space per 1,000 residents. L.A. barely reaches 10% of this national standard with a mere 1.107 acres per 1,000 residents.[31] • Many L.A. neighborhoods do not have any substantial trees or street landscaping. Acccording to a canopy analysis prepared for the City in 2006, L.A. has an average of only 21% canopy cover; in some districts, the canopy cover is as low as 7%.[32]	• Increases parks, open space and landscaping. • Complements the goals of the city's Million Trees LA Campaign. • Adds more wildlife habitat and enhances wetlands vegetation. • Many LID measures, such as increased landscaping, are aesthetically pleasing and help to beautify communities and make the city more pedestrian-friendly.	• L.A.'s Sepulveda Basin Wildlife Refuge is used to control major floods. It also provides 225 acres of wildlife habitat and recreation opportunities.[33] • Tree-lined streets are more walkable because they provide shade and some separation between cars and pedestrians.[34] • Attractive landscaping and plantings can increase property values by 15%.[35] • Trees and well-maintained grassy areas create a welcoming neighborhood atmosphere. Studies show this promotes social health and reduces crime and violent behavior.[36 37]



Green Jobs & Economy

Issues	How LID Helps	Supporting Facts
• The City of Los Angeles would like to encourage the development of "green-collar" jobs.[38] • The current economic recession has resulted in city budget cuts. More revenues are needed to fill the gaps.	• Encourages the growth of the green building industry. • Encourages the landscaping and gardening industry to shift to eco-friendly practices that emphasize native, drought-tolerant plants and rainwater harvesting. • Property drainage evaluations could increase the demand for "green industry" jobs in environmental assessment. • Trees and landscaping and reduced neighborhood flooding can enhance neighborhood property values, thus increasing tax revenues.	• L.A.'s Green Building Ordinance will create an anticipated 500 green-collar, union jobs.[39] • L.A.'s growing green building industry presents workforce development opportunities for auditors and landscapers and gardeners.[40] • Trees in Portland, OR generate approx. $13 million per year in property tax revenues by increasing real estate values.[41]



Construction & Building Costs

Issues	How LID Helps	Supporting Facts
• To maximize profits, developers usually select the most cost-efficient building and landscaping options. • To conserve funds, the City of L.A. makes it a priority to keep construction costs low for City projects.	• LID projects use less concrete & asphalt, and reduce the need for pipes and other stormwater control devices. As a result, site development and maintenance costs can be lowered. [42] • LID best management practices can eliminate the need for expensive curbs and gutters (catch basins). [43] • LID projects involve minimal clearing and grading, thus reducing the need for costly earth-moving equipment. [44]	• An EPA analysis of 17 LID projects from across the nation found that all but a few projects cost less than conventional water management controls. Savings ranged from 15–80%.[45] • Seattle's first green street (SEA Street #1) cost 25% less than conventional street designs. [46] • Extensive use of swales and rain gardens for a new subdivision in Somerset, MD cost 32% less than it would have for conventional stormwater controls.[47]

Endnotes

[1] Community Conservancy International. "The Green Solutions Project" report, March 2008. Executive Summary, p.ES-3. The report can be viewed at http://www.ccint.org/greensolution.html

[2] *First source of information:* Beckman, David S. and Noah Garrison. "NRDC Comment on AB32 Scoping Plan Appendices—Water Sector," August 11, 2008. Natural Resources Defense Council comments sent to the California Air Resources Board. *Second source of information:* Email message from Noah Garrison, Project Attorney at NRDC, on January 21, 2009. "LID Numbers for L.A. County."

[3] This calculation is based on the average daily per capita water use of Los Angeles residents from 2006-2007, which was 146 gallons per person per day. (According to the City of Los Angeles Department of Environmental Affairs website, http://www.lacity.org/EAD/2007environmental%20facts.htm, accessed on 2/22/09.) 146 gallons per day x 365 days per year = 53,290 gallons per person per year = .1635 AF/person/year. Conversion factor: 1 acre foot = 325,851 gallons. 74,600 AF per year saved / .1635 AF per person per year = the water used by 456,269 people. 152,000 AF per year saved / .1635 AF per person per year = the water used by 929,664 people.

[4] This calculation is based on the average monthly electricity use per household in the City of Los Angeles, which is 550 kWh. (According to the C40 Cities website, http://www.c40cities.org/bestpractices/renewables/la_renewable.jsp, accessed on 2/22/09.) 550 kWh per household per month x 12 months = 6,600 kWh = 6.6 mWh per household per year. 131,700 mWh saved per year / 6.6 mWh per household per year = 19,955 households per year. 428,000 mWh saved per year / 6.6 mWh per household per year = 64,848 households per year.

[5] City of Los Angeles, Million Trees LA program. *Why Get Involved?* Accessed on 4/1/09, http://www.milliontreesla.org/mtabout6.htm

[6] Information provided by Nancy Steele, Executive Director, Los Angeles & San Gabriel Rivers Watershed Council in an email message on February 10, 2009. Further information can be found at www.lasgrwc.org/WAS.htm

[7] City of Los Angeles Department of Public Works, Stormwater Program. *Stormwater Frequently Asked Questions.* Accessed on 8/25/08, http://www.lacity.org/SAN/wpd/Siteorg/residents/faqs.htm

[8] City of Los Angeles Department of Public Works, Stormwater Program. *City of Los Angeles Hyperion Sewage Treatment Plant.* Accessed on 10/3/08, http://www.lacity.org/SAN/Wpd/Siteorg/general/hypern1.htm

[9] Estimate calculated by the City of Los Angeles Department of Public Works, Bureau of Sanitation. The land use data was developed by the Southern California Association of Governments in 2005. Information obtained from an email message to Paula Daniels, Commissioner, Board of Public Works, sent by Shahram Kharaghani, Environmental Engineer, Bureau of Sanitation on January 29, 2009.

[10] Seattle Public Utilities Commission. *Street Edge Alternatives (SEA Streets) Project.* Accessed 12/31/08, http://www.seattle.gov/UTIL/About_SPU/Drainage_&_Sewer_System/Natural_Drainage_Systems/Street_Edge_Alternatives/index.asp

[11] Wise, Steve. "Green Infrastructure Rising: Best Practices in Stormwater Management." *Planning,* the magazine of the American Planning Association. August/September 2008. Pages 14-19.

[12] ibid.
[13] ibid.

[14] Heal the Bay. Online News: *L.A. County Takes a Major Leap in Protecting Water Quality,* October 10, 2008. Accessed on 1/5/09, http://www.healthebay.org/news/2008/10-07_LACounty-LID/default.asp

[15] City of Los Angeles Department of Public Works, Stormwater Program. *What is Stormwater Pollution?* Accessed on 10/3/08, http://www.lastormwater.org/Siteorg/residents/whatis.htm

[16] Heal the Bay. "2007-2008 Annual Beach Report Card." Accessed on 10/3/08. http://www.healthebay.org/assets/pdfdocs/brc/annual/2008/execsumm.pdf

[17] Community Conservancy International. "The Green Solutions Project" report, March 2008. Executive Summary, p.ES-3. The report can be viewed at http://www.ccint.org/greensolution.html

[18] Wise, Steve. "Green Infrastructure Rising: Best Practices in Stormwater Management." *Planning,* the magazine of the American Planning Association. August/September 2008. Pages 14-19.

[19] ibid.

[20] *First source of information:* Beckman, David S. and Noah Garrison. "NRDC Comment on AB32 Scoping Plan Appendices—Water Sector," August 11, 2008. Natural Resources Defense Council comments sent to the California Air Resources Board. *Second source of information:* Email message from Noah Garrison, Project Attorney at NRDC, on January 21, 2009. "LID Numbers for L.A. County."

[21] Los Angeles Department of Water & Power. "City of Los Angeles Water Supply Action Plan," p.4. May 2008.

[22] *First source of information:* Beckman, David S. and Noah Garrison. "NRDC Comment on AB32 Scoping Plan Appendices—Water Sector," August 11, 2008. Natural Resources Defense Council comments sent to the California Air Resources Board. *Second source of information:* Email message from Noah Garrison, Project Attorney at NRDC, on January 21, 2009. "LID Numbers for L.A. County."

[23] Estimates of potential stormwater runoff assuming an average yearly rainfall in Los Angeles of 15-inches on impervious surfaces. {Potential stormwater from a ¼-acre lot} = (0.25 x 43,560 sq.ft. per acre) x (15" rain per year) / (12" per ft.) x (7.481 gal. per cu.ft.) = 101,835 gallons. An ordinary, 2-lane street is 30 feet wide. {Potential stormwater from a city street, not including sidewalks} = (500 ft. long) x (30 ft. wide) x (15" rain per year) / (12" per ft.) x (7.481 gal. per cu.ft.) = 140,269 gallons. Calculation by the City of Los Angeles Bureau of Sanitation, November 2008.

[24] Wise, Steve. "Green Infrastructure Rising: Best Practices in Stormwater Management." *Planning,* the magazine of the American Planning Association. August/September 2008. Pages 14-19.

[25] Intergovernmental Panel on Climate Change. "Climate Change 2007: Synthesis Report. Summary for Policy Makers." IPCC Fourth Assesment Report (AR4); Summary for Policy Makers. Accessed on 1/2/09, http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

[26] Brasuell, James. *TreePeople Advocates for Practical and Holistic Solutions to Los Angeles' Environmental Crisis,* interview with Andy Lipkis. VerdeXchange News, Vol. 01: No. 03: June 2007. Accessed on 1/10/09, http://www.verdexchange.org/node/87

[27] Rosenfeld, Arthur H, Joseph J. Romm, Hashem Akbari, and Alan C. Lloyd. *"Painting the Town White—and Green."* Originally published in the February/March 1997 issue of MIT's Technology Review. Accessed on 1/5/09 from the Heat Island Group website: http://heatisland.lbl.gov/PUBS/PAINTING/

[28] *First source of information:* Beckman, David S. and Noah Garrison. "NRDC Comment on AB32 Scoping Plan Appendices—Water Sector," August 11, 2008. Natural Resources Defense Council comments sent to the California Air Resources Board. *Second source of information:* Email message from Noah Garrison, Project Attorney at NRDC, on January 21, 2009. "LID Numbers for L.A. County."

[29] ibid.

[30] Akbari, H. "Shade Trees Reduce Building Energy Use and CO_2 Emissions From Power Plants." *Environmental Pollution* 116 (2002) S119–S126. Accessed on 1/4/09, http://www.fs.fed.us/psw/programs/cufr/products/12/psw_cufr703_Akbari_Reduce_Energy_Use.pdf

[31] The Los Angeles Neighborhood Land Trust. *Why LANLT: Overview.* Accessed on 1/7/09, http://www.lanlt.org/

[32] E. Gregory McPherson, Center for Urban Forest Research, US Forest Service, Davis, CA; and J. R. Simpson, Q. Xiao, and C. Wu. "Million Trees LA Canopy Cover Assessment." Accesed on 4/1/09, http://ams.confex.com/ams/7Coastal7Urban/techprogram/paper_126994.htm

[33] City of Los Angeles Department of Recreation and Parks. *Sepulveda Basin Wildlife Reserve.* Accessed on 1/6/09, http://www.laparks.org/dos/horticulture/sepulvedabasin.htm

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34 Traffic Safety Center. *Can Pedestrian-friendly Planning Encourage Us to Walk?* Online newsletter Volume 2, Number 1, Spring 2004. Accessed on 1/9/09, http://www.tsc.berkeley.edu/newsletter/Spring04/planning.html

35 Lerner, Joel M. "A Property's Value Can Grow on Its Trees," *Washington Post* Saturday, September 23, 2006; Page F26. Accessed on 1/9/09, http://www.washingtonpost.com/wp-dyn/content/article/2006/09/21/AR2006092102046.html

36 Kuo, Frances E. "The Role of Arboriculture in a Healthy Social Ecology." *Journal of Arboriculture* 29(3): May 2003. Accessed on 1/6/09, http://treelink.org/joa/2003/may/04Kuo.pdf

37 Kuo, Frances E. "Environment and Crime in the Inner City: Does Vegetation Reduce Crime?" *Environment and Behavior,* Vol. 33, No. 3, 343-367 (2001). Accessed on 1/6/09 at http://eab.sagepub.com/cgi/reprint/33/3/343

38 City of Los Angeles, Office of Mayor Antonio Villaraigosa. *Energy & Environment: Green LA.* Accessed on 2/3/09, http://mayor.lacity.org/villaraigosaplan/EnergyandEnvironment/LACITY_004467.htm

39 Schmitz, Rob. *L.A. considers green building codes.* November 28, 2008. Accessed on 1/7/09 from the American Public Media: Marketplace website: http://marketplace.publicradio.org/display/web/2008/11/28/green_jobs/

40 Rosner, Signalle. "Job Implications in Los Angeles' Green Building Sector," May 2006. Accessed on 1/7/09 from the Green for All website: http://www.greenforall.org/resources/job-implications-in-los-angeles-green-building

41 USDA Forest Service, Pacific Northwest Research Station. *Study shows that street trees increase the value of Portland homes by more than $1 billion,* March 10, 2008. Accessed on 1/3/09, http://www.fs.fed.us/pnw/news/2008/03/trees.shtml

42 U.S. Environmental Protection Agency. *Questions and Answers: Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices.* From the Polluted Runoff (Nonpoint Source Pollution) web page. Accessed on 2/1/09, http://www.epa.gov/owow/nps/lid/costs07/q-and-a.html

43 ibid.
44 ibid.

45 U.S. Environmental Protection Agency. *Fact Sheet: Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices*, December 2007. From the Polluted Runoff (Nonpoint Source Pollution) web page. Accessed on 1/3/09, http://www.epa.gov/owow/nps/lid/costs07/factsheet.html

46 Wise, Steve. "Green Infrastructure Rising: Best Practices in Stormwater Management." *Planning,* the magazine of the American Planning Association. August/September 2008. Pages 14-19.

47 U.S. Environmental Protection Agency, Nonpoint Source Control Branch (4503T). "Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices," December 2007. EPA Document #EPA 841-F-07-006. Accessed on 1/3/09, http://www.epa.gov/owow/nps/lid/costs07/documents/reducingstormwatercosts.pdf

[5] Examples of LID Programs & Projects

Many cities across the country already have low impact development (LID) regulations, programs and projects underway, often pursued as an extension of a greater stormwater management, landscaping or sustainability program. This chapter describes a variety of LID efforts in the United States, with some specific focuses on local examples from Los Angeles and Southern California. This review is intended to be selective and not exhaustive. For more information on nationwide LID practices, please see the resources listed in Appendix I.

Maryland— LID Programs and Stormwater Regulations

Prince George's County: LID Urban Retrofit Program

In 1999, the Environmental Services Division of Prince George's County, Maryland, pioneered a radically different approach to stormwater management with the introduction of their manual titled, "Low Impact Development Design Strategies: An Integrated Design Approach."[1] This document has since become a leading reference guide on low impact development in the United States. By the end of 2006, Prince George's County had completed a number of projects to demonstrate the feasibility of incorporating LID principles into the urban landscape.

The pilot projects in the Anacostia River Watershed focused on infiltration and bio-retention BMPs to manage urban runoff, while keeping an eye on the overall landscaping aesthetics.[2] These projects incorporate key LID elements: conservation of existing natural and topographical features, emphasis on retrofitting as opposed to clearing new land, increased detention times over existing conditions, and the integration of small source-control projects into existing landscaping to improve local water quality.

Highway divider strip before and after the retrofit of an infiltration swale.

Credit: Final Technical Report – Pilot Projects for LID Urban Retrofit Program in the Anacostia River

Maryland Stormwater Act of 2007

Governor Martin O'Malley signed the Maryland Stormwater Act into law in 2007.[3] This act aims to maintain predevelopment runoff characteristics as nearly as possible by implementing "environmental site design" (ESD). ESD includes the conservation of natural features, minimizing use of impervious surfaces, slowing runoff, and preferentially using nonstructural practices or innovative stormwater management practices. Because of the Stormwater Act, the Maryland Stormwater Design Manual (originally released in 2000) has been revised to promote ESD as much as possible.[4]

Seattle— SEA Streets and Green Factor

SEA Streets Project

In 2001, Seattle completed its pilot “Street Edge Alternatives” Project (SEA Streets).[5] The city redesigned residential streets to reflect natural drainage patterns using swales and the addition of over 100 evergreen trees and 1100 shrubs. To support LID goals, the SEA Streets had 11% less impervious surfaces than a conventional street. Two years of monitoring has found that the SEA Streets have reduced the total volume of stormwater leaving the street by 99%.

Seattle□s SEA Street (Street Edge Alternatives) project includes bioswales and permeable pavement.

Seattle Green Factor

In 2006, the City of Seattle revised its building codes for business and commercial areas. A part of the revision included an innovative system called the Seattle Green Factor, which places an environmental value on virtually every exterior element of a property.[6] The Seattle Green Factor promotes LID principles using flexible requirements, which allows developers to select the most appropriate landscaping and building elements for their site. The Green Factor aims to increase the quantity and quality of natural drainage and landscaping elements. While layering vegetation and public visibility are prominent objectives, the Green Factor also promotes rainwater harvesting and the use of plants with low water requirements.

Seattle Green Factor Scoring Parameters

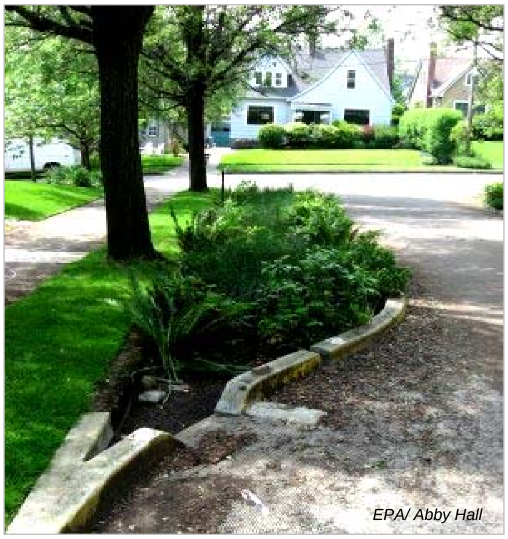
Element	Multiplier
Vegetated walls	0.7
Rain garden	0.7
Lawn □deep	0.7
Green roofs	0.7
Permeable pavement	0.6
Exceptional trees	0.5
Bigger trees	0.4
Smaller trees	0.3
Shrubs-deep	0.3
Shrubs □shallow	0.3
Lawn □shallow	0.2
Visibility (aesthetics) - bonus	0.1
Drought tolerant - bonus	0.1
Conventional pavement	0.0

As of January 2007, Seattle requires new developments in neighborhood business districts to achieve a final Green Factor score of 0.30 or higher. A “Green Factor Worksheet” lists various landscaping options along with their corresponding multipliers. The multipliers, which weigh the elements in proportion to their desirability and environmental effectiveness, are used with square footage measurements to calculate the total Green Factor value of a property. For example, asphalt, concrete and conventional pavement have low green factors of 0.0, but LID practices such as permeable paving (0.6) and green roofs (0.7) have much higher values.

Portland— Green Street Retrofits & Stormwater Management Program

Siskiyou Green Street Project

Portland, Oregon's first green street project on NE Siskiyou Street was completed in just two weeks during 2003.[7] Siskiyou Street was selected for the pilot project because the local homes would experience basement flooding during major storms.[8] Two stormwater curb extensions ("bump-outs") with attractive landscaping were added to this residential street for $17,000.[9] Strategically-placed curb cuts in the bump-outs allow street runoff to flow into the bioswales, where the water is then filtered and infiltrated into the ground. A flow test conducted in 2004 determined that the bump-outs would capture 85% of the runoff generated by a 25-year storm and delay the peak flow by twenty minutes.[10] Besides the major stormwater management benefits, the Siskiyou Street project also makes the street more attractive, filters out water pollutants and increases street safety by reducing the speed of cars.


EPA/ Abby Hall


Nevue Ngan Assoc / Kevin Robert Perry

Curb bump-outs on NE Siskiyou Street in Portland, OR.

Portland's Stormwater Management Manual

The City of Portland has a comprehensive approach to stormwater management that emphasizes the use of vegetated surfaces to treat and infiltrate stormwater on the property where the stormwater runoff originates. The Stormwater Management Manual (SWMM), developed by the Portland Bureau of Environmental Services in 1999 and most recently revised in July 2008, outlines the stormwater management requirements that apply to development and redevelopment on private and public properties.[11] The SWMM illustrates methods for infiltration and discharge, flow control, pollution reduction, operations and maintenance, and source control. The city promotes the use of vegetated surface infiltration facilities for meeting multiple requirements. SWMM provides design criteria for these vegetated facilities, many of which are LID-based.

Portland's Office for Sustainable Development also provides guidelines and practical solutions for designing and building of LID practices such as eco-roofs, rainwater harvesting, green streets, and water conservation.[12] This office uses a combination of technical assistance (including workshops for homeowners and businesses), outreach, research and policy development.

Chicago— Green Infrastructure

Water Agenda & Green Building Agenda

Chicago's green roof on City Hall

Photo: http://www.asla.org/meetings/awards/awds02/chicagocityhall.html

The City of Chicago published its "Water Agenda" in 2003 as a strategy for protecting its water resources by conserving water, protecting water quality, managing stormwater and providing outreach and encouraging mobilization—all focusing on "green" infrastructure as opposed to conventional "built" infrastructure.[13] The stormwater component of this plan relies on creating green infrastructure for City projects as well as private developments. Examples of low impact development (LID) practices include rooftop gardens, permeable alleys, rain gardens, green design and infrastructure requirements for developers' site plans, and wetlands rehabilitation. Building on experience, Chicago started a new green building program, "Chicago's Green Building Agenda 2005," with goals that include reduced operation and maintenance costs, conservation of natural resources, and the improvement of health and productivity. Ultimately, Chicago expects to create a "Green Building Code" to utilize green building technologies and strategies.

Green Alley Program

Chicago's "Green Alley" program, developed by their Department of Transportation, has completed projects that use permeable pavement to increase rainwater infiltration, recycled concrete, and surfaces that have a high solar reflectance (high albedo) to reduce the heat island effect.[14] "The Chicago Green Alley Handbook"[15] recently won the 2007 American Society of Landscape Architects award for Communications Honors[16] for its simple and easy-to-understand graphics explaining possible BMPs. Other cities (including Seattle, Baltimore and Vancouver) also have innovative programs to convert, sometimes unattractive, alleys into green spaces and stormwater BMPs.

Permeable alley during construction and after completion in Chicago.

Credit: Chicago Dept. of Transportation

Stormwater Ordinance and BMP Guide

The Chicago Stormwater Management Ordinance, effective January 1, 2008, specifically addresses many of the goals of the Water Agenda.[17] The ordinance requires "regulated development" to have an approved stormwater management plan in place for (1) managing the peak rate of stormwater discharge from the property, and (2) controlling *on site* (by capture) the volume generated by ½ inch of stormwater on the property's impervious surfaces.

The City of Chicago has also developed the "Guide to Stormwater Best Management Practices," which is a "how to" plan for residents, developers, and other community members on several LID BMPs for reducing the amount of stormwater.[18] The guide includes cost estimates and is a helpful resource for more information.

City of Ventura— Green Streets Policy & LID Resolution

In July 2008, the City of Ventura enacted its "Green Street" policy, which directed city staff to "begin incorporating Green Street elements into repaving projects on a city-wide basis," and identified South Catalina Street as the location for a Green Infrastructure Demonstration Project.[19] The projects all incorporate LID practices, and range from street and alley repaving projects to a requirement that all City parking lots include provisions to divert and retain stormwater runoff. To help plan future projects, the City developed a comprehensive "Green Streets Matrix" which contains BMP benefits and costs. *(See Appendix II.)*

City of Ventura, California

Credit: □Solving the Urban Runoff Problem□www.surfrider.org□ventura

At the same time, the Ventura City Council adopted a resolution in support of the "Resolution of the California Ocean Protection Council Regarding Low Impact Development."[20] The resolution, drafted by the Ocean Protection Council, aims to coordinate and improve the protection and management of California's ocean and coastal resources by implementing the Governor's Ocean Action Plan. The resolution states that LID is a "practicable and superior approach to minimize and mitigate increases in runoff and runoff pollutants" at a cost that is 15% to 80% less than when using conventional stormwater treatment facilities. Accordingly, the resolution promotes the use of LID principles for new developments and redevelopments and LID retrofits of existing impervious areas. It also describes a series of recommendations for the implementation of LID at the state and local level, which Ventura seeks to incorporate.

County of Los Angeles— Green Building Ordinances

In October 2008, the County of Los Angeles passed a comprehensive Green Building Program supported by three ordinances: 1) Green Building Ordinance, 2) Drought-Tolerant Landscaping Ordinance, and 3)

Low Impact Development Ordinance.[21] The Green Building Program ordinances apply to the unincorporated portions of Los Angeles County, as well as to all County of Los Angeles capital construction projects.[22] Draft versions of the "Low Impact Development Manual" and the "Green Building and Sustainability Guidelines" have been created.

The **Green Building Ordinance** will apply only to new construction. Buildings, no matter their size, will have to comply with the County's green building standards.[23] Larger residential, mixed use, hotel and high-rise buildings will also have to become LEED certified by the U.S. Green Building Council. The County's Green Building Standards support LID principles by requiring smart irrigation controllers and drought-tolerant plants (selected from a list of approved species) for at least 75% of the total landscaped area. Residential projects are also required to plant a specified number of drought-tolerant trees.

1100 S. Hope Street in downtown Los Angeles

The County's **Drought-Tolerant Landscaping Ordinance** amends Titles 21 and 22 of the Los Angeles County Code by establishing minimum standards for the design and installation of landscaping using drought-tolerant plants. This ordinance will apply to all construction of new private property as well as to expansions of existing buildings or structures in excess of 2,500 square feet; the ordinance requires that at least 70% of the landscaped area shall use plants from the "Drought-Tolerant Approved Plant List" maintained by Los Angeles County Department of Regional Planning.

The objectives of the **Low Impact Development Ordinance** include:[24]

a) Mimic the stormwater and urban runoff rates and volumes that would be found in an undeveloped area in any storm event up to and including the 50-year capital design storm[a] event;[25]
b) Prevent stormwater pollutants of concern from flowing off-site (for storms up to and including the water quality design storm event); and
c) Minimize impacts to natural drainage systems.

The County's LID Ordinance will apply to new development and redevelopments. Redevelopment projects that alter more than half of a site's impervious surfaces must bring the entire site up to LID standards. Otherwise, only the alteration itself needs to meet LID requirements. Projects that 1) alter less than 50% of impervious surfaces, and 2) have no more than four previously existing residential units are exempt from LID standards.[26]

[a] "Capital storm" is a 50-year design storm on a saturated watershed.

City of Los Angeles— River Master Plan and Green Streets

Los Angeles River Revitalization Master Plan

The **Los Angeles River Revitalization Master Plan** (LARRMP), published in April 2007, is a 20-year blueprint for the development and management of the first 32 miles of the river, from Canoga Park to downtown.[27] The goals of this plan are to restore the ecological and hydrological functions of L.A. River, to green adjacent neighborhoods, to capture community opportunities, and to create value for the local area. The plan recommends the transformation of the River Corridor into to a continuous River Greenway. Typical LID elements in the LARRMP include the implementation of greens streets and natural open spaces, daylighting of streams currently hidden by development, and the incorporation of stormwater BMPs into existing roadways, new streetscapes, and in all public landscapes.

Recent photo, San Fernando Valley

Revitalization Concept

Photo Credit: http://www.lariverrmp.org/CommunityOutreach/masterplan_download.htm.

Green Streets L.A. Program

Contaminated runoff is the largest source of ocean pollution in Southern California,[28 29] and the city's street infrastructure plays a major role in flushing these pollutants out to sea. The city has approximately 6,500 miles of streets[30] with 10,000 miles of sidewalk[31] and 34,000 catch basins.[32] The **Green Streets LA** program[33] was initiated by the Board of Public Works with the idea that the streets of Los Angeles offer an enormous opportunity to infiltrate, capture and filter urban runoff to prevent pollution and to convert stormwater into a valuable resource for groundwater recharge and water reuse.[34]

The **Green Streets Committee** is comprised of representatives from a number of City departments that work on issues related to street infrastructure. Monthly meetings are designed to help facilitate communication and coordination between these entities. Recently, the Green Streets Committee has focused on integrating LID practices into City infrastructure programs and construction standards. A preliminary set of Green Streets design guidelines were developed in 2008.

The **Green Alleys Committee** (a subcommittee of the Green Streets Committee) is working on identifying alleys in Los Angeles that could become pilot projects for a green retrofit. There is a total of 914 linear miles of alleys within the City of Los Angeles.[35] The committee is also investigating funding opportunities. The main representatives on the Green Alleys Committee come from the Board of Public Works, the Community Redevelopment Agency and the USC Center for Sustainable Cities Program (CSC). The CSC has developed detailed characteristics on over 300 alleys in Los Angeles.[36]

Green Streets Projects in Los Angeles

Oros Street is a residential street in the Elysian Valley section of Los Angeles. Runoff from this street drains directly to Los Angeles River. This is one of the first streets in Los Angeles to be converted into a green street. Completed in 2007 at a total cost of about $1 million, this project provides bio-retention areas in the street parkway, additional street landscaping and a large infiltration basin underneath Steelhead Park at the end of the block. The objective was to capture and treat 100% of the dry-weather runoff and at least ¾” of rainfall during storms. This project was a collaboration between North East Trees and the City of Los Angeles, represented by the Bureau of Street Services and the Watershed Protection Division from the Bureau of Sanitation.

Oros Street during and after “green street” reconstruction.

Riverdale Avenue is close to Oros Street and is expected to be converted to a green street by the end of 2009. The purpose of the retrofit is to capture and infiltrate urban runoff and stormwater from a 14.6-acre drainage area by using specially-designed diversion measures and infiltration planters. Existing parkways and sidewalks will be replaced by native plant species. Construction costs of this project are funded by a grant from the State Coastal Conservancy (up to $500,000) and the City of Los Angeles will provide in-kind design services.

Current view of Riverdale Ave. (left) and design concept for Riverdale green street retrofit (right).
Credit: LABOS / D. Deets

Elmer Avenue, between Stagg and Keswick Street in the Sun Valley watershed, will be retrofitted into a green street by the summer of 2009. The focus of this retrofit is to minimize the water demand for irrigation and to improve the quality of runoff that flows into L.A. River.[37] Project elements include runoff capture and infiltration on the public right-of-way and runoff capture and water conservation on residential properties (rain gardens, drought-tolerant landscaping, permeable surfaces). This project is a collaboration between residents, nonprofit organizations, granting agencies, Council District 6, and the Bureaus of Sanitation, Street Services and Engineering.[38] The Los Angeles and San Gabriel Rivers Watershed Council has agreed to provide a grant of $1.25 million. TreePeople will also provide educational and financial assistance to residents for converting their lawns to native landscaping and for using stormwater BMPs. This project is part of the L.A. Basin Water Augmentation Study led by the San Gabriel Rivers Watershed Council.[39]

Bimini Slough Ecology Park, near Second and Vermont Avenues in the Koreatown section of Los Angeles, is a new pocket park built on LID principles. Existing, well-established trees were incorporated into the park's redesign. New plants and trees were selected from native, drought-tolerant varieties. In the dry season, plants are maintained with a state-of-the-art drip irrigation system. The Bimini Slough Ecology Park incorporates a biofiltration swale to reuse stormwater.[40] A decomposed granite walkway allows for infiltration. Los Angeles County oversaw testing[41] to evaluate BMP performance, which indicated that the biofiltration swale effectively reduced total suspended solids, oil and grease and had some impact on reducing other constituents of concern.[b] The park opened to the public on January 26, 2006.

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[b] Testing was completed in 2005 and was limited to three sampling events in a particular wet year. Because the testing was very limited, meaningful performance statistics were not generated. However, test results seem to indicate effective performance at reducing oil and grease and Total Suspended Solids. Though not as conclusive, data also appeared to indicate reductions in lead and zinc. Analysis of samples for microorganisms and nutrients were not conclusive other than to indicate there was not a significant change, inlet to outlet.

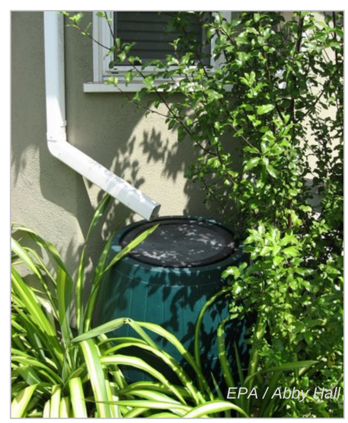
2005 View of 2nd street before park construction.
Credit: LABOS

Bimini Slough Ecological Park in East Hollywood by after plants became well established.
Credit: North East Trees

Los Angeles Downspout Disconnection Program

The City of Los Angeles initiated a pilot "Downspout Disconnection" program in December 2008 to prevent roof runoff from homes and businesses in the Ballona Creek watershed area from flowing onto into the storm drain system.[42] [43] Instead, the City will offer incentives and educational information to encourage citizens to redirect the water from their downspouts away from impervious surfaces and into planters or rain barrels for later reuse.

Santa Monica— Green Building Program



A Santa Monica home that collects roof runoff in a rain barrel.

The City of Santa Monica's Green Building Ordinance[44] is a component of its Green Building Program, which also includes construction guidelines, identifies green building materials, and establishes landscaping and irrigation requirements.[45] The Green Building Program provides incentives in the form of grants—ranging from $20,000 to $35,000—for the design of buildings certified under the U.S. Building Council's LEED Green Building Rating System. Another element of the City's program provides expedited permitting for LEED-registered projects.

Santa Monica has also published the "Santa Monica Residential Green Building Guide" that describes sustainable building practices that can be incorporated into new or remodel construction.[46] The guide explains the benefits of using environmentally-friendly alternatives for utilities, construction materials and landscaping. The guide includes extensive resources for products, technical guidance and financial resources such as grants.

City of San Diego— Stormwater Management & LID Program

The City of San Diego created the “Low Impact Development Handbook: Stormwater Management Strategies” in December 2007, in part, to satisfy the City’s Municipal Stormwater Permit. The city’s LID program protects water quality by preserving or mimicking nature through the use of stormwater planning and management techniques. The handbook provides a list of LID planning and stormwater management strategies for developers, builders, contractors, planners, landscape architects, engineers, and government employees to help in planning a new project site.[47] Eventually, all sites larger than one acre in the City of San Diego will be required to incorporate LID features. Though the handbook is now just a guide, many of the techniques will eventually be incorporated into the city’s SUSMP (Standard Urban Stormwater Mitigation Plan) requirements.

Northern California

Village Homes in Davis, CA

Village Homes is a well-established community and housing development in Davis, CA that was built around LID concepts. It is located in a climate similar to many parts of Los Angeles—warm summers, cool winters and limited rainfall (approximately 25% more than Los Angeles).[48] Developed in 1970s and early 1980s, Village Homes is an excellent example of residential low impact development. There are 225 homes and 20 apartments on 70 acres, and the entire development relies exclusively on a natural drainage system—creek beds, swales, and pond areas. The development is well known for these unique landscape design features. Village Homes also incorporates many other environmental features such as narrow streets, passive heating and cooling, and organic gardening practices.

Village Homes relies exclusively on natural drainage.
Photo credit: http://www.villagehomesdavis.org

Emeryville— Guidelines for Green Development

The City of Emeryville, CA released “Stormwater Guidelines for Green, Dense Redevelopment” in December 2005. It is a guide to integrating high density live/work communities, parking and ecological benefits.[49] It recommends land use and parking policies that minimize impervious surfaces and maximize green space for recreation, improved water quality, reduced heat-island effects and community aesthetics. The

Stacking cars reduces the need for impervious parking lots at this business in Emeryville.

guide comes with a companion spreadsheet model to evaluate various combinations of LID concepts, including detention systems, infiltration and flow-through planters and biofiltration swales. This simple model makes it easy to evaluate different storm scenarios for Emeryville, and could probably be adapted for use in other regions.

San Francisco— Rainwater Harvesting Program

The San Francisco Public Utilities Commission (SFPUC) began its rainwater harvesting program in October 2008. Its main goal is to reduce the amount of water flowing into the municipal combined sewer system, but it also promotes the use of rainwater for irrigation and non-potable applications.[50] The SFPUC is subsidizing the cost of rain barrels for city residents and not requiring permits for their use. The same program is also promoting the use of cisterns on larger properties.

Endnotes

[1] Prince George's County (MD) Department of Environmental Resource Programs and Planning Division. "Low-Impact Development Design Strategies An Integrated Design Approach," June 1999. Accessed 8/15/08, http://www.lowimpactdevelopment.org/pubs/LID_National_Manual.pdf

[2] Prince George's County (MD) Department of Environmental Resources. "Final Technical Report: Pilot Projects for LID Urban Retrofit Program in the Anacostia River Watershed, Phase III," December 30, 2006. Accessed 8/15/08, http://www.co.pg.md.us/Government/AgencyIndex/DER/ESG/pdf/Final%20Technical%20Report_Phase%20III.pdf

[3] State of Maryland Department of the Environment. *Maryland Stormwater Mangement Act of 2007.* Accessed 10/2/08, http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/swm2007.asp

[4] State of Maryland Department of the Environment. *Maryland Stormwater Design Manual—Volumes I & II,* effective October 2000. Accessed 10/2/08, http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/stormwater_design/index.asp

[5] Seattle Public Utilities Commission. *Street Edge Alternatives (SEA Streets) Project.* Accessed 12/31/08, http://www.seattle.gov/UTIL/About_SPU/Drainage_&_Sewer_System/Natural_Drainage_Systems/Street_Edge_Alternatives/index.asp

[6] City of Seattle (WA) Department of Planning & Development. *Seattle Green Factor: What is the Seattle Green Factor?* Accessed November 2008, http://seattle.gov/dpd/permits/greenfactor/Overview/

[7] City of Portland (OR) Bureau of Environmental Services. "NE Siskiyou Green Street Project: Project Summary," April 2005. Accessed on 1/2/08 at http://www.portlandonline.com/bes/index.cfm?a=78299&c=45386

[8] City of Portland (OR) Bureau of Environmental Services. "Flow Test Report: Siskiyou Curb Extension, August 4th 2004." Accessed on 1/2/08, http://www.portlandonline.com/shared/cfm/image.cfm?id=63097

[9] City of Portland (OR) Bureau of Environmental Services. "NE Siskiyou Green Street Project: Project Summary," April 2005. Accessed on 1/2/08, http://www.portlandonline.com/bes/index.cfm?a=78299&c=45386

[10] City of Portland (OR) Bureau of Environmental Services. "Flow Test Report: Siskiyou Curb Extension, August 4th 2004." Accessed on 1/2/08, http://www.portlandonline.com/shared/cfm/image.cfm?id=63097

[11] City of Portland (OR) Bureau of Environmental Services. "City of Portland Stormwater Management Manual," Revision 4, July 1, 2008. Accessed 10/2/08, http://www.portlandonline.com/bes/index.cfm?c=47952&

[12] City of Portland (OR) Bureau of Planning and Sustainability. *Stormwater Management.* Accessed on 10/1/08, http://www.portlandonline.com/osd/index.cfm?c=42113

[13] City of Chicago (IL). "Chicago's Water Agenda 2003." Accessed on 10/1/08, http://egov.cityofchicago.org/webportal/COCWebPortal/COC_EDITORIAL/wateragenda_1.pdf

[14] City of Chicago, Department of Transportation. *Green Alleys.* Accessed October 2008, http://egov.cityofchicago.org/city/webportal/portalContentItemAction.do?BV_SessionID=@@@@1030171822.1233726916@@@@&BV_EngineID=cccdadeggjimimjcefecelldffhdfhm.0&contentOID=536946345&contenTypeName=COC_EDITORIAL&topChannelName=Dept&blockName=Transportation%2FGreen+Alleys%2FI+Want+To&context=dept&channelId=0&programId=0&entityName=Transportation&deptMainCategoryOID=-536883915

[15] City of Chicago (IL). "The Chicago Green Alley Handbook." Accessed on 10/1/08, http://egov.cityofchicago.org/webportal/COCWebPortal/COC_EDITORIAL/GreenAlleyHandbook.pdf

[16] American Society of Landscape Architects, Illinois Chapter. *2007 Awards.* Accessed on 10/1/08, http://www.il-asla.org/awards_2007.html

[17] City of Chicago (IL). Chicago Stormwater Management Ordinance, "Substitute Ordinance." Accessed on 10/1/08, http://egov.cityofchicago.org/webportal/COCWebPortal/COC_EDITORIAL/StormwaterManagementOrdinance1206.pdf

[18] City of Chicago (IL). "A Guide to Stormwater Best Management Practices: Chicago's Water Agenda," 2003. Accessed on 10/1/08, http://egov.cityofchicago.org/webportal/COCWebPortal/COC_ATTACH/GuideToStormwaterBMPs.pdf

[19] City of Ventura (CA). "Administrative Report," written by Rick Cole, City Manager, to Ronald J. Calkins, Public Works Director on July 7, 2008. Council action date: July 14, 2008. Agenda item #13.

[20] California Ocean Protection Council. *Announcements.* Accessed on 10/2/08, http://resources.ca.gov/copc/

[21] County of Los Angeles. "Ordinances for Green Building, Low Impact Development and Drought-Tolerant Landscaping," November 14, 2008. Accessed on 12/15/08. http://planning.lacounty.gov/assets/upl/data/ord_green-building-final-ordinances.pdf

[22] County of Los Angeles, Department of Regional Planning. *Special Projects: Green Building Program.* Accessed on 7/17/08, http://planning.lacounty.gov/spGreenBuildingProgram.htm

[23] County of Los Angeles. "Ordinances for Green Building, Low Impact Development and Drought-Tolerant Landscaping," November 14, 2008. Accessed on 12/15/08. http://planning.lacounty.gov/assets/upl/data/ord_green-building-final-ordinances.pdf

[24] ibid.

[25] County of Los Angeles, Department of Public Works. "Hydrology Manual," January 2006. Accessed on 7/31/08, http://dpw.lacounty.gov/wrd/publication/engineering/2006_Hydrology_Manual/2006%20Hydrology%20Manual-Divided.pdf

[26] County of Los Angeles. "Ordinances for Green Building, Low Impact Development and Drought-Tolerant Landscaping," November 14, 2008. Accessed on 12/15/08. http://planning.lacounty.gov/assets/upl/data/ord_green-building-final-ordinances.pdf

[27] City of Los Angeles Department of Public Works, Bureau of Engineering. "Los Angeles River Revitalization Master Plan," April 2007. Available online at http://www.lariverrmp.org/CommunityOutreach/masterplan_download.htm

[28] Heal the Bay. Online News: *L.A. County Takes a Major Leap in Protecting Water Quality,* October 10, 2008. Accessed on 1/5/09, http://www.healthebay.org/news/2008/10-07_LACounty-LID/default.asp

[29] City of Los Angeles Department of Public Works, Bureau of Sanitation. "Water Quality Compliance Master Plan for Urban Runoff," Draft, December 4, 2007.

[30] City of Los Angeles Department of Public Works. *The Department of Public Works.* http://www.lacity.org/DPW/dpwhome.htm

[31] Zahniser, David. "City to pass the bucks on sidewalks?" *Los Angeles Times,* February 21, 2008. Accessed on 2/1/09, http://articles.latimes.com/2008/feb/21/local/me-sidewalk21

[32] Sonenshein, Raphael J. *Los Angeles: Structure of a City Government,* p.77. (2006) Published by the League of Women Voters of Los Angeles.

[33] Daniels, Paula (Commissioner, City of Los Angeles Board of Public Works.) "Green Streets LA," presentation to Local Government Commission, September 13, 2007. Accessed on 8/21/08, http://water.lgc.org/water-workshops/la-workshop/Green_Streets_Daniels.pdf/view

[34] Walla, Claire. "New SCNC environmental committee takes on local pollution," Interview with Commissioner Paula Daniels. *Sherman Oaks Sun.* Accessed on 9/4/08, http://www.suncommunitynewspapers.com/index.php?mact=News,cntnt01,detail,0&cntnt01articleid=1004&cntnt01returnid=58

[35] Daniels, Paula (Commissioner for the City of Los Angeles Board of Public Works). "For the Board Meeting of 10-5-2007: Motion." Accessed on 9/4/08, http://eng.lacity.org/docs/dpw/agendas/2007%2F200710%2F20071005/bd/20071005_ag_cmrpd_1.pdf

[36] Cassidy, Arly, Josh Newell and Jennifer Wolch. "Transforming Alleys into Green Infrastructure for Los Angeles," June 2008. USC Center for Sustainable Cities. Accessed July 2008, http://college.usc.edu/geography/ESPE/documents/alleyreport_final_reduced.pdf

[37] City of Los Angeles Department of Public Works, Stormwater Program. *Elmer Avenue: A Model Stormwater Green Street.* Accessed November 2008, http://www.sga-inc.net/BACKUP/LA_newsletter/Elmer_Avenue.html

[38] ibid.

[39] Los Angeles & San Gabriel Rivers Watershed Council. *L.A. Basin Water Augmentation Study.* Accessed November 2008, http://www.lasgrwc.org/WAS.htm

[40] Los Angeles & San Gabriel Rivers Watershed Council. "Accomplishments: Fiscal Years 2002 – 2003 and 2003 – 2004." Accessed November 2008, http://www.lasgrwc.org/publications/AccomplishmentsFY02_04.pdf

[41] County of Los Angeles, Department of Public Works. "Los Angeles County BMP Effectiveness Study," August 2005. Accessed November 2008, http://dpw.lacounty.gov/wmd/NPDES/1994-05_report/Appendices/Appendix%20H-BMP%20Effectiveness.pdf

[42] City of Los Angeles, Department of Public Works, Stormwater Program. *Coming to a Neighborhood Near You - Disconnected Downspouts.* Accessed November 2008, http://www.sga-inc.net/BACKUP/LA_newsletter/Coming_to_a_Neighborhood_Near_You.html

[43] City of Los Angeles, Department of Public Works, Public Affairs Office. "City Asks Residents to Disconnect Downspouts and Help Save Water, Reduce Urban Runoff," Press release, 12/24/08. Accessed 1/4/09, http://www.ci.la.ca.us/bpw/press/bpwpress9057412_12242008.pdf

[44] Clean Air Cool Planet. *Green Building Ordinances.* Accessed 1/5/09, http://www.cleanair-coolplanet.org/for_communities/green_building_ordinances.php (This website lists community programs around the county with Green Building Ordinances.)

[45] City of Santa Monica, Energy & Green Building Programs. *New Green Building Ordinance.* Accessed on 1/3/09, http://greenbuildings.smgov.net/index.html

[46] City of Santa Monica, Energy & Green Building Programs. "Santa Monica Residential Green Building Guide." Accessed on 1/3/09, http://greenbuildings.smgov.net/pdf/Residential_GB_Guidelines.pdf

[47] County of San Diego, Department of Planning and Land Use. "Low Impact Development Handbook: Stormwater Management Strategies," December 31, 2007. Accessed November 2008, http://www.co.san-diego.ca.us/dplu/docs/LID-Handbook.pdf

[48] Village Homes (Davis, CA). *About Village Homes.* Accessed November 2008, http://www.villagehomesdavis.org/public/about

[49] City of Emeryville (CA), Department of Planning & Building. "Stormwater Guidelines for Green, Dense Redevelopment," December 2005. Accessed on 1/3/09, http://www.ci.emeryville.ca.us/planning/pdf/stormwater_guidelines.pdf

[50] San Francisco Public Utilities Commission. *Rainwater Harvesting Program.* Accessed on 12/31/08, http://sfwater.org/msc_main.cfm/MC_ID/14/MSC_ID/361

Part II:

Making LID Work for Los Angeles

Bioswale installed voluntarily by the developer of 1100 S. Hope Street in downtown Los Angeles.

[6] Funding & Maintaining a LID Program

How Much Does LID Cost?

Pilot projects have shown that using low impact development (LID) techniques instead of conventional stormwater controls can result in considerable capital cost savings. **An analysis of LID projects from across the nation conducted by the U.S. Environmental Protection Agency (EPA) in 2007 found that with just a few exceptions, the capital costs of LID projects were less than conventional water management controls.** As shown in the table below, savings ranged from 15–80%.[1] (Please see Appendix III for a fact sheet about the report.) It is important to note that the EPA's analysis did not account for the value of the environmental, social and community benefits created by the projects.

Project [a]	Estimated Conventional Development Cost	Actual LID Cost	Cost Savings[b]	Percent Savings[b]
2nd Avenue SEA Street (Washington)	$868,803	$651,548	$217,255	25□
Auburn Hills (Wisconsin)	$2,360,385	$1,598,989	$761,396	32□
Bellingham City Hall (Washington)	$27,600	$5,600	$22,000	80□
Bellingham Park (Washington)	$52,800	$12,800	$40,000	76□
Gap Creek (Arkansas)	$4,620,600	$3,942,100	$678,500	15□
Garden Valley (Washington)	$324,400	$260,700	$63,700	20□
Kensington Estates (Washington)	$765,700	$1,502,900	□$737,200	□96□
Laurel Springs (Wisconsin)	$1,654,021	$1,149,552	$504,469	30□
Mill Creek[c] (Illinois)	$12,510	$9,099	$3,411	27□
Prairie Glen (Wisconsin)	$1,004,848	$599,536	$405,312	40□
Somerset (Maryland)	$2,456,843	$1,671,461	$785,382	32□
Tellabs Corporate Campus (Illinois)	$3,162,160	$2,700,650	$461,510	15□

EPA Report:

Cost Comparisons Between Conventional and LID Approaches

Notes:

[a] Some of the case study results do not lend themselves to display in the format of this table (Central Park Commercial Redesigns, Crown St., Poplar Street Apartments, Prairie Crossing, Portland Downspout Disconnection, and Toronto Green Roofs).
[b] Negative values denote increased cost for the LID design over conventional development costs.
[c] Mill Creek costs are reported on a per-lot basis.

Source: "Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices." USEPA, 2007.

The above examples include projects such as Seattle's first green street (SEA Street #1, described earlier in Chapter 5), which cost 25% less than conventional street designs,[2] and the extensive use of swales and rain gardens for a new subdivision in Somerset, MD, which saved developers 32% of the cost for conventional stormwater controls.[3]

Research conducted by the City of Ventura may be helpful in determining the potential costs of implementing low impact development in Los Angeles, as Ventura is also located in Southern California and has a similar climate. A copy of Ventura's "Green Streets Matrix" is included in Appendix II. It contains an analysis of the costs, benefits, challenges and drawbacks for 17 different kinds of LID best management practices. The City of Los Angeles' Green Streets LA program is also in the process of developing its own cost estimates.

GREEN STREETS MATRIX City of Ventura Department of Public Works, 2008

Level I	Description	Example	Cost / Benefits	Challenges / Drawbacks
Storm Inlet Trash Excluders	Trash excluders are screens that are installed inside catch basins or at curb inlets. They prevent trash from entering the storm drain system. Screen size opening is typically around 4 mm. Smaller debris / silt and contaminants such as heavy metals will still pass through the screens.		Low cost/low effectiveness (~$1,500 each)	On-going maintenance is required to clean trash from catch basins. Only prevents trash from entering tributaries (not chemicals, silt). On-going maintenance costs for cleaning catch basins will increase as more are installed.
Planting of medium to large canopy trees in parkways and medians	Plant new or preserve existing medium to large canopy trees in parkways and medians. Tree species should be compatible with adjacent curbs and sidewalks to minimize potential damage that may be caused by roots.		Low upfront cost /high effectiveness (~$400 for 24" box tree). Once mature, larger canopy trees are effective in reducing peak storm run-off rates by capturing rainfall in their canopy. They are also very attractive and can raise property values by $10,000 or more.	Medium to high maintenance cost to control and preserve the trees. Bulbouts or sidewalk realignments may need to be installed in narrower parkways (see *Parkway Tree Bulbouts*). Tree roots can be destructive to buried utilities, sidewalks, curbs and gutters. Residents may not care for the increased maintenance (leaf pickup). Overhead utilities can be problematic for ongoing pruning that can damage trees.
Utilization of recycled materials in new and resurfaced streets	Utilize rubberized asphalt (recycled tires), 15% recycled mix, in-place pulverized asphalt and aggregates in the construction of new streets or in street resurfacing projects		Cost competitive compared to using new materials. Relative costs are likely to decrease due to supply constraints and hauling costs for new materials.	Projects may take longer to construct depending on time-of-year and other factors. Tighter inspections (QA/QC) also required.

A sample page from the City of Ventura's "Green Streets Matrix"

The Need for Maintenance Funding

In a time of government budget cuts, searching for steady funding to support new public works projects and regular maintenance services has never been more important. Consistent maintenance of low impact development (LID) best management practices will ensure that they continuously perform at a high standard. For instance, porous pavement needs to be vacuum-swept several times per year and vegetated swales may need occasional pruning or irrigation. The rest of this chapter highlights a number of ideas that could help secure a steady revenue stream for city projects and services.

Funding Strategies: Municipal Bonds

Municipal bonds can be issued by the City or its agencies to finance capital expenditures for public-purpose projects.[4] [5] There are two main categories of bonds: general obligation bonds that are secured by the government's taxing powers, and revenue bonds that are secured by a pledge of the project's revenues.[6] Municipal bonds could help raise funds for the construction and installation of new low impact development projects in the City of Los Angeles. However, bond money can only be used to cover capital costs; therefore ongoing maintenance expenditures must be funded from separate sources.

Fees & Assessments

Summary of LID Funding Strategies for Construction and Operations & Maintenance			
	Strategy	**Const.**	**O & M**
Bonds	Municipal bonds	✓	
Fees & Assessments	LID in-lieu fees	✓	✓
	Increased stormwater abatement charge	✓	✓
	Individualized parcel drainage fees	✓	✓
	"One Percent for Green Streets" fund	✓	✓
	Parking increment financing	✓	✓
	Maintenance assessments		✓
	Quimby fees for parks	✓	
Grants	Dept. of Water & Power funding	✓	✓
	Proposition 84 grants	✓	
	Proposition O grants	✓	
	Private foundation grants	✓	✓
Partner-ships	"Adopt-A-Garden" program		✓
	Corporate sponsorship	✓	✓
Emerging Markets	Sales of L.A. City carbon offsets	✓	✓

LID In-Lieu Fees

Some areas of the city may be too densely developed to allow for significant levels of infiltration. For these locations, the City could raise funds by charging developers in-lieu fees, which would then go towards developing or maintaining LID projects nearby.[7] In-lieu fees would add some flexibility to low impact development regulations, making this a politically attractive option. Since low impact development aims to treat stormwater on the local level, it is very important that in-lieu projects be located close to their original project locations. (Read more in Chapter 10, p.97.)

Increased Stormwater Pollution Abatement Charge

The Stormwater Pollution Abatement Charge (SPAC)—found on residents' L.A. County tax bills—is used to generate "funds for receiving, transporting, pumping, constructing and maintaining storm drain facilities and for the treatment and/or disposal of storm drainage through the storm drain system."[8] The L.A. City Bureau of Sanitation's Watershed Protection Division receives this money (currently, approximately $28.6 million per year[9]) through the County of Los Angeles and uses it to develop and implement stormwater pollution abatement projects within City limits.

Increasing the Stormwater Pollution Abatement Charge could be a very good source of revenue for future LID projects and maintenance costs. The SPAC rate, originally set in 1993, is $23.00 per EDU (equivalent dwelling unit) and due to the constraints of Proposition 218 (which limits the ability of government to increase fees), it has been held at the same level for 15 years. **If the SPAC rate had increased with the national rate of inflation, then in 2008 it would have been $33.81,[10] generating an additional $13.4 million[11] for the City.** Thus the total SPAC revenue for the Watershed Protection Division in 2008 could have been $42 million instead of just $28.6 million, a 46% difference.

Using LID Rebates to Lower Residents' Stormwater Bills:

To create an economic incentive for retrofit of existing private properties, the City could develop an incentive structure that gives a rebate to businesses and residents who install low impact development features on their properties. The system could be designed so that properties which infiltrate and/or capture all of their runoff would not have to pay any SPAC fee at all. However, the fee imposed would likely have to be high enough to create an economic incentive.

Individualized Parcel Drainage Fees

Individualized stormwater drainage fees based on a property's impervious surface area has been a common practice in Germany for a number of years, but is relatively new to the United States.[12] Individual parcel assessments (IPAs) are especially appropriate for low impact development because (1) they provide an economic incentive for citizens to reduce the amount of impervious surface on their lots, (2) they affect the entire city (which supports the LID goal of decentralized stormwater management), and (3) the data collected from parcel assessments can provide the city with useful information for future watershed planning efforts.[13]

A vegetated swale with curb cuts collects runoff at the RioHondo Golf Course in Downey, CA.

In contrast to IPAs, the City of Los Angeles currently bases its stormwater pollution abatement fee on the number of dwelling units per lot—not on the size or amount of water-permeable surfaces found on the property. Consequently, there is no incentive for businesses or residents to install low impact development BMPs. The City could consider a rebate system that reduces or exempts fees for properties that capture or infiltrate 100% of their runoff.

The main drawback to IPAs is that estimating the impervious surfaces for each parcel can be labor intensive and expensive, though new satellite technology and mapping systems have made the task somewhat easier. To help with this problem, some German municipalities rely on customer questionnaires to establish a parcel's stormwater burden and/or to verify the government's estimates.[14] When there are small discrepancies, the customers' estimates are generally accepted. Larger discrepancies are resolved through site visits by the government agency.

To reduce the cost of estimating the impervious surface areas of each property in Los Angeles, during the first year of an IPA program the City could require businesses (and maybe even home owners) to pay for a professional site assessment, and then in the second year the public would start paying the drainage charges.

<u>Example: Seattle's Stormwater Drainage Fees</u>

The City of Seattle, WA charges all property owners an annual fee for stormwater management services based on each property's estimated impact on the municipal drainage system.[16] The revenues generated by this fee are used to build new stormwater management infrastructure and to fund ongoing operations and maintenance expenses.[17] Small lots are charged a flat-rate fee, while the fees for larger lots are based on their estimated amount of impervious surfaces (as determined by the City from 2007 aerial photos).[18 19] Properties with functional, on-site stormwater detention basins can apply for credits to reduce their drainage bills. The table on the previous page shows Seattle's 2009 drainage fees.

If Seattle's drainage fees were applied to Los Angeles, a typical residential lot sized at 50 feet x 130 feet (6,500 sq. ft. or about 1/7 of an acre) would be charged $202.17 per year. Again, the City of Los Angeles could then offer a rebate program that would give rebates to businesses and residents who install low impact development features on their properties. The system could even be set up so that properties which infiltrate and/or capture all of their runoff would not have to pay any drainage fee at all.

The City of Minneapolis, MN has a similar stormwater fee and credit program also based on a property's amount of impervious surface.[20]

Seattle's 2009 Drainage Fee Rates [15]

Small Residential, Annual rate per parcel (a)	
Under 3000 sq. ft.	$102.90
3000-4999 sq. ft.	$149.56
5000-6999 sq. ft.	$202.17
7000-9999 sq. ft.	$256.38
All Other Properties, Annual rate per 1,000 sq. ft.	
Undeveloped (0-15□ Impervious)	
Regular	$16.85
Low Impact (b)	$10.19
Light (16-35□ Impervious)	
Regular	$25.20
Low Impact (b)	$18.98
Medium (36-65□ Impervious)	
Regular	$36.61
Low Impact (b)	$29.70
Heavy (66-85□ Impervious)	$47.34
Very Heavy (86-100□ Impervious) (c)	$56.23

(a) Single Family Residential □ Duplex parcels less than 10,000 sq. ft. which are charged a flat rate per parcel rather than a fee based on the percent impervious. Rates for other properties are per 1,000 sq. ft. based on the percent of impervious surface.
(b) A customer in the Undeveloped, Light or Medium rate category with a significant amount of highly pervious (absorbent) surface may qualify for the Low Impact rate.
(c) "Very heavy" does not necessarily mean heavily developed. A parking lot would be classified as "very heavy" since it is 100□ impervious.

"One Percent for Green Streets" Fund

The City of Portland, OR currently has a *One Percent for Green* fund that collects 1% of the construction budget for projects within the city's right-of-way that are not subject to the requirements of Portland's Stormwater Management Manual. The fund was established in 2007 when the Portland City Council passed its Green Streets Policy. The *One Percent for Green* fund is used to finance the construction of green street features that follow LID guidelines.[21] Private parties can apply for green streets grants to help fund the design, construction, and materials for LID projects. If a similar program were implemented in Los Angeles, it could be designed to fund operations and maintenance costs as well as construction costs.

Parking Increment Financing

Parking increment financing has the potential to generate significant revenues that could be used to build new low impact development projects, and more importantly, fund ongoing operations and maintenance costs.[22] "The High Cost of Free Parking" by UCLA Professor Donald Shoup cites Old Pasadena as an excellent local example.[23] In 1993, the City of Pasadena installed parking meters in the rundown area of Old Pasadena in order to raise funds for revitalization. The city reinvested the revenue from parking fees back into the neighborhood. They made local street improvements and repairs, and the Business Improvement District relies on the funds to pay for cleaning and maintenance services. In 2001, the parking meters in Old Pasadena generated $1.2 million in net revenue.[24] Today, Old Pasadena is one of the most popular shopping districts in the Los Angeles region.

One of L.A.'s new parking pay stations

Several factors may make parking increment financing a viable option for Los Angeles. First, the City started replacing its old parking meters in 2007 with centrally-controlled, computerized pay stations.[25] [26] This technological advance allows the City to easily adjust parking fees. (Shoup's research suggests that parking prices should be set high enough to create a 15% vacancy rate on each block so that customers can always find an open spot.[27]) Second, to help tackle climate change, the City of Los Angeles is looking for ways to encourage people to get out of their cars and onto public transit. Higher parking rates could help achieve this goal. Finally, in the past couple years a number of American cities have considered implementing congestion pricing policies to reduce traffic. This has introduced the idea that people should pay for the privilege of driving—a notion that could also apply to parking increment financing.

In order to use parking increment financing to promote LID in Los Angeles, the City would need to ensure that an adequate amount of parking revenues is set aside for funding green streets projects and maintenance.

Special Benefit Assessment Districts

Special benefit assessment districts could be used to raise funds to acquire open space for low impact development programs or to create maintenance districts. Benefit assessment districts typically assess property owners in a defined geographic area and provide benefits to those residents, such as roads, parks, and recreational facilities,[28] but have also been used to fund sidewalk maintenance. An important principle is that property owners are assessed a fee that is proportional to the special benefits created by the improvements. If the assessment price exceeds the value of the special benefit, then the charges are considered a tax.[29]

The State of California has approximately twenty different statutes that authorize local agencies to levy assessments for specific purposes. The statutes that would be most relevant to a low impact development program include:[30]

1. Open Space Maintenance Act
2. Habitat and Maintenance Assessment District
3. Municipal Improvement Act of 1913
4. Landscaping and Lighting Act of 1972
5. Benefit Assessment Act of 1982—especially appropriate for LID because it is dedicated to assessments for the installation, operation and maintenance of drainage and flood control facilities.

Proposition 218, which was passed in 1996, governs the procedures for establishing a special benefit district. For instance, it requires that local property owners vote to approve assessments. Proposition 218 also rules that increased property values are not enough evidence to demonstrate special benefit; there must be other benefits, such as improved recreational opportunities or flood control.[31] It can be a challenge for government agencies to evaluate exactly how much a property will benefit from a project, making it difficult to determine the appropriate assessment fee.

Quimby Fees for Parks

The 1975 Quimby Act authorizes cities and counties in the State of California to pass ordinances that require developers to set aside land, donate conservation easements, or pay fees for park improvements. Revenues generated by the Quimby Act must go towards the creation of new parks and *cannot* be used for the general operations and maintenance of park facilities.[32] In Los Angeles, the fees must be used within two miles of where they are gathered.[33]

Bimini Slough Ecological Park, created by North East Trees in East Hollywood, daylights an existing storm drain and provides on-site stormwater management. *Credit: North East Trees*

As of February 2008, the City's Department of Recreation and Parks had a balance of $129 million in Quimby fees.[34] This surplus funding could be an excellent opportunity for the City to implement low impact development on a neighborhood scale by creating new parks. (Quimby fees cannot be used for ongoing maintenance operations.) The City could require that all Quimby projects employ LID best management practices, and if possible, runoff from the local area should be directed into the parks (instead of the storm drains). Additionally, projects would have to be distributed throughout the city since Quimby fees must be used within two miles of their origination. This requirement actually dovetails well with low impact development's goal of decentralized stormwater management using natural drainage techniques.

Grants

Department of Water & Power Funding

The Los Angeles Department of Water & Power (LADWP) is concerned about securing Los Angeles' water supply for the future. Currently only 13% of our water comes from local sources, but widespread implementation of low impact development could increase that amount significantly.[35] LADWP has begun funding LID pilot projects and is considering implementing programs that train landscape maintenance workers in LID techniques.

Proposition 84 Grants

Proposition 84, titled "Water Quality, Safety and Supply. Flood Control. Natural Resource Protection. Park Improvements," was passed by California voters in November 2006.[36] It authorized $5,388,000,000 in general obligation bonds to fund projects for "safe drinking water, water quality and supply, flood control, waterway and natural resource protection, water pollution and contamination control, state and local park improvements, and public access to natural resources, and water conservation efforts."[37] The State Water Resources Control Board runs a Proposition 84 Stormwater Grant Program to provide local agencies with funds to reduce pollution flowing into waterways.[38] This could be a promising source for funding future LID projects in Los Angeles.

Proposition O Grants

Los Angeles voters passed Proposition O in Novermber 2004. It authorized the City of Los Angeles to issue up to $500 million in general obligation bonds for projects that clean up water pollution in order to meet Federal Clean Water Act requirements.[39] It also funds improvements to protect water quality, provide flood protection, and increase water conservation, habitat protection, and open space—all of which are important aspects of low impact development.[40]

Curb cuts leading to an infiltration zone at the Rio Hondo Golf Course in Downey, CA

Private Foundation Grants

Private foundations may be interested in funding low impact development pilot projects, citizen education programs, vocational training for LID landscaping professionals and gardeners.

Public-Private Partnerships

Adopt-a-Garden

The Crown Street pilot project in Vancouver, British Columbia, is a good example of how city residents can help maintain LID landscaping and best management practices.[41] In order to protect local salmon habitat, Vancouver's Green Streets program rebuilt Crown Street to include vegetated swales and rain gardens.[42] Since the city does not have enough funding to maintain the project, they rely on the local community to take care of the landscape features. Residents must apply to adopt a garden.[43] If accepted, the city gives them a manual on how to keep the vegetation healthy. As an incentive, Vancouver also provides some gardening materials and pays for some of the residents' gardening costs.

Swale in the middle of Vancouver's Crown Street pilot project. *Credit: Vancouver Dept. of Eng.*

The Adopt-a-Garden concept is a viable, low-cost idea for the City of Los Angeles that does not involve many political hurdles for implementation. A team of student researchers from Pepperdine University[44] has recommended that Los Angeles hold annual garden competitions to motivate the citizen gardeners and to raise awareness about the Adopt-a-Garden program. Partnerships with organizations such as the Los Angeles chapter of California Garden Clubs Inc., the L.A. County Arboretum, North East Trees, TreePeople, and landscape design schools could help with the design, promotion and implementation of this program.

Corporate Sponsorship

Corporate sponsorship for the installation and/or maintenance of low impact development BMPs could help reduce some of the City's expenditures on green infrastructure and foster the involvement of businesses in the community. Sponsorships can come in various forms, such as cash donations, product donations, pro bono services, and employee volunteers. In exchange, the city could provide some incentives for the businesses such as public recognition or signage that identifies the LID BMPs paid for or maintained by corporations.

Emerging Markets

Sales of L.A. City Carbon Offsets

Recently, a number of companies have made efforts to become "carbon neutral" by purchasing carbon offsets to counterbalance their impacts on the environment. This could be an appropriate option for businesses (such as corporate offices) that traditionally have been seen as non-polluting, but may actually cause local air pollution due to employee travel and the energy used by office buildings. Moreover, ordinary residents who are eager to reduce their carbon footprints can also purchase carbon offsets. Municipal carbon offset programs are relatively new. In the United States, the San Francisco Carbon Fund[45] is currently under development and the Colorado Carbon Fund[46] is up and running.

Establishing a "Los Angeles Carbon Fund" would ensure that carbon offset money goes towards *local* climate change mitigation projects, instead of projects in far-off locations across the globe. Carbon offset money could be used to fund the construction and maintenance of LID projects in Los Angeles such as bioswales and tree plantings. The City of Los Angeles may wish to consider starting with a voluntary carbon offset pilot program, and then making it mandatory in future years. Implementing a simple carbon offset program could be a very cost-effective way to raise funds. Users could make their payments online by credit card.

The greatest hurdles to implementing a carbon offset program are: (1) figuring out how much carbon emissions a person or business generates, (2) calculating the quantity of emissions "saved" by an offset project, and (3) for how much a unit of carbon should be sold. However, to implement a voluntary pilot program, the calculations need not be complicated—rough estimates should be adequate, and Los Angeles may be able to look to Colorado's program as a model.

The Colorado Carbon Fund's website (www.coloradocarbonfund.org) has a simple carbon footprint calculator that lets users figure out how many metric tons of CO_2 are emitted by their homes, automobiles and airplane flights each year. The Fund charges approximately $20.00 per year or $1.67 per month for one metric ton of CO_2.[47] Before the website calculates offset fees, users are directed to a web page that contains advice on how to reduce their energy consumption and environmental impact.[48] This important educational feature may help reduce the carbon footprints of Colorado residents in the future.

For More Information:

For more information and case studies about funding green infrastructure, please refer to the 2008 EPA publication titled, "*Managing Wet Weather with Green Infrastructure: Municipal Handbook - Funding Options.*" It can be accessed at http://www.epa.gov/npdes/pubs/gi_munichandbook_funding.pdf.

Endnotes

[1] U.S. Environmental Protection Agency. *Fact Sheet: Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices*, December 2007. From the Polluted Runoff (Nonpoint Source Pollution) web page. Accessed on 1/3/09, http://www.epa.gov/owow/nps/lid/costs07/factsheet.html

[2] Wise, Steve. "Green Infrastructure Rising: Best Practices in Stormwater Management." *Planning,* the magazine of the American Planning Association. August/September 2008. Pages 14-19.

[3] ibid.

[4] Municipal Securities Rulemaking Board. *What Are Bonds?* Accessed on 1/10/09, from Electronic Municipal Market Access. http://emma.msrb.org/EducationCenter/WhatAreBonds.aspx

[5] Investopedia ULC. *What Does Municipal Bond Mean?* and *Investopedia explains Municipal Bond.* Accessed on 1/10/09, from Investopedia. Web site: http://www.investopedia.com/terms/m/municipalbond.asp

[6] Fahim, Mayraj. *Municipal bonds have been issued by US local government since 1812* (abridged), May 14, 2008. Accessed on 1/10/09, from City Mayors. Web site: http://www.citymayors.com/finance/bonds.html

[7] Conversation with Dr. W. Bowman Cutter (Assistant Professor, Department of Economics, Pomona College), 8/13/08.

[8] City of Los Angeles, Department of Public Works, Bureau of Sanitation. *Stormwater Pollution Abatement Charge.* Accessed on 1/11/09, from City of Los Angeles, Department of Public Works, Bureau of Sanitation, Financial Management Division. Web site: http://lacitysan.org/fmd/spac.htm

[9] City of Los Angeles, internal document. "Stormwater Pollution Abatement Fund: Basis for the Proposed Budget, 2007-2008."

[10] Calculations made using the United States Department of Labor/Bureau of Labor Statistics' "Consumer Price Index (CPI) Inflation Calculator." http://data.bls.gov/cgi-bin/cpicalc.pl

[11] Calculations made using the United States Department of Labor/Bureau of Labor Statistics' "Consumer Price Index (CPI) Inflation Calculator." http://data.bls.gov/cgi-bin/cpicalc.pl

[12] Keely, Melissa. "Using Individual Parcel Assessments to Improve Stormwater Management." Journal of the American Planning Association, Vol. 73, No. 2, Spring 2007.

[13] ibid.
[14] ibid.

[15] City of Seattle (WA). *Drainage Rate Schedule.* Accessed on 1/10/09 from Seattle.gov, http://www.ci.seattle.wa.us/util/Services/Drainage_&_Sewer/Rates/DrainageRates/RateSchedule/index.htm

[16] City of Seattle (WA). *Drainage Rates.* Accessed on 1/10/09 from Seattle.gov, http://www.ci.seattle.wa.us/util/Services/Drainage_&_Sewer/Rates/DrainageRates/index.htm

[17] City of Seattle (WA). *Drainage Rate Increase FAQ.* Accessed on 1/10/09 from Seattle.gov, http://www.ci.seattle.wa.us/util/Services/Drainage_&_Sewer/Rates/DrainageRates/RateIncreaseFAQ/index.htm

[18] City of Seattle (WA). *Drainage Rate Schedule.* Accessed on 1/10/09 from Seattle.gov, http://www.ci.seattle.wa.us/util/Services/Drainage_&_Sewer/Rates/DrainageRates/RateSchedule/index.htm

[19] City of Seattle (WA). *Understanding Your Drainage Bill FAQ.* Accessed on 1/10/09 from Seattle.gov, http://www.ci.seattle.wa.us/util/Services/Drainage_&_Sewer/Rates/DrainageRates/UnderstandingYourBillFAQ/index.htm

[20] City of Minneapolis (MN). (1997-2009). *Stormwater Utility Fee Frequently Asked Questions.* Accessed on 1/10/09 from Minneapolis: City of Lakes, http://www.ci.minneapolis.mn.us/stormwater/fee/stormwater_faq.asp

[21] City of Portland (OR). *1% for Green.* Accessed on 1/10/09 from Portland Bureau of Environmental Sciences. Web site: http://www.portlandonline.com/bes/index.cfm?c=48702&

[22] Conversation with Dr. W. Bowman Cutter (Assistant Professor, Department of Economics, Pomona College), 8/13/08.

[23] Shoup, Donald, *The High Cost of Free Parking, Chapter 1 (The Twenty-first Century Parking Problem).* Chicago: Planners Press, 2005. Accessed on 1/10/09 from Donald Shoup's UCLA webpage, http://shoup.bol.ucla.edu/Chapter1.pdf

[24] Kolozsvari, Douglas and Shoup, Donald. (2003). *Turning Small Change Into Big Changes.* Accessed on 1/10/09 from Walkable Streets, http://www.walkablestreets.com/meter.htm

[25] Powell, Amy. *New and improved parking meters unveiled*, December 13, 2007. Accessed on 1/10/09 from KABC-TV Los Angeles, http://abclocal.go.com/kabc/story?section=news/local&id=5833424

[26] Sentinel News Service. *New Parking Meters to Increase City's Revenue*, January 1, 2009. Accessed on 1/10/09 from Los Angeles Sentinel, http://www.lasentinel.net/New-Parking-Meters-to-Increase-City-s-Revenue.html

[27] Shoup, Donald C. (1999). "The Trouble With Minimum Parking Requirements." *Transportation Research Part A*, Vol. 33, pp. 549-574. Accessed on 1/10/09 from Victoria Transport Policy Institute, http://www.vtpi.org/shoup.pdf

[28] The Trust For Public Land. *Benefit Assessment Districts.* Accessed on 1/10/09 from The Trust For Public Land: Conservation Finance, http://www.tpl.org/tier3_cd.cfm?content_item_id=1058&folder_id=825

[29] Institute For Local Government. (2005) *Funding Open Space Acquisition Programs: A Guide for Local Agencies in California*, "Chapter 8: Creating Benefit Assessment Districts." Accessed on 1/10/09 from League of California Cities, http://www.cacities.org/resource_files/23925.ILG_OpenSpace_Ch8.pdf

[30] ibid.
[31] ibid.

[32] Westrup, Laura. "Quimby Act 101: An Abbreviated Overview." *California Parks & Recreation*, Vol. 58, no. 3, p. 8 (2002). Accessed on 1/11/09 from California Park & Recreation Society, http://www.cprs.org/membersonly/Sum02_Quimby.htm

[33] Scott, Anna. "Quimby Questions Continue." *Los Angeles Downtown News*, October 15, 2007, p. 6. Accessed on 1/11/09 from Los Angeles Downtown News.com, http://www.downtownnews.com/articles/2007/10/15/news/news04.txt

[34] Richardson, Eric. (2009). *Catching Up With… Quimby Fees.* Accessed on 1/11/09 from BlogDowntown, http://blogdowntown.com/2009/01/3929-catching-up-with-quimby-fees

[35] *First source of information:* Beckman, David S. and Noah Garrison. "NRDC Comment on AB32 Scoping Plan Appendices—Water Sector," August 11, 2008. Natural Resources Defense Council comments sent to the California Air Resources Board. *Second source of information:* Email message from Noah Garrison, Project Attorney at NRDC, on January 21, 2009. "LID Numbers for L.A. County."

[36] League of Women Voters. (2006). *Proposition 84—Water Quality, Safety and Supply. Flood Control. Natural Resource Protection. Park Improvements State of California.* Accessed on 1/11/09 from League of Women Voters of California Education Fund, http://www.smartvoter.org/2006/11/07/ca/state/prop/84/

[37] California State Parks. (2006). *Proposition 84—Water Quality, Safety and Supply. Flood Control. Natural Resource Protection. Park Improvements State of California. Official Title and Summary.* Accessed on 1/11/09 from California State Parks, http://www.parks.ca.gov/pages/1008/files/Prop_84_text.pdf

[38] California Environmental Protection Agency, State Water Resources Control Board. *Proposition 84 Storm Water Grant Program.* Accessed on 1/11/09, http://www.waterboards.ca.gov/water_issues/programs/grants_loans/prop84/index.shtml

[39] City of Los Angeles, Proposition O website. *Proposition O Background.* Accessed on 1/11/09, http://www.lapropo.org/

[40] City of Los Angeles, Department of Public Works, Bureau of Engineering. "Proposition O – Clean Water Bond Program: August 2008 Monthly Report." Accessed on 1/11/09, http://www.lapropo.org/sitefiles/docs/engineering/BOE_MnthlyReport_August.pdf

[41] Collins, Gregory M., Jared Weidenbaum, Lu Xing, Scott Scholnick, Cathy Lysaught, Vanessa Towning, and Li Feng. "Social Entrepreneurship: This document consists of our research and recommendations with regard to the maintenance and funding of Los Angeles's 'Green Street' Initiative." Report by students from Pepperdine University done for the L.A. City Board of Public Works. December 5, 2007.

[42] City of Vancouver (Canada), Engineering Services. *Streets: Environmentally Sustainable Options.* Accessed on 1/11/09, http://vancouver.ca/ENGSVCS/streets/design/enviro.htm

[43] City of Vancouver (Canada), Engineering Services. *Streets: Green Streets Program.* Accessed on 1/11/09, http://vancouver.ca/engsvcs/streets/greenstreets/index.htm

[44] Collins, Gregory M., Jared Weidenbaum, Lu Xing, Scott Scholnick, Cathy Lysaught, Vanessa Towning, and Li Feng. "Social Entrepreneurship: This document consists of our research and recommendations with regard to the maintenance and funding of Los Angeles's 'Green Street' Initiative." Report by students from Pepperdine University done for the L.A. City Board of Public Works. December 5, 2007.

[45] City and County of San Francisco. *Press Room: Press Release.* "Mayor Newsom Unveils First-Ever City Carbon Offsets to Fight Global Warming," December 18, 2007. Accessed on 1/12/09, http://sfgov.org/site/mayor_index.asp?id=72509

[46] Colorado Carbon Fund. *Project C: We Have The Power.* Accessed on 1/12/09, http://www.coloradocarbonfund.org/

[47] Calculated on 1/12/09 using the Colorado Carbon Fund's carbon footprint calculator. http://www.coloradocarbonfund.org/think_1.cfm

[48] Colorado Carbon Fund. *Take Action, Save Money.* Accessed on 1/12/09. http://www.coloradocarbonfund.org/act.cfm

[7] Existing Stormwater Regulations & Green Infrastructure Programs in Los Angeles

A comprehensive low impact development (LID) ordinance would help protect the integrity of Los Angeles' natural waterways and ensure a more stable water supply for the future; fortunately, a number of existing regulations and programs could serve as building blocks for the city's future LID efforts. Existing stormwater regulations and green infrastructure programs that apply to the City of Los Angeles originate from the federal, state, county and city levels of government.

Federal and State Regulations & Programs

National Pollution Discharge Elimination System (NPDES)

The federal Clean Water Act requires the U.S. Environmental Protection Agency (EPA) to regulate the amount of pollution that flows into the waters of the United States. The EPA established the National Pollution Discharge Elimination System (NPDES) permitting program to address this issue.[1] There are two types of permits that are most pertinent to LID efforts in Los Angeles: (1) the Municipal Stormwater Permit, and (2) the General Construction Activities Stormwater Permit.

Within California, the EPA authorizes the state government to run the NPDES permitting program. Therefore, our local L.A. County NPDES stormwater permit is essentially overseen by both the state and federal governments.

Municipal Stormwater Permit—In cities like Los Angeles that have a "municipal separate storm sewer system" (known as MS4s), the storm drains flow straight into rivers and oceans, with no treatment facilities along the way.[2] [3] The NPDES permits that

Existing Regulations & Programs

Federal & State Level

- National Pollution Discharge Elimination System (NPDES)
- California Porter-Cologne Water Quality Control Act
- California Model Landscape Ordinance*

County Level

- L.A. County Stormwater Permit and SUSMP
- Low Impact Development Ordinance & Green Building Program

City Level

- City of L.A. Stormwater Program
- Green Streets LA Program
- Million Trees LA Initiative
- Green Building Ordinance
- Landscape Ordinance
- Stream Protection Ordinance*
- Zoning Ordinances
- General Plan, Community Plans & Specific Plans
- L.A. River Revitalization Master Plan
- L.A. River Improvement Overlay District*
- Integrated Resources Plan
- Water Quality Compliance Master Plan

** Regulation that is proposed or in the development stage. Has not been fully adopted or implemented.*

are issued to MS4 municipalities require the use of best management practices (BMPs) to reduce pollutants to the "maximum extent practicable."[4] (A description of the related L.A. County SUSMP stormwater standards can be found on the next page.) The NPDES permits must be renewed every five years, which creates some instability for stormwater protection in Los Angeles because future permits could have less stringent environmental controls.

General Construction Activities Stormwater Permit— The State Water Resources Control Board (SWRCB) adopted its last statewide NPDES General Stormwater Permit for Construction Activities in 1999, and is well overdue for its five-year renewal.[5] The permit's section on "Post-Construction Storm Water Management"[6] contains language to reduce runoff from sites of one acre or more. It states that properties should have best management practices (BMPs) that "minimize impervious surfaces" and treat "storm water runoff using infiltration, detention/retention, biofilter BMPs, and efficient irrigation systems."[7]

Playa del Rey beach in Los Angeles after a storm.
Credit: Heal the Bay / HF Chau

While these requirements speak to fundamental low impact development (LID) principles, there are some limitations to the state's post-construction stormwater permit:[8]

1. ***The permit applies only to large sites*** of one acre or more, which is problematic because the City of Los Angeles has many smaller lots.[9] (Construction projects on smaller lots fall under the municipal MS4 stormwater permit.)
2. ***The permit only regulates newly-built construction or redevelopment projects.*** It does not address older properties that could benefit from a retrofit program.

Porter-Cologne Water Quality Control Act, 1969

The Porter-Cologne Water Quality Control Act (also known as the California Water Code) was enacted by California in 1969 to protect the state's surface and groundwater quality and resources. Under this act, the State and Regional Water Quality Control Boards can establish water policies, administer federally-mandated MTBE permits, enforce water quality standards, and regulate point-source and non-point source discharges.[10] Nine Regional Boards develop regional water quality control plans based on the State Board's policies.[11]

Porter-Cologne makes a very important point related to low impact development (LID) and stormwater management: *waste discharges to state waters are a privilege, not a right.*[12] To further protect ocean and surface water quality, the State Board has adopted statewide water quality control plans such as the California Ocean Plan and a Plan for California's Non-Point Source Pollution Control Program.[13]

State of California Model Landscape Ordinance *(adoption pending)*

California's Department of Water Resources (DWR) is currently working on an update of the state's "Model Water Efficient Landscape Ordinance." DWR planed to adopt the revised ordinance in March 2009,[14] and local municipalities will be expected to adopt it by 2010. Local governments will have the option to adopt their own landscape ordinance as long as it is "at least as effective as" the state's model.[15]

The updated model landscape ordinance will cover new construction and rehabilitated landscapes (both public and private) of at least 2,500 square feet. The ordinance also requires existing landscapes of at least 43,560 sq. ft. to conduct landscape irrigation audits every five years.[16] Compared to the current landscape ordinance, the updated version places a greater emphasis on efficient irrigation systems and reducing water waste.[17]

The model landscape ordinance does require landowners to implement a number of LID strategies such as grading sites to reduce erosion and runoff, installing efficient irrigation systems, and installing recycled water irrigation systems. However, other important LID strategies are highly recommended but *not* required. They include the use of native and drought-tolerant plants and the installation of stormwater BMPs.[18]

Drought-tolerant landscaping in West L.A.

Los Angeles County Regulations & Programs

L.A. County Stormwater Permit and SUSMP

As mentioned earlier in this chapter, the L.A. County Municipal Stormwater Permit addresses federal NPDES requirements and is administered by the State of California. The permit standards are written by the Los Angeles Regional Water Quality Control Board and must be reissued every five years.[19]

An important part of the County's NPDES permit, which applies to the City of Los Angeles, is the Standard Urban Stormwater Mitigation Plan (SUSMP) infiltration requirements. In general, SUSMP applies to new and redevelopments of a certain minimum size.[20] The best management practices installed on-site must be able to infiltrate, capture and reuse, or treat all of the runoff from an 85th percentile storm, which equivalent to a ¾" storm. New guidelines approved on July 9, 2008 require developers to give top priority to BMPs that infiltrate stormwater and lowest priority to mechanical/hydrodynamic units.[21]

Although many of Los Angeles' existing low impact development BMPs were installed thanks to SUSMP requirements, there are some drawbacks to relying solely on SUSMP to fulfill the city's low impact development needs. First, SUSMP was designed to reduce the amount of pollution entering our waterways and is therefore especially focused on reducing the environmental damage caused by the first flush of a storm. The fact that SUSMP BMPs sometimes address groundwater recharge and can increase local water supply is incidental. Since SUSMP standards do not require native and/or drought-tolerant plants in landscape BMPs, this could actually have the unintended consequence of exacerbating L.A.'s water conservation issues, as developers could install water-thirsty plants requiring large amounts of irrigation during the dry season.

Also, SUSMP only applies to new and major redevelopments, leaving out a large amount of existing development in Los Angeles. Third, the L.A. County Stormwater Permit must be reissued every five years, and there is no guarantee that new stormwater permits will have the same requirements as previous ones. Finally, the legality of the stormwater permit (and accompanying SUSMP requirements) is currently being challenged. In the case of Cities of Arcadia, et al. v. State Water Resources Control Board, et al. (Superior Court of Orange County, 2007, No. 06CCO2974) the court concluded that the L.A. Regional Water Quality Control Board "failed to consider whether the standards could be met and the economic effect they would have."[22] [23] The county's stormwater permit program has been put on hold until the issue is resolved.

Low Impact Development Ordinance & Green Building Program

In October 2008, the County of Los Angeles passed a comprehensive Green Building Program supported by a trio of ordinances: the 1) Green Building Ordinance, 2) Drought-Tolerant Landscaping Ordinance, and 3) Low Impact Development Ordinance.[24] These ordinances are augmented by the "Low Impact Development Standards Manual"[25], "Green Building and Sustainability Guidelines"[26] and a "Drought-Tolerant Plant List."[27] Together, the three ordinances will discourage the use of impervious surfaces and excess turf landscaping, while requiring green building methods, smart irrigation, the use of stormwater BMPs, and drought-tolerant landscaping.[28] [29] [30] [31]

The Green Building Program's ordinances will only apply to the *unincorporated* portions of Los Angeles County. They will also affect the County of Los Angeles' capital construction projects (such as libraries and administration buildings) regardless of the city in which they are located.[32] **Even though the County's ordinances do not apply to the City of Los Angeles, the City will still benefit from the LID improvements made to neighboring portions of the watershed.** Notably, the County's LID Ordinance is that it only applies to new developments and major redevelopments, not existing properties. A more detailed description of the County's Green Building Program can be found in Chapter 5, and a copy of the LID ordinance can be found in Appendix II.

City of Los Angeles Regulations & Programs

City of Los Angeles Stormwater Program

The City of Los Angeles' Stormwater Program is run by the Department of Public Works. It has two major divisions—Pollution Abatement and Flood Control. The program focuses on reducing stormwater pollution through the National Pollutant Discharge Elimination System (NPDES) municipal stormwater permit.[33] The Stormwater Program is the city's major source of public information regarding stormwater best management practices, which include many LID strategies.

Green Streets LA Program

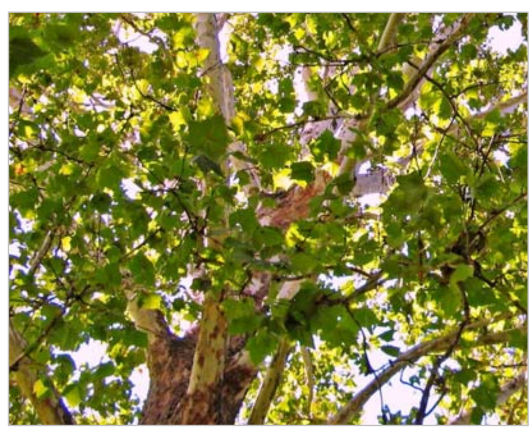
Contaminated stormwater runoff is the largest source of ocean pollution in Southern California,[34] and the city's street infrastructure plays a major role in flushing these pollutants out to sea. The city has approximately 6,500 miles of streets with 10,000 miles of sidewalk and 34,000 catch basins.[35] The **Green Streets LA** program was initiated by the Board of Public Works with the idea that the streets of Los Angeles offer an enormous opportunity to infiltrate, capture and filter urban runoff to prevent pollution, and to convert stormwater into a valuable source of groundwater and recycled water.[36]

The Green Streets Committee is comprised of representatives from a number of city departments that work on issues related to street infrastructure. Monthly meetings are designed to help facilitate communication and coordination between these entities. Recently, Green Streets has focused on integrating LID practices into City infrastructure programs and construction standards. A preliminary set of Green Streets design guidelines were developed in 2008, and a pilot project on Riverdale Avenue is in development.

The **Green Alleys Committee** (a subcommittee of Green Streets) is working on identifying alleys in Los Angeles that could become pilot projects for a green retrofit. There is a total of 914 linear miles of alleys within the City of Los Angeles.[37] The committee is also investigating funding opportunities. The main representatives on the Green Alleys Committee come from the Board of Public Works, the Community Redevelopment Agency and the USC Sustainable Cities Program.

Million Trees LA initiative

The Million Trees L.A. (MTLA) Initiative was created by Mayor Villaraigosa with the goal of making Los Angeles the largest, cleanest, and greenest city in the United States.[38] Through public-private partnerships, one million trees will be planted throughout Los Angeles.

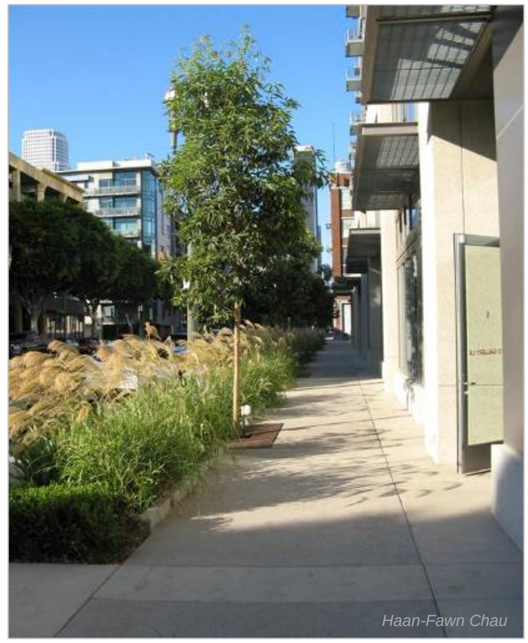


Canopy of a native sycamore tree. *Credit: Haan-Fawn Chau*

MTLA can help low impact development by providing more landscaping, stormwater capture and infiltration opportunities in the city. The water benefits of planting trees far outweigh the water lost to irrigation.[39] Additionally, planting large canopy trees reduces the urban heat island effect.

City Green Building Ordinance

Signed by the mayor on Earth Day 2008, the City of Los Angeles' Green Building Ordinance requires large, new developments to meet the intent of the U.S. Green Building Council's LEED green building standards. (Actual LEED certification is optional.) Additionally, large redevelopments that spend more than 50% of the replacement cost of the existing building must also meet LEED standards.[40]



Bioswales and tree wells along 1100 S. Hope Street in downtown Los Angeles

LEED green building standards include a number of LID strategies in the categories of "Sustainable Sites" and "Water Efficiency," but it is possible for a developer to construct a LEED certified building while avoiding any significant water management or conservation measures.[41] LEED does not address exterior landscaping issues nearly as well as it addresses the composition of an actual building. Additionally, only LEED-ND (Neighborhood Design) standards address street infrastructure, and it involves a completely separate process from the LEED certification of an individual building.

City Landscape Ordinance

The L.A. City Landscape Ordinance, originally written in 1996, was revised in April 2005 to make it a "more effective tool for reducing landscape water use, to mitigate the urban heat island effect, to reduce the dependence on fossil fuels to heat and cool buildings, to address surface erosion, and to improve groundwater recharge."[42] As noted earlier in this chapter, in 2010 the City of Los Angeles will be required to either adopt The State of California's "Model Water Efficient Landscape Ordinance" (described earlier in this chapter) or update its current ordinance to meet or exceed the State's standards.

At the heart of the current Landscape Ordinance, there are two points-based systems: a landscape points system and a water management points system.[43] Every new development project must attain a certain number of points for each system based on the size of the site. The landscape points system contains a number of measures that overlap with low impact development, such as the installation of drought-tolerant trees and plants, permeable pavement and reduced grading (cut and fill). The water management points system also includes drought tolerant plants, as well as rainfall recharge areas and the use of reclaimed water for irrigation.

Despite these features, the current Landscape Ordinance cannot fulfill low impact development principles on its own. First, the ordinance applies only to new construction projects and major renovations that require building, grading, or land-use permits. It does not encompass the vast quantity of existing buildings in Los Angeles. Second, the ordinance mentions a number of LID techniques but does not actually require projects to use them. The current flexibility of the points-based system makes it possible for developers to fulfill their landscape points using measures such as recycling vegetative waste, widening sidewalks at bus shelters, putting utility lines underground, installing ecological art, and providing handicapped accessibility—all of which are beneficial to the community but do not help with low impact development efforts. Finally, the landscape ordinance does not have measures that specifically focus on slowing down the velocity of stormwater.

City Stream Protection Ordinance *(proposed)*

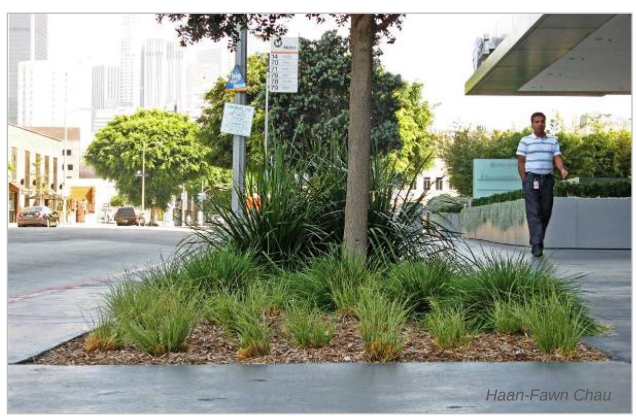
In October 2007, the Stream Protection Task Force completed a draft for a proposed Stream Protection Ordinance. Its goals are to: "(1) protect a valuable natural resource; (2) protect and maintain the existing ephemeral, perennial, intermittent or seasonal streams located within the City of Los Angeles; (3) protect and maintain native vegetation in riparian and wetland areas."[44] The main provision of this proposed ordinance is a 100-foot setback from the stream's edge with two zones: a 30-foot protected zone of no new development and a 70-foot buffer zone that allows limited development.

If enacted, the Stream Protection Ordinance would support low impact development by ensuring enough open space to allow for infiltration and groundwater recharge. By limiting development next to streams, the possibility of new pollution entering the watershed is also reduced.

It is important to note that the proposed ordinance also defines what a stream is. This is essential in L.A.'s dry climate since many streams do not run year-round. The June 2008 decision made by the U.S. Army Corps of Engineers to reduce the status of the Los Angeles River to "non-navigable" in most locations underscores this point. "Non-navigable" rivers are *not* protected by the Clean Water Act, the NPDES permit system, or L.A. County SUSMP standards. Therefore, local ordinances would be a more certain way to protect Los Angeles' waterways in a changeable political climate.

City Zoning Ordinances

The City's zoning ordinances are a major force in shaping the density of and types of land uses found in Los Angeles. Zoning regulations can be used to support low impact development efforts by promoting an even distribution of open space, parks and agricultural land throughout the city. Additionally, zoning can be used to encourage compact and infill development in central city areas, preventing the growth of new developments on open lands.



1150 South Olive Street in downtown Los Angeles

General Plan, Community Plans & Specific Plans

The **General Plan**, created by the Department of City Planning, is the major policy document that informs planning and development decisions in the City of Los Angeles. All zoning ordinances must match the policies put forth in the General Plan. The General Plan is divided into a number of "elements" to address specific issues. The elements most relevant to low impact development include the Land Use Element, Conservation Element (last updated in 2001)[45], Open Space Element (updated 1973)[46] and Transportation Element (updated 1999).[47] [48] Unfortunately many of these elements are outdated and their policies do not adequately address current environmental concerns. Although efforts are underway to update the plans, completion of each element update takes a few years.

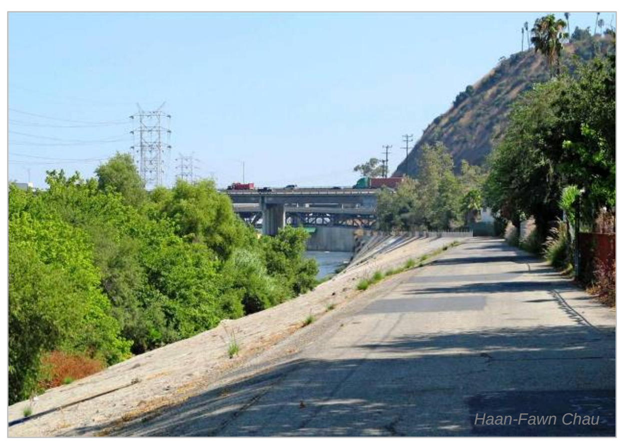
The Land Use Element is the largest element in the General Plan. It is actually comprised of thirty-five different **Community Plans** which address the particular needs and character of each area. On an even smaller scale, there are some neighborhoods that have their own **Specific Plans** which are tailored to very local conditions. Specific Plans are only created by the planning department on an as-needed-basis, usually when an area undergoing rapid changes could benefit from having more guidance than what is offered by the Community Plan.[49]

The General Plan (and its elements), Community Plans, and Specific Plans all offer opportunities to institutionalize water management and environmental protection by incorporating LID strategies into planning policies. As Community Plans are rewritten and new Specific Plans are developed, LID could become a standard component.

L.A. River Rivitalization Master Plan

The Los Angeles River Revitalization Master Plan (LARRMP) was completed in 2007.[50] Its recommendations provide "a framework for restoring the River's ecological function and for transforming it into a valuable, celebrated resource for residents and visitors to the City."[51] In the chapter titled "Revitalize the River," most of the goals and recommendations directly support low impact development. Some of these items include:

- Identify opportunities for peak flood storage outside the river channel.
- Emphasize "green infrastructure" improvements.
- Create landscape-based water quality treatment.
- Create "green strips" to treat stormwater runoff from streets.
- Create a continuous riparian corridor.



The Los Angeles River near Steelhead Park

The LARRMP is a policy document that presents a long-range vision and conceptual plan that identifies important revitalization strategies.

L.A. River Improvement Overlay District (proposed)

The proposed Los Angeles River Improvement Overlay District (LA RIO) was created to implement recommendations made in the LARRMP.[52] If enacted by ordinance, the LA RIO would be "a special use district that requires new projects to achieve points in three design categories: Watershed, Urban Design, and Mobility." The district would reach about ½ mile on either side of the L.A. River and would include all neighborhoods directly adjacent to the river. All new developments and significant redevelopments would have to meet LA RIO design guidelines.

Enacting the LA RIO would support low impact development by requiring developers to incorporate green infrastructure into their projects. Examples inlcude bioswales, bioretention ponds, green roofs, high efficiency irrigation systems, porous pavement and native plants.

Integrated Resources Plan

The City of Los Angeles' Integrated Resources Plan (IRP) is a multidisciplinary, cross-departmental effort to integrate the planning of three interdependent water systems: wastewater, recycled water and stormwater.[53] The IRP has worked collaboratively with community stakeholders to address the many water supply, pollution, and management challenges that face the Los Angeles area. Some of the strategies include optimizing the use of existing water infrastructure, increasing water conservation and reuse, and improving the management of dry and wet weather runoff using strategies such as better stormwater treatment infrastructure and low impact development-type projects.

Water Quality Compliance Master Plan

In 2007, the City of Los Angeles' Energy and the Environment/AdHoc River Committee filed a Motion directing the Bureau of Sanitation to create a Water Quality Compliance Master Plan (WQCMP) that outlines a strategy for the City to achieve Clean Water Act standards as well as compliance with all urban runoff regulations and mandates.[54] Some of the principles followed by the WQCMP that support low impact development include:[55]

- Identify all pollutants of concern in the City by type and location, including watershed or water body;
- Prioritize polluted areas within the City and create a compliance timetable;
- Identify strategies — such as on-site retention/infltration, structural best management practices, regional multi-use benefit projects (including the identification of potential sites for such projects), and non-structural educational and regulatory measures (including ordinance changes to encourage on-site infiltration) for the City to meet Clean Water Act standards by pollutant and by water body or watershed;

- Identify water quality data gaps including those that need to be filled in order to determine if the City is in full compliance with water quality requirements in the Los Angeles County stormwater permit and applicable TMDLs; and
- The proposed Master Plan will integrate existing efforts already underway such as the Integrated Resources Plan, Integrated Regional Water Management Plan, the Draft Los Angeles River Revitalization Master Plan, and other relevant watershed management plans, and will be developed in partnership with stakeholders from the public, environmental groups, and regulators including the Los Angeles Regional Water Quality Control Board and local municipalities.
- Include public workshops to seek input from not only from the above stakeholders, but also from the general public.

Endnotes

[1] U.S. Environmental Protection Agency. *National Pollutant Discharge Elimination System (NPDES).* Accessed on 8/11/08, http://cfpub.epa.gov/npdes

[2] U.S. Environmental Protection Agency. *National Pollutant Discharge Elimination System (NPDES).* Accessed on 8/11/08, http://cfpub.epa.gov/npdes

[3] U.S. Environmental Protection Agency. *Stormwater Discharges From Municipal Separate Storm Sewer Systems (MS4s).* Accessed on 8/11/08, http://cfpub.epa.gov/npdes/stormwater/munic.cfm

[4] Gentile, Laura, John Tinger, John Kosco, Wes Ganter, and James Collins. "Storm Water Phase I MS4 Permitting: Writing More Effective, Measurable Permits." Presented at the National Conference on Urban Stormwater: Enhancing Programs at the Local Level, February 17-20, 2003. Accessed on 8/11/08 from U.S. Environmental Protection Agency, http://www.epa.gov/owow/nps/natlstormwater03/13Gentile.pdf

[5] "A Review Of Low Impact Development Policies: Removing Institutional Barriers to Adoption," December 2007. Commissioned by California State Water Resources Control Board Stormwater Program and The Water Board Academy. Prepared by the Low Impact Development Center. Accessed on 8/1/08, http://www.waterboards.ca.gov/water_issues/programs/low_impact_development/docs/ca_lid_policy_review.pdf

[6] California State Water Resources Control Board. "State Water Resources Control Board (SWRCB) Order No. 99 - 08 – DWQ, National Pollutant Discharge Elimination System (NPDES) General Permit No. CAS000002, Waste Discharge Requirements (WDRS) For Discharges Of Storm Water Runoff Associated With Construction Activity." Page 18 of this portion of the document/page 62 of entire PDF. Accessed on 2/8/09, http://www.swrcb.ca.gov/water_issues/programs/stormwater/docs/finalconstpermit.pdf

[7] "A Review Of Low Impact Development Policies: Removing Institutional Barriers to Adoption," December 2007. Commissioned by California State Water Resources Control Board Stormwater Program and The Water Board Academy. Prepared by the Low Impact Development Center. Accessed on 8/1/08, http://www.waterboards.ca.gov/water_issues/programs/low_impact_development/docs/ca_lid_policy_review.pdf

[8] ibid.

[9] California State Water Resources Control Board. *Stormwater Program: Construction Stormwater Program.* Accessed on 2/8/09, http://www.swrcb.ca.gov/water_issues/programs/stormwater/construction.shtml

[10] U.S. Department of Energy. *Porter-Cologne Water Quality Control Act*. Accessed on 8/111/08, http://www.etec.energy.gov/Regulation/Porter-Cologne-Water-Quality-Control-Act.html

[11] "A Review Of Low Impact Development Policies: Removing Institutional Barriers to Adoption," December 2007. Commissioned by California State Water Resources Control Board Stormwater Program and The Water Board Academy. Prepared by the Low Impact Development Center. Accessed on 8/1/08, http://www.waterboards.ca.gov/water_issues/programs/low_impact_development/docs/ca_lid_policy_review.pdf

[12] ibid.
[13] ibid.

[14] Email message from Simon Eching of the California Department of Water Resources, Office of Water Use Efficiency Transfers. January 14, 2009.

[15] State of California Department of Water Resources, Office of Water Use and Efficiency Transfers. *Updated Model Water Efficient Landscape Ordinance AB 1881.* Accessed on 1/15/09. http://www.owue.water.ca.gov/landscape/ord/updatedOrd.cfm/

[16] State of California Department of Water Resources, Office of Water Use and Efficiency Transfers. "Modified Text of Proposed Regulation," California Code of Regulations Title 23, Sections 490 - 495 regarding the Model Water Efficient Landscape Ordinance. November 26, 2008. Accessed on 1/15/09, http://www.owue.water.ca.gov/docs/Modified_Text_of_Proposed_Regulation.pdf

[17] LandscapeOnline.com. *California Water Ordinance Update.* Accessed on 8/22/08, http://www.landscapeonline.com/research/article/10189

[18] State of California Department of Water Resources, Office of Water Use and Efficiency Transfers. "Modified Text of Proposed Regulation," California Code of Regulations Title 23, Sections 490 - 495 regarding the Model Water Efficient Landscape Ordinance. November 26, 2008. Accessed on 1/15/09, http://www.owue.water.ca.gov/docs/Modified_Text_of_Proposed_Regulation.pdf

[19] County of Los Angeles Stormwater Ordinance. "Title 12, Chapter 12.80 - Stormwater and Runoff Pollution Control." Accessed on 2/1/09, http://ordlink.com/codes/lacounty/_DATA/TITLE12/Chapter_12_80_STORMWATER_AND_R.html

[20] State of California, California Regional Water Quality Control Board, Los Angeles Region. "Waste Discharge Requirements for Municipal Storm Water and Urban Runoff Discharges Within the County of Los Angeles, and the Incorporated Cities Therein, Except the City of Long Beach." Order No. 01-182, NPDES Permit No. CAS004001. December 13, 2001. (Also known as the L.A. County Stormwater Permit SUSMP standards.)

[21] ibid.

[22] California State Water Resources Control Board. Letter from Michael A.M. Lauffer, Office of Chief of Counsel, to Dorothy Rice, Executive Director. July 16, 2008. Subject: "Cities of Arcadia, et al. v. State Water Resources Control Board, et al.,

(Super. Ct. Orange County, 2007, No. 06cco2974): Impact of peremptory writ of mandate on enrollments under the general industrial and general construction storm water permits."

[23] Pierson, David. "Beach pollution protections voided; building permits stalled." *Los Angeles Times,* July 18, 2008.

[24] Heal the Bay. Online News: *L.A. County Takes a Major Leap in Protecting Water Quality,* October 10, 2008. Accessed on 1/5/09, http://www.healthebay.org/news/2008/10-07_LACounty-LID/default.asp

[25] County of Los Angeles. "County of Los Angeles Low Impact Development Standards Manual," January 2009. Accessed on 1/10/09, http://planning.lacounty.gov/assets/upl/project/green_la-county-lid-manual.pdf

[26] County of Los Angeles Green Building Program, Department of Regional Planning and Department of Public Works. "Green Building and Sustainability Guidelines for the County of Los Angeles," 2008 Edition. Accessed on 1/10/09, http://planning.lacounty.gov/assets/upl/project/green_20080507-rpc-attachment-6.pdf

[27] County of Los Angeles, Green Building Program. *Drought-Tolerant Plant List.* Accessed on 1/10/09, http://planning.lacounty.gov/assets/upl/project/green_drought-tolerant-plants.pdf

[28] County of Los Angeles. "Ordinances for Green Building, Low Impact Development and Drought-Tolerant Landscaping," November 14, 2008. Accessed on 12/15/08. http://planning.lacounty.gov/assets/upl/data/ord_green-building-final-ordinances.pdf

[29] ibid.
[30] ibid.
[31] ibid.

[32] County of Los Angeles, Department of Regional Planning. *Special Projects: Green Building Program.* Accessed on 7/17/08, http://planning.lacounty.gov/spGreenBuildingProgram.htm

[33] City of Los Angeles, Stormwater Program. *History.* Accessed on 8/12/08, http://www.lastormwater.org/Siteorg/program/history.htm

[34] Heal the Bay. Online News: *L.A. County Takes a Major Leap in Protecting Water Quality,* October 10, 2008. Accessed on 1/5/09, http://www.healthebay.org/news/2008/10-07_LACounty-LID/default.asp

[35] Sonenshein, Raphael J. *Los Angeles: Structure of a City Government,* p.77. (2006) Published by the League of Women Voters of Los Angeles.

[36] Daniels, Paula. (City of Los Angeles, Board of Public Works). "Green Streets LA" presentation. Accessed July 2008 from the Local Government Commission website, http://water.lgc.org/water-workshops/la-workshop/Green_Streets_Daniels.pdf/view

[37] Cassidy, Arly, Josh Newell and Jennifer Wolch. "Transforming Alleys into Green Infrastructure for Los Angeles," June 2008. USC Center for Sustainable Cities. Page 5. Accessed July 2008, http://college.usc.edu/geography/ESPE/documents/alleyreport_final_reduced.pdf

[38] City of Los Angeles, Million Trees LA. *Frequently Asked Questions.* Accessed on 8/12/08, http://www.milliontreesla.org/mtabout8.htm

[39] Conversation with Edith Ben-Horin, T.R.E.E.S. Project Associate, from TreePeople (Beverly Hills, CA). August 27, 2008.

[40] City of Los Angeles, Department of City Planning. "Building a Green Los Angeles: Framework for the City's Green Building Program," May 2008. Accessed on 8/13/08, http://cityplanning.lacity.org/code_studies/GreenLa/Brochure.pdf

[41] U.S. Green Building Council. "LEED® for New Construction & Major Renovations," Version 2.2, October 2005. Accessed on 8/6/08, http://www.usgbc.org/ShowFile.aspx?DocumentID=1095

[42] City of Los Angeles, Department of City Planning. "Los Angeles City Planning Department Recommendation Report." Report to the City Planning Commission, February 10, 2005. Case No: CPC-1992-0043-CA, CEQA: ENV-2003-7106-CE. Accessed on 8/6/08, http://cityplanning.lacity.org/Code_Studies/Other/landscape.pdf

[43] City of Los Angeles, Department of City Planning, Office of Zoning Administration. “City of Los Angeles Landscape Ordinance.” Ordinance No. 170,978. Effective May 12, 1996, Operational July 12, 1996 (as amended through April 10, 2005). Accessed 8/7/08, http://cityplanning.lacity.org/Forms_Procedures/landsc%20guidelines%204-05.pdf

[44] City of Los Angeles. Draft memo from Paula Daniels, Chair, Stream Protection Task Force. “Re: Proposed Stream Protection Ordinance.” October 3, 2007.

[45] City of Los Angeles, Department of City Planning. “Conservation Element of The City of Los Angeles General Plan.” City Plan Case No. 2001-0413-GPA. Council File No. 01-1094. Adopted by the City Council September 26, 2001. Approved by the City Planning Commission March 10, 2001. Accessed on 8/13/08, http://cityplanning.lacity.org/cwd/gnlpln/consvelt.pdf

[46] City of Los Angeles, Department of City Planning. “Open Space Plan.” June 1973. City Plan Case No. 24533.

[47] City of Los Angeles, Department of City Planning. “Transportation Element of the General Plan.” Adopted my City Council on September 8, 1999. Approved by City Planning Commission July 24, 1997. Accessed on 8/13/08, http://cityplanning.lacity.org/cwd/gnlpln/transelt/index.htm

[48] City of Los Angeles, Department of City Planning. *General Plan Elements.* Accessed on 8/13/08, http://cityplanning.lacity.org

[49] Conversation with Bryan Lobel, City of Los Angeles, Department of City Planning. August 13, 2008.

[50] City of Los Angeles, Los Angeles River Revitalization Master Plan website. *Objectives of the Master Plan: Project Background & Purpose*. Accessed 8/17/09, http://www.lariverrmp.org/Background/master_plan.htm

[51] City of Los Angeles. Department of Public Works, Bureau of Engineering. *Los Angeles River Revitalization Master Plan.* p. 1-2. April 2007. Available at http://www.lariverrmp.org/CommunityOutreach/masterplan_download.htm

[52] City of Los Angeles, Department of City Planning. “RIO Fact Sheet: River Improvement Overlay District,” July 2007. Accessed on 8/19/08, http://cityplanning.lacity.org/Code_Studies/Rioproject/factsheet.pdf

[53] City of Los Angeles. Department of Public Works, Bureau of Sanitation. “Integrated Resources Plan (IRP): A New Strategy for LA’s Water Infrastructure—Information Sheet,” January 26, 2006. Accessed 1/31/09, http://www.lacity.org/SAN/irp/documents/factsheet012006.pdf

[54] City of Los Angeles. Department of Public Works, Bureau of Sanitation. *Water Quality Compliance Master Plan.* Accessed on 1/31/09, http://www.lastormwater.org/siteorg/general/WQCMP/intro.htm

[55] The text from this description was taken from the “Water Quality Compliance Master Plan” page of the City of Los Angeles Stormwater Program website. http://www.lastormwater.org/siteorg/general/WQCMP/intro.htm (See previous citation.)

[8] Strategies to Codify Low Impact Development and Green Infrastructure

The Benefits of an Ordinance

As described in Chapter 4, low impact development strategies could help the City of Los Angeles tackle a range of urban issues, from stormwater runoff to climate change to green jobs. To reap these benefits, the City's best approach may be to enact a low impact development (LID) ordinance. Chapter 7 details a number of stormwater and green infrastructure regulations, policies and programs that already exist at the federal, state, county and city levels. While these items touch on some low impact development principles, the City still lacks a comprehensive, enforceable law that can be used to make LID a common practice in Los Angeles.

The two greatest advantages to enacting a LID ordinance—as opposed to relying only on LID policies---are (1) enforcement, and (2) long-term reliability. While enacting LID policies (in the General Plan, for instance) may be an important step toward widespread LID implementation, a complementary city ordinance can ensure that LID practices are enforceable by the rule of law and more broadly applicable. Additionally, unlike the L.A. County Municipal NPDES Stormwater Permit which needs to be reissued every five years, city ordinances are a permanent part of the municipal code and can only be reversed with legislative action by the city council.

Recent Challenges to Watershed Protection

Even with federal, state and county water protection regulations, there can be court-ordered changes, and sometimes even reversals. Two recent examples illustrate just how precarious the legal status of watershed protection and stormwater management can be in Los Angeles.

First, on June 4, 2008 the Army Corps of Engineers determined that only two small sections of the Los Angeles River—totaling

Benefits of a LID Ordinance

Two greatest advantages to enacting ordinances, as opposed to relying exclusively on policies:

1. enforcement
2. long-term reliability

Right now, standards from the L.A. County Stormwater Permit's Standard Urban Stormwater Mitigation Plan (SUSMP) are the closest that Los Angeles has to a LID ordinance. However, SUSMP standards are subject to revision and do not yet comprehensively require all the elements of a low impact development strategy.

Alternatives to a City LID Ordinance

1. Meet SUSMP requirements using LID standards
2. Revise Landscape Ordinance to include LID standards
3. Revise Green Building Ordinance to include LID standards
4. Rely on LID planning policies instead of ordinances
5. Combined ordinance and incentive structure
6. Enacting LID ordinance after voluntary pilot phase

8% of its length—qualified as "traditional navigable waters" of the United States.[1 2] This could have an impact on water quality because only navigable waters of the United States are protected under the federal Clean Water Act.

A driveway that allows for infiltration (Los Angeles)

A second example of a challenge to watershed protection occurred one month later on July 2, 2008. In the case of *Cities of Arcadia, et al. v. State Water Resources Control Board, et al.*, the Orange County Superior Court concluded that the Los Angeles Regional Water Quality Control Board had not properly "analyzed the reasonableness of its stormwater quality control standards," especially with regards to their economic impacts.[3] This ruling directly challenges the validity of NPDES stormwater pollution controls under the Clean Water Act and the accompanying SUSMP standards in Los Angeles and Ventura counties.[4]

If the City of Los Angeles were to codify water protection standards at the *local* level, it would provide some leadership and assurance against unpredictable shifts in federal, state and county regulations.

Alternatives to a Stand-Alone LID Ordinance

A comprehensive low impact development ordinance would be the most effective way to implement LID strategies on a wide scale. However, enacting major new ordinances can take a lot of time and political will. There are a few alternative ways that LID could be implemented on a smaller scale. Also, the following ideas could be used as short-term LID solutions while the City works on developing a full-scale LID ordinance or program.

Alternative #1: Meet SUSMP Requirements Using LID Standards

The City could require all projects that fall under the L.A. County Stormwater Permit's SUSMP rules to also meet strict LID standards defined by the City.

<u>*Drawbacks:*</u> (a) SUSMP only applies to major new developments and redevelopments, not existing buildings and infrastructure. (b) The stormwater permit must be renewed every five years, and there is no certainty as to the level of protection in future versions.

Alternative #2
Revise Landscape Ordinance to Include LID Standards

The City's Landscape Ordinance could be revised to include more low impact development strategies. As mentioned in Chapter 7, the State has created a Model Water Efficient Landscape Ordinance with a few LID elements which will apply only to new and major redevelopments.[5] The City will be required to match or exceed the State's landscape ordinance by 2010.

Additionally, a points-based system similar to the U.S. Green Building Council's LEED standards could be initiated for landscapes in the city. The Sustainable Sites Initiative,[6] organized by landscape architects, is currently developing a system to certify environmentally-friendly landscapes and site design.

<u>*Drawbacks:*</u> (a) Many effective LID techniques fall outside the purview of a landscape ordinance (i.e. green roofs, porous pavement, water storage cisterns, curb cuts leading to swales). (b) A landscape ordinance would miss large areas of the city because it would not apply to infrastructure such as streets, sidewalks, alleys and parks. (c) The proposed State standards do little to address existing landscapes. (d) The proposed State standards recommend but do not require the use of native and drought tolerant plants.

Demonstrating water infiltration through pervious concrete (left) and porous asphalt (right). Parking lot at Villanova University, Pennsylvania. *EPA / Abby Hall*

Alternative #3
Revise Green Building Ordinance to Include LID Strategies

Currently, it is possible for developers to comply with the City's Green Building Ordinance without implementing stormwater BMPs and water efficiency measures. The ordinance could be revised to require buildings to achieve specific points related to low impact development in the "Sustainable Sites" and "Water Efficiency" categories of LEED green building standards.

<u>*Drawbacks:*</u> (a) Stormwater management is an optional, but not required, part of LEED certification and only counts for one out of 26 points necessary for certification.[7] (b) Water efficiency points are also optional, and only two points relate to LID strategies.[8] (c) The Green Building Ordinance does not apply to existing buildings and only covers major redevelopments. (d) The Green Building Ordinance does not apply to infrastructure such as streets, sidewalks, alleys and parks.

Alternative #4
Rely on LID Planning Policies Instead of Ordinances

Adopting policies can sometimes be more politically feasible for the City than adopting ordinances. City-wide goals and policies for low impact development could be added to the General Plan, possibly in the conservation element. Then, as the city's 35 community plans are updated one by one, LID strategies can be tailored to each area's potential to manifest LID principles. (i.e. Some areas have very permeable soils and therefore can infiltrate more water than others. Conversely, some locations may be too densely developed to rely heavily on infiltration.)

Even if the City decides to move forward with developing a LID ordinance, LID policies could be adopted first. These policies will then provide the foundation and information to support the passage of a LID ordinance.

Drawbacks: (a) It takes a long time to update all 35 community plans, so LID implementation would happen very slowly. (b) Policies are not enforceable in the same way as ordinances. (c) Policies can be changed without exhaustive public review, making a LID policy potentially more vulnerable than an ordinance. (d) Policies are more subject to alteration with a change in executive leadership.

Alternative #5
Combined Ordinance and Incentive Program

The City could establish a low impact development program that relies on a combination of a LID ordinance and a LID incentive structure. First, the ordinance would require that new developments and redevelopments use LID techniques. Then, to promote LID for existing developments, the City would create a rebate program to provide some reimbursement for people who choose to install low impact development BMPs on their properties.

This combined strategy (ordinance + incentive program) could use individualized parcel stormwater assessments, a concept which is described in greater detail in Chapter 6. Assessments would be based on the amount of impervious surface found on a property, and rebates could be offered for people who install LID BMPs to increase on-site permeability. To make this work, the assessment fees would have to be high enough to motivate people to install LID projects that qualify for a rebate.

Infiltration swale for a supermarket parking lot.
7676 Firestone Blvd., Downey, CA.

Alternative #6
Enacting LID Ordinance After Voluntary Pilot Phase

Because the widespread use of low impact development strategies is a relatively new idea for Los Angeles, the City may want to begin with a voluntary, one-year LID program that serves as an instructive pilot phase. To ensure enough participation during this test period, the City could offer incentives such as rebates for the installation of LID best management practices. At the end of the year, the City would revise and codify the LID ordinance, making it mandatory for property owners to follow. However, there is a drawback to relying on a voluntary program to implement low impact development: it would take a long time for the widespread use of LID to occur, and due recent droughts throughout the state, the City of Los Angeles has an imminent need to conserve water now.

Endnotes

[1] Kerr, Mary. *Press Release: Chairman Oberstar and Waxman Demand Answers From Corps.* August 7, 2008. U.S. House of Representatives, 111th Congress, Transportation and Infrastructure Committee. Accessed on 8/11/08, http://transportation.house.gov/News/PRArticle.aspx?NewsID=728

[2] Hopkins, Ed and Judy Anderson. "Clean Water Act in Jeopardy." *Southern Sierran* newsletter, p.1. August 2008, Volume 64, No. 8. Published by the Angeles Chapter of the Sierra Club.

[3] California State Water Resources Control Board. Letter from Michael A.M. Lauffer, Office of Chief of Counsel, to Dorothy Rice, Executive Director. July 16, 2008. Subject: "Cities of Arcadia, et al. v. State Water Resources Control Board, et al., (Super. Ct. Orange County, 2007, No. 06cco2974): Impact of peremptory writ of mandate on enrollments under the general industrial and general construction storm water permits."

[4] Pierson, David. "Beach pollution protections voided; building permits stalled." *Los Angeles Times,* July 18, 2008.

[5] State of California Department of Water Resources, Office of Water Use and Efficiency Transfers. *Updated Model Water Efficient Landscape Ordinance AB 1881.* Accessed on 1/15/09. http://www.owue.water.ca.gov/landscape/ord/updatedOrd.cfm/

[6] The Sustainable Sites Initiative homepage. Accessed on 9/22/08, http://www.sustainablesites.org/index.html

[7] The U.S. Green Building Council, Leadership in Energy & Environmental Design (LEED). "Green Building Rating System for New Construction & Major Renovations (LEED-NC), Version 2.1," p.11. November 2002, revised March 14, 2003. Accessed on 7/31/08, http://www.usgbc.org/Docs/LEEDdocs/LEED_RS_v2-1.pdf

[8] The U.S. Green Building Council, Leadership in Energy & Environmental Design (LEED). "Green Building Rating System for New Construction & Major Renovations (LEED-NC), Version 2.1," p.16–17. November 2002, revised March 14, 2003. Accessed on 7/31/08, http://www.usgbc.org/Docs/LEEDdocs/LEED_RS_v2-1.pdf

[9] Defining the Scope of a LID Strategy for Los Angeles

This chapter sets forth possibilities for the scope of a low impact development (LID) strategy for the City of Los Angeles. Since the city could greatly benefit from implementing LID on a wide scale (see Chapter 4), the sections below assume that it would take a comprehensive, thorough approach to LID.

1150 S. Olive Street, Los Angeles

To Whom Would LID Apply?

Currently, most LID-type requirements in Los Angeles apply only to new developments or major redevelopments; they do not address the enormous mass of existing development in the city. Additionally, regulations tend to focus on individual sites and parcels of land, not the connecting infrastructure of roads, sidewalks, parks and alleys. Therefore, a comprehensive LID program would encompass all of the following:

- **Government & public infrastructure:** The City government controls large portions of land, buildings, streets, parks and infrastructure throughout Los Angeles. *The Green Solutions Project* report written by Community Conservancy International found that close to 40% of L.A. County's urban runoff needs could be met by implementing LID on publicly-owned lands.[1] Additionally, more than half of Los Angeles is covered by impermeable surfaces.[2] Thus, integrating public green spaces into the water management network and changing the City's street paving and construction practices could have very positive effects.
- **Private residences:** Private homes and apartment buildings cover a sizeable proportion Los Angeles, and they often have lawns and gardens which are prime candidates for LID infiltration projects. Additionally, lawns are a major source of pollution because nutrients and fertilizers flow into the storm drain system. Infiltration would reduce these impacts.
- **Commercial/retail:** Commercial and retail developments often have very large, paved surfaces (such as parking lots) that produce contaminated runoff. They provide an opportunity to infiltrate using permeable pavement and bioswales.
- **Industrial:** Even though many industrial buildings are already subject to pollution controls, implementing LID practices in areas that do not have serious contamination issues would also

help to recharge groundwater supply. Like commercial properties, industrial lots often have large, paved surfaces that could be converted to infiltration zones.

Encompassing New and Existing Development

Applying LID requirements to all sectors and to both new and *existing* developments of all sizes would move beyond the limited scope of L.A. County's current SUSMP stormwater management standards and the City's Green Building Ordinance. Again, this is important because **low impact development practices are most effective when distributed throughout the watershed.** As highlighted in Chapter 4, *widespread* implementation of low impact development on public lands could address 40% of L.A. County's polluted runoff needs,[3] and so one could hypothesize that extending LID practices to private lands would greatly increase this percentage. Additionally, it has been found that implementing LID on suitable public and private properties could reduce the amount of water imported by 74,600–152,500 acre-feet per year.[4] Thus, to achieve wide-scale benefits, existing development should be included in the City's strategy for LID.

Since existing developments are currently exempt from the LID measures found in the County's SUSMP standards and the City's green building and landscape ordinances, there may also be some resistance to including existing developments in a mandated low impact development strategy. **Introducing a city-wide LID rebate program for existing development could be a successful way to address these concerns and provide a financial incentive to install green infrastructure features on these properties.** The City could develop a rebate structure that allows property owners to recoup some (or all) of their stormwater fees by using low impact development BMPs such as rain gardens, bioswales, cisterns and even permeable pavement.

In very densely developed areas, it may be difficult to infiltrate or capture all runoff on-site, so the city may consider using in-lieu fees to allow developers to compensate for any shortfalls. The in-lieu fees could then be used to install additional LID projects nearby. (See Chapter 6 for a detailed discussion of in-lieu fees.)

A 2008 publication by the EPA, titled *"Managing Wet Weather with Green Infrastructure: Municipal Handbook - Green Infrastructure Retrofit Policies,"* contains more information and case studies on this topic. It can be accessed at http://www.epa.gov/npdes/pubs/gi_munichandbook_retrofits.pdf.

Brownfields and LID

Los Angeles' brownfields provide good opportunities for infill redevelopment. However, depending upon the characteristics of the site, infiltration BMPs may not always be appropriate. Factors to consider when developing brownfields include the level and type of contamination, how much remediation has already been done, the type of soil in the area, the depth of groundwater, and the rates and direction of hydrologic flow on-site. Many brownfield sites may be better served by mechanical and chemical treatment methods instead of infiltration. However, brownfields could still be part of a groundwater recharge system. Water from contaminated sites could be captured and cleaned, and then be piped to a recharge location outside of the contaminated area.

The City of Emeryville, CA has been particularly successful in using low impact development and green infrastructure techniques for brownfields redevelopment.[5] The city's handbook, *Stormwater Guidelines for Dense, Green Redevelopment,* details some of the LID options that developers can use for infill sites.[6] Due to soil contamination, the Emeryville brownfields projects do not infiltrate stormwater into the aquifers. Instead, stormwater is captured for filtration and/or reuse. Vegetated detention basins and swales use plants to remove pollutants from stormwater (bioremediation).

Reaching Beyond Current Performance Standards

Chapter 7 noted that the L.A. County Stormwater Permit's "Standard Urban Stormwater Mitigation Plan" (SUSMP) contains the most important LID-related infiltration and stormwater capture requirements that apply to the City of Los Angeles. **While SUSMP standards are the closest that Los Angeles has to a LID ordinance, they still fall short of a comprehensive low impact development strategy for a number of reasons.**

A clogged catch basin in Los Angeles.

For instance, SUSMP does not require native and/or drought-tolerant plants for landscape BMPs[7]. If developers install water-thirsty plants requiring large amounts of irrigation during the dry season, this could have the unintended consequence of exacerbating L.A.'s water conservation issues. And as mentioned above, the standards only apply to major new developments and redevelopments, not existing developments. (See Chapter 7 for more SUSMP information.)

Moreover, it is worth noting that SUSMP is especially geared towards dealing with the pollution in the first flush of a storm, and was not designed to encompass concerns about groundwater recharge. Given Los Angeles' concern about long-term water supplies, the City may want to adopt *even more* ambitious performance standards than SUSMP. (Current SUSMP standards require that a project capture, infiltrate or treat all of the runoff from an 85th percentile storm, which equivalent to a ¾" storm.)

Setting New Performance Standards

Some basic questions to consider when setting new performance standards for low impact development are listed below. A more extensive list can be found at the beginning of the next chapter.

- Should LID performance standards vary with soil type and the character of the local water table?
- LID attempts to restore pre-development hydrology and flows, but these have changed quite a bit over history. How far back in time should we look?
- Should LID performance standards vary with building size or type?
- Should there be different expectations for dense neighborhoods vs. low density neighborhoods?
- How should the performance of a LID program or project be measured?
- On what scale or level should LID performance be measured—by parcel, block, neighborhood or watershed?
- What will be measured? Water quality parameters, water flow from a site, etc.
- Who will be responsible for monitoring?

Contents of a LID Ordinance

Rain chains guide water into rocky infiltration swales in Seattle's High Point neighborhood.

If the City of Los Angeles were to adopt a low impact development ordinance, what would it contain? LID ordinances passed by other municipalities provide good examples, though the City may want to adapt them to suit the unique needs and goals of Los Angeles. Of particular interest is the Low Impact Development Ordinance recently passed by the County of Los Angeles in October 2008 as part of its landmark green building program.[8] Chapters 5 & 7 contain more detailed descriptions and analysis of the County's LID Ordinance, and the text of the ordinance can be found in Appendix II.

The components of a LID ordinance for the City of Los Angeles should include:[9] [10]

- The purpose of the ordinance
- Definitions of important terminology
- To what and whom the ordinance applies
- LID standards for the pre-development (site planning) phase and construction phase
- LID performance standards for specific types of properties
- Whether performance standards are prescriptive (requiring the use of specific BMPs) or flexible (using BMPs preferred by the developer to meet performance thresholds)
- The prioritization of BMPs to place emphasis on infiltration into aquifers (see Chapter 3)
- Tying LID standards to a manual of LID standards for the City of Los Angeles (see next section)

- Tying LID standards to a list of recommended native and/or drought tolerant plants suited to the local habitats and climate
- Stream and riparian habitat protection measures
- Any incentives offered by the City to encourage property owners to install LID measures
- LID site plan review and approval process
- Requirements for continued maintenance and operation of LID best management practices
- Monitoring and evaluating the performance of LID programs and projects
- Adapting the LID standards or ordinance to reflect the knowledge gained from monitoring program.

Developing a LID Manual for Los Angeles

Every major municipal low impact development program has developed a technical manual to accompany its policies or ordinances. Particularly notable examples are from Prince George's County (MD), the Puget Sound region (WA), Emeryville (CA), Los Angeles County, San Diego County and the U.S. Department of Defense. Web links to all of these manuals can be found in Appendix I.

In general, LID manuals do the following:

- Explain the purpose of and principles behind low impact development
- Clarify the meaning and application of LID performance standards
- Describe site assessment, planning and design techniques
- Describe an array of LID best management practices (including advantages, drawbacks, cost considerations, and maintenance needs)
- Provide diagrams and plans for common BMPs
- Supply information on hydrologic flow modeling

If L.A. City were to create a low impact development manual, it would not have to start from scratch. Much of the material from L.A. County's new "Low Impact Development Manual," as well as its old 2002 "Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP)," can be applied to the needs of the City of Los Angeles.[11]

Endnotes

[1] Community Conservancy International. "The Green Solutions Project" report, March 2008. Executive Summary, p.ES-3. The report can be viewed at http://www.ccint.org/greensolution.html

[2] City of Los Angeles, Inter-Departmental Correspondence. May 21, 2008. "CF: 05-0752 Alternative Street Surfacing Materials." To: Energy and the Environment Committee, from: Department of Public Works and Environmental Affairs Department. This document can be accessed online at http://www.lacity.org/ead/greenbuilding/eadgreenbuilding298555988_10022008.pdf

[3] Community Conservancy International. "The Green Solutions Project" report, March 2008. Executive Summary, p.ES-3. The report can be viewed at http://www.ccint.org/greensolution.html

[4] *First source of information:* Beckman, David S. and Noah Garrison. "NRDC Comment on AB32 Scoping Plan Appendices Water Sector," August 11, 2008. Natural Resources Defense Council comments sent to the California Air Resources Board. *Second source of information:* Email message from Noah Garrison, Project Attorney at NRDC, on January 21, 2009. "LID Numbers for L.A. County."

[5] U.S. Environmental Protection Agency, Brownfields and Land Revitalization Program. "Case Studies for Stormwater Management on Compacted, Contaminated Soils in Dense Urban Areas," April 2008. Accessed on 8/14/08, http://www.epa.gov/brownfields/publications/swcs0408.pdf

[6] City of Emeryville (CA), Planning and Building Department. "Stormwater Guidelines for Green, Dense Redevelopment," December 2005. Accessed on 1/5/09, http://www.ci.emeryville.ca.us/planning/pdf/stormwater_guidelines.pdf

[7] State of California, California Regional Water Quality Control Board, Los Angeles Region. "Waste Discharge Requirements for Municipal Storm Water and Urban Runoff Discharges Within the County of Los Angeles, and the Incorporated Cities Therein, Except the City of Long Beach." Order No. 01-182, NPDES Permit No. CAS004001. December 13, 2001.

[8] Heal the Bay. Online News: *L.A. County Takes a Major Leap in Protecting Water Quality,* October 10, 2008. Accessed on 1/5/09, http://www.healthebay.org/news/2008/10-07_LACounty-LID/default.asp

[9] County of Los Angeles. "Ordinances for Green Building, Low Impact Development and Drought-Tolerant Landscaping," November 14, 2008. Accessed on 12/15/08. http://planning.lacounty.gov/assets/upl/data/ord_green-building-final-ordinances.pdf

[10] Vermont League of Cities & Towns. "Model Low Impact Development Stormwater Management Bylaw," May 2008. Accessed on 7/21/08, http://resources.vlct.org/u/o_LID-secured.pdf

[11] County of Los Angeles, Department of Public Works. *Development Planning for Storm Water Management: A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP) - September 2002 Revision.* Accessed on 8/5/08, http://ladpw.org/wmd/NPDES/table_contents.cfm

[10] Considerations for LID Implementation

Low impact development (LID) offers promising strategies for the City of Los Angeles to significantly improve stormwater management, water supply and green space while reducing its impact on climate change and the environment in general. However, the city should consider the following challenges and issues before developing and implementing a comprehensive LID program.

Curb cut that directs water from the street into a bioswale. Voluntarily installed at 1100 S. Hope Street in downtown L.A.

Defining LID Goals & Standards

Some questions to consider when defining LID goals and standards include:

Determining goals:

- How much water should be infiltrated and/or captured? Should LID requirements be similar to current SUSMP standards or more ambitious?
- Should the City create a LID rebate program to encourage property owners to install more best management practices (BMPs)?
- LID attempts to restore pre-development hydrology and flows, but these have changed quite a bit over the city's history. How far back in time should we look?
- Our urban landscape is always changing, and it may be a challenge for LID projects to keep up with those changes. For example, if a low density area with plenty of LID BMPs starts changing to a high density area, would this change any of the fundamental LID infrastructure or strategies?

Defining standards:

- Should LID standards be performance-based (to allow for flexibility) or should they prescribe the use of specific LID best management practices?
- What methods should be used to measure the performance of a LID program or project?
- On what scale or level should LID performance goals be measured—by parcel, block, neighborhood or watershed?
- Should LID performance standards vary with soil type, the character of the local water table and the slope of the land?

- Should there be different expectations for dense neighborhoods vs. low density neighborhoods?
- Should LID performance standards vary with building size, type or purpose?

Balancing Smart Growth and Infiltration

Smart growth planning practices encourage compact development for a number of reasons: to reduce a city's environmental impact, to preserve open space, support access to public transportation, and improve walkability. Nonetheless, increased urban density can make it difficult or expensive to infiltrate on-site, especially if a building's footprint takes up the entire lot of land. How can the city encourage LID infiltration, but not at the expense of compact development?

Four options may help solve this dichotomy: (1) in-lieu fees, and (2) reduced parking requirements in exchange for the installation of low impact development BMPs,[1] (3) requiring that properties capture, filter and reuse runoff water instead of infiltrating it, and (4) setting LID infiltration goals on a larger, neighborhood scale instead of parcel-by-parcel.

In-Lieu Fees

In very densely developed areas, it may be difficult to infiltrate or capture all runoff on-site, so the city may consider using in-lieu fees to allow developers to compensate for any shortfalls. The in-lieu fees could then be used to install additional LID projects nearby.[2] The *advantages* of this system include that (1) it raises money for the City to pay for general LID implementation and maintenance projects, and (2) it creates some flexibility in how developers can decide to fulfill LID requirements. *Disadvantages* of this system include that (1) it may actually be more cost-effective and less burden for the City to require developers to install infiltration BMPs, and (2) by allowing property owners a way to avoid installing infiltration BMPs, the City runs the risk of having no LID infiltration BMPs at all in very dense neighborhoods.

If the City were to move forward with allowing in-lieu fees, the fees should go towards the installation of LID projects that are close to the original development sites that generated the fees. Also, the in-lieu-fees should not be used to build centralized treatment plants, as these would not fulfill the LID goals of enhancing natural drainage systems and managing stormwater on a local scale.

Exchanging Parking Requirements or Density Bonuses for LID BMPs

The City could use density bonuses or reduced parking requirements as incentives for installing low impact development features in highly urbanized areas. Both incentives increase the amount of space that can be built—a valuable opportunity for developers working in such areas.

As shown by the table on the right, parking facilities are very expensive to build, and City-mandated parking requirements can place major constraints on how developers can use their land.[3] In very dense portions of the city, exchanging parking spaces for effective, well-planned LID infiltration projects could prove to be a powerful economic incentive.[4]

Average Development Cost of Parking (excluding land)

Source: http://www.livableplaces.org/bpolicy/parking.html

Type of parking facility	Cost/space
Surface lot	$2,000
Multi-level above ground	$10,000
Subterranean	$20,000

Capture, Filtration & Reuse

The City could designate certain "densely developed areas" of the Los Angeles (such as downtown, where soils are not conducive to infiltration and basement width often extends under the sidewalk area), where it would allow developers to capture, filter and reuse water runoff from a property instead of infiltrating it into the ground. On-site treatment facilities could be used to remove pollutants from runoff. If the property has no way of reusing the filtered water, the City could allow it to connect to the storm drain system or direct its flow to another property for reuse.

Setting LID Goals at Neighborhood Level

Basing LID infiltration goals on larger areas—such as entire neighborhoods or watersheds instead of parcel-by-parcel—could allow some flexibility to deal with infiltration problems at an individual site while still achieving the City's overall infiltration goals. Making some concessions to accommodate compact growth could help prevent suburban sprawl, saving valuable open space from being developed. To successfully adhere to low impact development principles, the City would need to evaluate the amount of filtration and groundwater recharge that would be gained by preserving open space in comparison to requiring smaller infiltration zones in dense urban locations.

Administrative Challenges

Before implementing a low impact development program, the City would need to resolve a number of administrative challenges:

Administering a LID program:

- Which department would be responsible for LID implementation? A comprehensive LID program would probably require coordination between several departments.
- Will additional staff be needed to administer the LID program?

- To encourage innovative LID projects, the process for approving non-standard BMP designs should be streamlined.
- A plan to monitor adherence to LID standards and to tell whether property owners continue to maintain their low impact development BMPs should be developed.
- The LID program should be administered in a way that will not create an extra layer of bureaucracy for building plan checks.
- Possible increases in maintenance: porous pavements need to be vacuum-swept several times a year.

Resolving conflicts with LID:

- Some LID practices may conflict with building and safety codes. Historically, building and safety codes have aimed to direct water out to the storm drain as fast as possible—the opposite of what low impact development tries to accomplish. Also, there may be some building codes that restrict how water can be reused and what kinds of pavement can be used for fire lanes.
- Sometimes the City requires developers to change the slope of the site in a way that does not benefit low impact development. The City's grading requirements tend to favor the urban street grid and are not based on the land's natural topography.
- Hillside areas may not be conducive to infiltration due to the potential for soil subsidence, and may need to be exempted from LID.

A large cistern collects roof runoff from a commercial building in Chicago.

Other points of note:

- Potential private property issues: For LID to have a significant positive impact, it should be employed on private as well as public property. From an environmental standpoint, if a particular property has very little infiltration area but an adjacent property has plenty of space for infiltration, low impact development goals could be fulfilled by infiltrating the runoff from the first property on the second property. However, allowing one property to manage the other's runoff could cause some legal complications.
- A LID ordinance for the City of Los Angeles would not apply to the Los Angeles Unified School District (LAUSD), a major land holder. The school district is currently following county-wide SUSMP stormwater management standards because of political pressure. Moreover, LAUSD generally uses state architects to design their sites. Instead of using the LEED green building certification system run by the U.S. Green Building Council (which is the centerpiece of L.A.'s Green Building Ordinance), they use the CHPS program (Collaborative for High Performance Schools) which applies only to K-12 schools.

LID Readiness & Education

Low impact development will be a new concept to many. To properly implement a LID program, the City should take steps to ensure that there is an adequate support structure and professional knowledge base.

- How ready are we for LID change? City planning staff, engineers and street maintenance crews would need to learn about LID principles and standards.
- Are Los Angeles' architecture and landscape design professionals ready to design and install LID features? Local landscape architects may not have enough knowledge about ecology and native plants to implement LID techniques effectively. Making a landscape look attractive is very different from designing it to successfully perform stormwater management functions.
- Low impact development training should be offered to the landscape and gardening industry so that they can understand how to maintain landscape BMPs and smart irrigation systems.
- More trained professionals are needed to help monitor, collect data and analyze the effectiveness of LID projects in Los Angeles. They will be needed in both the government and private sectors.
- The people who evaluate LID programs and projects must have a thorough understanding of the biological and ecological calculations that go into LID.

Implementing LID Effectively

In order to effectively implement low impact development in Los Angeles, a number of points should be kept in mind:

- Site evaluation is very important to ensure that LID best management practices appropriate for the local drainage patterns are installed at optimal locations on a property.
- If the city's goal is to maximize groundwater recharge, then it must emphasize drought-tolerant plants. Planting additional water-thirsty species could actually increase the city's demand for water. Therefore, to fulfill the goal of increasing water supply while reducing demand, planting drought-tolerant plant and tree species is imperative.
- Infiltration and groundwater recharge is not necessarily optimal where the ground is composed of impenetrable clay, as the case in some areas of the city. In such areas, the emphasis should be placed on slowing and cleaning instead.
- Development companies must carefully plan the paths for their construction equipment in order to prevent the removal of topsoil and excess grading and compaction, all of which reduce the effectiveness of LID infiltration techniques.

LID Knowledge, Data and Evaluation

Since low impact development and green infrastructure programs are relatively new in the United States, the knowledge base is still developing. There is a need to gather information about LID projects in dry climates such as Los Angeles. The City can help fill these information gaps by considering the following:

Vegetated swale with curb cuts at a shopping center. 8500 Firestone Blvd., Downey, CA.

- Who will be responsible for monitoring and evaluating LID programs and projects? What will be measured? (Water quality parameters, water flow from a site, rate of infiltration, etc.) How does LID data compare to baseline data for conventional stormwater practices in Los Angeles?
- There is quite a bit of existing data on implementing LID in wet climates, but not enough for dry climates. There needs to be more test cases and studies specific to Southern California's climate, especially regarding effectiveness and costs of LID. The City may be able to cooperate with universities to accomplish this.
- The City could develop a methodology to quantify and assess the true value of low impact development strategies. It is important to account for all the economic, environmental and social benefits and costs when conducting a financial analysis of LID. Many analyses tend to focus only on capital costs, but when looking at the large-scale ecological picture, LID is often a more cost-effective strategy than conventional stormwater management. There is significant value created by nature's services, such as pollution removal by plants, potential flood waters absorbed by soil, and carbon sequestered by trees.
- The results of a cost-benefit analysis can also vary from site to site. For instance, the value of removing a certain amount of bacterial pollution may be worth more at one site than another. How could this be included in a comprehensive LID program?
- Some BMPs may have long-term issues with maintenance, so more test cases are needed to gather data on this topic.

Equity Issues

Implementing low impact development throughout Los Angeles may generate some concerns about equity issues in low-income areas. For instance, because dense neighborhoods have relatively small lots and are dominated by buildings and paved surfaces, there is little space to install LID infiltration BMPs. Therefore, drainage fees based solely on the percentage of impervious surface that covers a property may place a proportionately higher burden on dense neighborhoods. Since low-income neighborhoods are often located in very dense parts of the city, these residents could be subject to relatively high fees.

One way to ameliorate this problem would be to base drainage fees on the total square footage of a property's impervious surfaces. Since central-city properties and buildings tend to be more compact than suburban ones, this approach is more likely to result in lower fees per living unit for dense neighborhoods. The City may wish to explore other options, such as subsidies and rebates, to help ensure that low-income communities are not unfairly burdened by LID fees.

Endnotes

1 Conversation with Dr. W. Bowman Cutter (Assistant Professor, Department of Economics, Pomona College), 8/13/08.

2 ibid.

3 Shoup, Donald. "Graduated Density Zoning." *Zoning Practice*, January 2009, p. 2–7. Accessed on 1/20/09 from the University of California Los Angeles website, http://its.ucla.edu/shoup/GraduatedDensityZoning.pdf

4 Conversation with Dr. W. Bowman Cutter (Assistant Professor, Department of Economics, Pomona College), 8/13/08.

[11] Recommended Next Steps

This chapter recommends a number of steps that the City of Los Angeles can pursue to implement a more comprehensive low impact development (LID) and green infrastructure program. The recommendations are listed roughly in the order in which they should be accomplished. Additional background on these items can be found in Chapters 6□10.

Tree well near the intersection of Grand and 12th Streets in downtown Los Angeles.

Internal Review

1. Review low impact development strategy with the City's Green Team, Green Streets Committee and City Council committees.

Stakeholder Review

1. Determine which groups need to be involved with LID brainstorming, review and feedback: environmental groups, developers, architects, landscape architects, planners, civil engineers, community organizations, gardening industry, etc.

Analysis and Foundation Steps

1. Create a task force or implementation team for LID and green infrastructure.
2. Survey and analyze current policies, ordinances and standards to identify potential conflicts with LID and green infrastructure. Make recommendations for necessary changes. (See Chapters 7 & 10.) Engineering and building & safety standard plans, practices, and ordinances should be a top priority. Also check fire and flood ordinances and insurance maps for conflicts with LID.
3. Create a menu of best management practices (BMPs) appropriate for LID projects in Los Angeles. Place special focus on natural/biological BMPs.
4. Create design and engineering guidelines for LID best management practices. These standard plans will allow LID BMPs to be easily approved.
5. What can be done to make it easier to implement LID projects until we have sufficient cost-benefit information for our climate?
6. Examine questions regarding scope, applicability, and internal process & management. (See Chapters 9 & 10.)
7. Develop methodology for cost-benefit analysis to include capital costs AND a way to quantify nature's services.
8. Generate comprehensive cost-benefit estimates for implementing LID.

Testing & Evaluation

1. Identify potential LID and green infrastructure pilot projects to gather LID data for our area/climate.
2. Develop and implement pilot projects.
3. Collect and analyze data from pilot projects to help inform future LID efforts and to enhance our understanding of how LID can be implemented in dry climates.
4. Universities and nonprofit organizations may be good partners to help with identifying and designing projects, data collection and analysis.

Policy Development & Implementation

1. Develop a BMP manual for LID practices. Include list of drought-tolerant, native plants suitable for bioswales in our climate. It would be helpful to suggest: (1) BMPs for different climate/environmental conditions, and (2) BMPs that remove specific pollution constituents. (Northeast Trees is already working on a project that matches chemical constituents to appropriate BMPs.)
2. Create decision trees to help developers and the general public to understand what kinds of LID decisions need be made for each type of development. Decision trees should be made for new development, redevelopments and existing developments.
3. Integrate LID principles into the Conservation Element of the General Plan.
4. Integrate LID principles into a revised Landscape Ordinance, which the state requires every city to adopt by 2010. (See Chapter 7.)
5. Explore the feasibility of integrating LID into the Green Building Ordinance.
6. As the city's 35 community plans are updated, integrate LID principles into each plan. This will especially help to address land use issues as they relate to LID.
7. Create Green Streets design guidelines for incorporation into standard plans.
8. Review the need for a LID ordinance.
9. Develop a working group to draft a LID ordinance.

[12] Conclusion

Southern California was designed and built mostly in the 20th Century, and the prevailing idea at the time was to move water quickly and directly to the ocean. In the 21st Century, we have learned how to design our streets, sidewalks, and landscaping to soak up runoff through a more natural process, weaving the textures of nature into the fabric of the city. We have begun to capitalize on the valuable services that nature can offer us: capturing, cleaning, and storing stormwater.

Low impact development is an emerging and important international stormwater management trend. Nationwide research has proven that low impact development can be a cost effective solution to pressing problems pertaining to water quality and water supply, as well the other benefits noted in this paper, such as flood control, mitigation of climate change, and creation of more natural spaces. For instance, studies have shown that if runoff is directed over vegetated areas, or areas with other kinds of porous material, the process of soaking through the soil cleans up or treats the pollution naturally and recharges groundwater aquifers as well.

Urban runoff is the number one source of water pollution in Southern California. Research conducted in Los Angeles has found that the City can significantly increase its water supply, ameliorate climate change issues, and address of much of the pollution found in urban runoff by converting its paved areas from gray to green. Moreover, implementing low impact development will create new, local "green-collar" jobs through the development of a workforce trained to install and maintain green infrastructure features.

A curb cut that directs water from the street and sidewalk into a bioswale. 1100 S. Hope Street in downtown Los Angeles.

The LID principles become particularly crucial as climate change impacts to our environment produce changing weather patterns that are currently predicted to result in longer term drought conditions throughout California. Harvesting all available rainwater by the various methods shown in this paper is an important means of addressing this looming problem.

The City of Los Angeles is well underway toward implementing the principles of low impact development into its designs for streets, sidewalks and alleys, through its Green Streets and Green Alleys program. With over 6,500 miles of streets and 900 miles of alleys, much could be accomplished by incorporating LID principles into new construction and by phasing in LID conversions for existing infrastructure. However, these paved areas only account for a portion of the hardscape found in Los Angeles, and thus only a portion of the stormwater burden. Implementation of low impact development on a wider and more intensive scale throughout the city is worth consideration, both on public and private property.

Appendices

A large neighborhood development in Wilsonville, Oregon that
incorporates decentralized stormwater management features throughout.

Appendix I:

Additional LID Resources & Information

General Information About LID

The following websites are excellent sources of information about low impact development (LID) in general, and often serve as clearinghouses for LID knowledge, developments and issues. Some sites are focused on green infrastructure or stormwater best management practices (BMPs), which also apply to LID. Additionally, most the manuals and technical guides listed in the next section contain a wealth of low impact development information.

Low Impact Development Center— a non-profit organization dedicated to the advancement of Low Impact Development technology. Has a wealth of projects, research, publications and web links to pull from. http://www.lowimpactdevelopment.org/

U.S. Environmental Protection Agency

- *Low Impact Development (LID),* http://www.epa.gov/nps/lid/
- *Managing Wet Weather with Green Infrastructure*, http://cfpub.epa.gov/npdes/home.cfm?program_id=298
- "Green Infrastructure Municipal Handbook," http://cfpub.epa.gov/npdes/greeninfrastructure/munichandbook.cfm
- "Case Studies for Stormwater Management on Compacted, Contaminated Soils in Dense Urban Areas," April 2008. http://www.epa.gov/brownfields/publications/swcs0408.pdf
- "Reduce Runoff: Slow It Down, Spread It Out, Soak It In," online video. http://www.epa.gov/owow/nps/lid/video.html
- Green infrastructure photo gallery, by Abby Hall of the USEPA. http://picasaweb.google.com/buildgreeninfrastructure

The Conservation Fund, Green Infrastructure Program

- Green infrastructure website, http://www.greeninfrastructure.net/
- "Green Infrastructure: Smart Conservation for the 21st Century," by Mark A. Benedict and Edward T. McMahon, http://www.sprawlwatch.org/greeninfrastructure.pdf

Natural Resources Defense Council— "Stormwater Strategies: Community Responses to Runoff Pollution," Chapter 12, Low Impact Development. May 1999. http://www.nrdc.org/water/pollution/storm/chap12.asp

The Green Infrastructure Center— assists communities in developing strategies for protecting and conserving their ecological and cultural assets through environmentally-sensitive decisions planning. http://www.gicinc.org/

Center for Neighborhood Technology—website contains information on a number of green infrastructure projects. http://www.cnt.org/natural-resources/

Greenroofs.com— news portal that promotes green roofs. Has a significant green roofs project database. www.greenroofs.com

Manuals and Technical Guides

The following manuals and technical guides provide valuable information on how other cities approach low impact development and contain research on effective stormwater best management practices. Most of these publications also have introductory information about low impact development, green infrastructure and stormwater BMPs. Some also contain technical information on specific projects.

California

County of Los Angeles

- Green Building Program, http://planning.lacounty.gov/green
  - "Low Impact Development Standards Manual," January 2009. http://planning.lacounty.gov/assets/upl/project/green_la-county-lid-manual.pdf
  - "Green Building and Sustainability Guidelines for the County of Los Angeles," 2008 Edition. http://planning.lacounty.gov/assets/upl/project/green_20080507-rpc-attachment-6.pdf
  - "Drought-Tolerant Plant List," http://planning.lacounty.gov/assets/upl/project/green_drought-tolerant-plants.pdf

- Department of Public Works
  - "Development Planning for Storm Water Management: A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP)," September 2002 Revision. http://ladpw.org/wmd/NPDES/table_contents.cfm
  - *Methodology For Prioritizing Structural BMP Implementation*, overview webpage. http://ladpw.org/WMD/bmpmethod/overview.shtm
  - "Los Angeles County-Wide Structural BMP Prioritization Methodology: A Guidance Manual for Strategic Storm Water Quality Project Planning," 2006. http://ladpw.org/WMD/bmpmethod/manual.shtm
  - "Hydrology Manual," January 2006. http://dpw.lacounty.gov/wrd/publication/engineering/2006_Hydrology_Manual/2006%20Hydrology%20Manual-Divided.pdf

City of Santa Monica— "Santa Monica Residential Green Building Guide." http://greenbuildings.smgov.net/pdf/Residential_GB_Guidelines.pdf

TreePeople— "Rainwater as a Resource: A Report on Three Sites Demonstrating Sustainable Stormwater Management." Description, cost assessments, maintenance schedules and schematics for three projects in Los Angeles. http://www.treepeople.org/vfp.dll?OakTree~getPage~&PNPK=207

City of Emeryville— "Stormwater Guidelines for Green, Dense Redevelopment," December 2005. Department of Planning & Building. http://www.ci.emeryville.ca.us/planning/pdf/stormwater_guidelines.pdf

County of San Diego— "Low Impact Development Handbook: Stormwater Management Strategies," December 31, 2007. Department of Planning and Land Use. http://www.co.san-diego.ca.us/dplu/docs/LID-Handbook.pdf

Other States / National

U.S. Environmental Protection Agency— "Storm Water Technology Fact Sheet—Vegetated Swales," September 1999. http://www.epa.gov/npdes/pubs/vegswale.pdf

U.S. Department of Defense— "United Facilities Criteria (UFC): Low Impact Development," October 25, 2004. http://www.wbdg.org/ccb/DOD/UFC/ufc_3_210_10.pdf

Prince George's County (MD)— Department of Environmental Resources, Programs and Planning Division.

- "Low Impact Development Design Strategies: An Integrated Approach," June 1999. www.lowimpactdevelopment.org/pubs/LID_National_Manual.pdf
- "Low-Impact Development Hydrologic Analysis," July 1999. http://www.lowimpactdevelopment.org/pubs/LID_Hydrology_National_Manual.pdf

State of Maryland— *Maryland Stormwater Design Manual—Volumes I & II,* effective October 2000. Department of the Environment. http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/stormwater_design/index.asp

Puget Sound Area (WA)— "Low Impact Development: Technical Guidance Manual for Puget Sound," January 2005. Puget Sound Action Team, Washington State University Pierce County Extension. www.psp.wa.gov/downloads/LID/LID_manual2005.pdf

City of Portland (OR)— "City of Portland Stormwater Management Manual," Revision 4, July 1, 2008. Bureau of Environmental Services. http://www.portlandonline.com/bes/index.cfm?c=47952&

Fairfax County (VA)— "Fairfax County – LID BMP Fact Sheets" February 28, 2005. These fact sheets contain detailed information about the specific stormwater BMPs (purpose, costs, benefits, effectiveness, maintenance requirements, technical drawings, LEED credits, etc.). Includes bioretention systems, filtering technologies, permeable pavements, site design strategies, soil amendments, vegetative systems and water conservation measures. http://www.lowimpactdevelopment.org/fairfax.htm

City of Chicago (IL)—

- "The Chicago Green Alley Handbook." http://egov.cityofchicago.org/webportal/COCWebPortal/COC_EDITORIAL/GreenAlleyHandbook.pdf
- "A Guide to Stormwater Best Management Practices: Chicago's Water Agenda," 2003. http://egov.cityofchicago.org/webportal/COCWebPortal/COC_ATTACH/GuideToStormwaterBMPs.pdf

State of Idaho— Department of Environmental Quality

- "Stormwater: Catalog of Stormwater BMPs for Idaho Cities and Counties," September 2005. http://www.deq.state.id.us/water/data_reports/storm_water/catalog/
    - "Volume 3. Low Impact Development Techniques," http://www.deq.state.id.us/water/data_reports/storm_water/catalog/vol_3.pdf

Implementing LID in Los Angeles

The following resources investigate important issues pertaining to the implementation of low impact development specifically in Los Angeles.

Community Conservancy International— "The Green Solutions Project" report, March 2008. Assesses the benefits of using LID on public lands in Los Angeles. http://www.ccint.org/greensolution.html

USC Center for Sustainable Cities— http://college.usc.edu/geography/ESPE/

- "Transforming Alleys into Green Infrastructure for Los Angeles," June 2008. http://college.usc.edu/geography/ESPE/documents/alleyreport_final_reduced.pdf

Greenforall.com— "Job Implications in Los Angeles' Green Building Sector," by Signalle Rosner, May 2006. http://www.greenforall.org/resources/job-implications-in-los-angeles-green-building

Los Angeles & San Gabriel Rivers Watershed Council (LASGRWC)

- *L.A. Basin Water Augmentation Study.* The Groundwater Water Augmentation Model (GWAM) was developed by the U.S. Bureau of Reclamation and the LASGRWC for the Los Angeles Basin Water Augmentation Study. By performing a soil moisture accounting, the model provides an estimate of the amount of infiltration, runoff and deep percolation under current conditions and the potential for greater groundwater recharge if various capture strategies are implemented. http://www.lasgrwc.org/WAS.htm

City of Los Angeles—

- "Porous Pavement Report," May 21, 2008. "CF: 05-0752 Alternative Street Surfacing Materials." Interdepartmental correspondence, to: Energy and the Environment Committee, from: Department of Public Works and Environmental Affairs Department. http://www.lacity.org/ead/greenbuilding/eadgreenbuilding298555988_10022008.pdf
- *Elmer Avenue: A Model Stormwater Green Street.* Department of Public Works, Stormwater Program. http://www.sga-inc.net/BACKUP/LA_newsletter/Elmer_Avenue.html*Coming to a Neighborhood Near You - Disconnected Downspouts.* Department of Public Works, Stormwater Program. http://www.sga-inc.net/BACKUP/LA_newsletter/Coming_to_a_Neighborhood_Near_You.html

- "Los Angeles River Revitalization Master Plan," April 2007. Bureau of Engineering. http://www.lariverrmp.org/CommunityOutreach/masterplan_download.htm
- "RIO Fact Sheet: River Improvement Overlay District," July 2007. Department of City Planning. http://cityplanning.lacity.org/Code_Studies/Rioproject/factsheet.pdf
- "Integrated Resources Plan (IRP): A New Strategy for LA's Water Infrastructure—Information Sheet," January 26, 2006. Department of Public Works, Bureau of Sanitation. http://www.lacity.org/SAN/irp/documents/factsheet012006.pdf

County of Los Angeles—

- "Los Angeles County BMP Effectiveness Study," August 2005. Department of Public Works. http://dpw.lacounty.gov/wmd/NPDES/1994-05_report/Appendices/Appendix%20H-BMP%20Effectiveness.pdf
- "Watershed Management Techniques: Economic Valuation Model," February 28, 2005. Report prepared by the Natelson Company, Inc. for the Department of Public Works, Watershed Management Division. Presents a methodology for cost-benefit analysis.

California State Water Resources Control Board— "A Review Of Low Impact Development Policies: Removing Institutional Barriers to Adoption," December 2007. Prepared by the Low Impact Development Center. http://www.waterboards.ca.gov/water_issues/programs/low_impact_development/docs/ca_lid_policy_review.pdf

California Department of Water Resources— Office of Water Use and Efficiency Transfers.

- *Updated Model Water Efficient Landscape Ordinance AB 1881*, overview webpage. http://www.owue.water.ca.gov/landscape/ord/updatedOrd.cfm/
- "Modified Text of Proposed Regulation," California Code of Regulations, Title 23, Sections 490 - 495 regarding the Model Water Efficient Landscape Ordinance. November 26, 2008. http://www.owue.water.ca.gov/docs/Modified_Text_of_Proposed_Regulation.pdf

Evaluating the Effectiveness of LID

Reports and articles regarding the effectiveness of LID for controlling water flows and mitigating pollution levels. Some of these are case studies that included monitoring and evaluation.

County of Los Angeles— "Los Angeles County BMP Effectiveness Study," August 2005. Department of Public Works. http://dpw.lacounty.gov/wmd/NPDES/1994-05_report/Appendices/Appendix%20H-BMP%20Effectiveness.pdf

Los Angeles & San Gabriel Rivers Watershed Council (LASGRWC)— *L.A. Basin Water Augmentation Study.* The Groundwater Water Augmentation Model (GWAM) was developed by the U.S. Bureau of Reclamation and the LASGRWC for the Los Angeles Basin Water Augmentation Study. By performing a soil moisture accounting, the model provides an estimate of the amount of infiltration, runoff and deep percolation under current conditions and the potential for greater groundwater recharge if various capture strategies are implemented. http://www.lasgrwc.org/WAS.htm

U.S. Environmental Protection Agency— "Urban Stormwater BMP Performance Monitoring: A Guidance Manual for Meeting the National Stormwater BMP Database Requirements," April 25, 2002. http://www.epa.gov/guide/stormwater/files/montch1and2.pdf

City of Portland (OR)— "Flow Test Report: Siskiyou Curb Extension, August 4th 2004." Bureau of Environmental Services. http://www.portlandonline.com/shared/cfm/image.cfm?id=63097

Prince George's County (MD)— "Final Technical Report: Pilot Projects for LID Urban Retrofit Program in the Anacostia River Watershed, Phase III," December 30, 2006. Department of Environmental Resources. http://www.co.pg.md.us/Government/AgencyIndex/DER/ESG/pdf/Final%20Technical%20Report_Phase%20III.pdf

Costs of Implementing LID & Funding Strategies

The reports, articles and web pages listed below analyze the economic costs and benefits of LID projects and programs. They also contain strategies for funding LID efforts.

California

County of Los Angeles— "Watershed Management Techniques: Economic Valuation Model," February 28, 2005. Report prepared by the Natelson Company, Inc. for the Department of Public Works, Watershed Management Division. Presents a methodology for cost-benefit analysis.

UC Riverside, Department of Environmental Sciences—

- "Costs and Infiltration Benefits of the Watershed Augmentation Study Sites," by Autumn DeWoody, W. Bowman Cutter, David Crohn. April 17, 2006. Five non-residential land uses located in Los Angeles County were equipped with infiltration BMPs. Study estimated the groundwater recharge benefits relative to total costs. http://www.lasgrwc.org/WAS/Documents/UCR_LASGRWC_041806.pdf
- "Capturing Urban Stormwater Runoff: A Decentralized Market-Based Alternative," by Kenneth A. Baerenklau, W. Bowman Cutter, Autumn DeWoody, Ritu Sharma, and Joong Gwang Lee. *Policy Matters,* Volume 2, Issue 3. Fall 2008. Investigates the cost-effectiveness of implementing parcel-level BMPs in a Los Angeles area watershed using competitive bidding. http://policymatters.ucr.edu/pmatters-vol2-3-water.pdf
- "Costs and Benefits of Capturing Urban Runoff With Competitive Bidding for Decentralized Best Management Practices," by W. Bowman Cutter, Kenneth A. Baerenklau, Autumn DeWoody, Ritu Sharma, and Joong Gwang Lee. *WaterResources Research,* September 6, 2008. Investigates the cost effectiveness of implementing BMPs in a Los Angeles area watershed with two voluntary incentive mechanisms: competitive bidding and a fixed subsidy. http://www.agu.org/pubs/crossref/2008/2007WR006343.shtml

Kolozsvari, Douglas and Donald Shoup— (2003). *Turning Small Change Into Big Changes*. Article about parking increment financing. http://www.walkablestreets.com/meter.htm

Institute For Local Government— (2005) *Funding Open Space Acquisition Programs: A Guide for Local Agencies in California*, "Chapter 8: Creating Benefit Assessment Districts." http://www.cacities.org/resource_files/23925.ILG_OpenSpace_Ch8.pdf

City and County of San Francisco—*Press Room: Press Release.* "Mayor Newsom Unveils First-Ever City Carbon Offsets to Fight Global Warming," December 18, 2007. http://sfgov.org/site/mayor_index.asp?id=72509

Other States/National

U.S. Environmental Protection Agency

- *Fact Sheet: Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices*, December 2007. http://www.epa.gov/owow/nps/lid/costs07/factsheet.html
- "Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices," December 2007. EPA Document #EPA 841-F-07-006. http://www.epa.gov/owow/nps/lid/costs07/documents/reducingstormwatercosts.pdf
- "Managing Wet Weather with Green Infrastructure: Municipal Handbook - Funding Options." 2008. http://www.epa.gov/npdes/pubs/gi_munichandbook_funding.pdf

Keely, Melissa— "Using Individual Parcel Assessments to Improve Stormwater Management." Journal of the American Planning Association, Vol. 73, No. 2, Spring 2007.

The Trust For Public Land— *Benefit Assessment Districts.* How benefit assessment districts can be used for conservation finance. http://www.tpl.org/tier3_cd.cfm?content_item_id=1058&folder_id=825

ECONorthwest— "The Economics of Low Impact Development: A Literature Review," November 2007. http://www.econw.com/reports/ECONorthwest_Low-Impact-Development-Economics-Literature-Review.pdf

City of Seattle (WA)— *Drainage Rate Schedule*. Stormwater drainage fees for 2009. http://www.ci.seattle.wa.us/util/Services/Drainage_&_Sewer/Rates/DrainageRates/RateSchedule/index.htm

City of Minneapolis (MN)— *Stormwater Utility Fee: Frequently Asked Questions.* http://www.ci.minneapolis.mn.us/stormwater/fee/stormwater_faq.asp

City of Portland (OR)— *1% for Green* funding program. Portland Bureau of Environmental Sciences. http://www.portlandonline.com/bes/index.cfm?c=48702&

Colorado Carbon Fund— *Project C: We Have The Power.* Website for the State of Colorado's carbon offset sales program. http://www.coloradocarbonfund.org/

LID-Related Performance & Rating Systems

The following websites and article highlight rating systems that were created or are in development to help implement LID and green infrastructure practices in a systematic way.

U.S. Green Building Council— LEED (Leadership in Energy and Environmental Design) green building rating system. http://www.usgbc.org/DisplayPage.aspx?CategoryID=19

Sustainable Sites— a system proposed by landscape architects to certify the ecological design of outdoor spaces, separate from buildings. www.sustainablesites.org

City of Seattle (WA)— *Seattle Green Factor: What is the Seattle Green Factor?* Department of Planning & Development. http://seattle.gov/dpd/permits/greenfactor/Overview/

Keely, Melissa— "Using Individual Parcel Assessments to Improve Stormwater Management." Journal of the American Planning Association, Vol. 73, No. 2, Spring 2007. Article discusses the Green Area Ratio as a way to assess how "green" properties are.

Examples of LID Programs & Projects

Listed below are links to low impact development programs and projects happening in other cities. The earlier section on "Manuals and Technical Guides" and the items featured in Appendix II also contain references to programs in other cities.

Wise, Steve— "Green Infrastructure Rising: Best Practices in Stormwater Management." *Planning*, the magazine of the American Planning Association. August/September 2008. Pages 14-19. Article describes a wide variety of projects from around the United States.

County of Los Angeles— Green Building Program, Department of Regional Planning. http://planning.lacounty.gov/green

City of Santa Monica— Energy & Green Building Programs. http://greenbuildings.smgov.net/index.html

Village Homes (Davis, CA)— *About Village Homes.* http://www.villagehomesdavis.org/public/about

City of Portland (OR)—

- *A Sustainable Approach to Stormwater Management,* http://www.portlandonline.com/bes/index.cfm?c=34598
- "NE Siskiyou Green Street Project: Project Summary," April 2005. Bureau of Environmental Services. http://www.portlandonline.com/bes/index.cfm?a=78299&c=45386
- *Hyperlocalizing Hydrology in the Post-Industrial Urban Landscape*. February 18, 2008. An independent blog that features excellent photos of the NE Siskiyou Street project. http://pruned.blogspot.com/2008/02/hyperlocalizing-hydrology-in-post.html

City of Seattle (WA)— *Street Edge Alternatives (SEA Streets) Project.* Public Utilities Commission. http://www.seattle.gov/UTIL/About_SPU/Drainage_&_Sewer_System/Natural_Drainage_Systems/Street_Edge_Alternatives/index.asp

City of Chicago (IL)— Green Alleys program, Department of Transportation. http://egov.cityofchicago.org/city/webportal/portalContentItemAction.do?BV_SessionID=@@@@1030171822.1233726916@@@@&BV_EngineID=cccdadeggjimimjcefecelldffhdfhm.0&contentOID=536946345&contenTypeName=COC_EDITORIAL&topChannelName=Dept&blockName=Transportation%2FGreen+Alleys%2FI+Want+To&context=dept&channelId=0&programId=0&entityName=Transportation&deptMainCategoryOID=-536883915

City of Boston (MA)— *Low Impact Development Tool Kit.* Boston Metropolitan Area Planning Council. http://www.mapc.org/LID.html

City of Vancouver (Canada)—

- Green Streets Program, Department of Engineering Services. http://vancouver.ca/engsvcs/streets/greenstreets/index.htm
- Sustainable Streets and "Country Lanes" programs, Department of Engineering Services. http://vancouver.ca/ENGSVCS/streets/design/enviro.htm
- *Streets: Environmentally Sustainable Options.* Department of Engineering Services. http://vancouver.ca/ENGSVCS/streets/design/enviro.htm
- Green Streets and Adopt-A-Street Garden programs, http://vancouver.ca/engsvcs/streets/greenstreets/index.htm

Appendix II:

LID Ordinances and Programs from Other Municipalities

The following items have been included in this appendix:

1. County of Los Angeles: Low Impact Development Ordinance
2. City of Ventura: Green Streets Matrix

Additional resources on LID ordinances and programs can be found at these websites:

Clean Air Cool Planet— website that lists community programs around the county with Green Building Ordinances. http://www.cleanair-coolplanet.org/for_communities/green_building_ordinances.php

County of Los Angeles— "Ordinances for Green Building, Low Impact Development and Drought-Tolerant Landscaping," November 14, 2008. http://planning.lacounty.gov/assets/upl/data/ord_green-building-final-ordinances.pdf

City of Santa Monica— Energy & Green Building Programs. *New Green Building Ordinance.* http://greenbuildings.smgov.net/index.html

State of Maryland— *Maryland Stormwater Mangement Act of 2007.* Department of the Environment. http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/swm2007.asp

Vermont League of Cities & Towns—

- "Model Low Impact Development Stormwater Management Bylaw," May 2008. http://resources.vlct.org/u/o_LID-secured.pdf
- "Riparian Buffer Model Ordinance," http://resources.vlct.org/u/o_riparianbuffer-secured.pdf

County of Los Angeles: LID Ordinance

The County's Low Impact Development Ordinance was one of three "green" ordinances passed on October 7, 2008. The text of the other two ordinances (Drought Tolerant Landscaping Ordinance and Green Building Ordinance) can be found at http://planning.lacounty.gov/assets/upl/data/ord_green-building-final-ordinances.pdf.

COUNTY OF LOS ANGELES
OFFICE OF THE COUNTY COUNSEL
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November 14, 2008

Agenda No. 76
10/07/08

The Honorable Board of Supervisors
County of Los Angeles
383 Kenneth Hahn Hall of Administration
500 West Temple Street
Los Angeles, California 90012

Re: Ordinances for Green Building, Low Impact Development, and Drought-Tolerant Landscaping

Dear Supervisors:

Following your hearing on October 7, 2008, your Board instructed our office to prepare final ordinances, subject to the modifications approved by your Board, to establish development standards for green building, low impact development, and drought-tolerant landscaping for projects constructed after January 1, 2009. As instructed, enclosed are the analyses and ordinances for your consideration and adoption, with your Board's approved modifications.

Very truly yours,

RAYMOND G. FORTNER, JR.
County Counsel

By
LAWRENCE L. HAFETZ
Principal Deputy County Counsel
Property Division

APPROVED AND RELEASED:

for Leela Kapur
RAYMOND G. FORTNER, JR.
County Counsel

LLH:gl

Enclosures

HOA.565921.1

ANALYSIS

This ordinance amends Title 12 - Environmental Protection, Title 21 - Subdivisions, and Title 22 - Planning and Zoning of the Los Angeles County Code to establish low impact development standards for developments constructed after January 1, 2009. The low impact development standards are intended to distribute stormwater and urban runoff across development sites to help reduce adverse water quality impacts and help replenish groundwater supplies. The ordinance creates low impact development standards which are to be reflected in development site plans and in separate low impact development plans.

RAYMOND G. FORTNER, JR.
County Counsel

By L 1 Haf
LAWRENCE L. HAFETZ
Principal Deputy County Counsel
Property Division

LLH:sh
10/09/08 (requested)
11/12/08 (revised)

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ORDINANCE NO. ____________

An ordinance amending Title 12 - Environmental Protection, Title 21 - Subdivisions, and Title 22 - Planning and Zoning of the Los Angeles County Code to establish low impact development standards for developments constructed after January 1, 2009.

The Board of Supervisors of the County of Los Angeles ordains as follows:

SECTION 1. Chapter 12.84 is hereby added to Title 12 to read as follows:

CHAPTER 12.84

LOW IMPACT DEVELOPMENT STANDARDS

Sections:

12.84.410 Purpose.
12.84.420 Definitions.
12.84.430 Applicability.
12.84.440 Low Impact Development Standards.
12.84.450 Site Plan/LID Plan Review.
12.84.460 Additional Requirements.

12.84.410 Purpose.

The purpose of this chapter is:

A. To require the use of low impact development ("LID") standards in developments. LID encourages site sustainability and smart growth in a manner that respects and preserves the characteristics of the County's watersheds, drainage paths, water supplies, and natural resources. LID builds on conventional design strategies by utilizing every softscape and hardscape surface in a development to perform a beneficial hydrologic function by retaining, detaining, storing, changing the timing of, or

563934_2

filtering stormwater and urban runoff. LID encompasses the use of structural devices, engineered systems, vegetated natural designs, and education in order to distribute stormwater and urban runoff across a development site. LID reduces the impact from the development and provides the benefits of:

1. Replenishing groundwater supplies;
2. Improving the quality of surface water runoff;
3. Stabilizing natural stream characteristics;
4. Preserving natural site characteristics; and
5. Minimizing downstream impacts.

B. The provisions in this Chapter 12.84 shall be construed to augment any county, state, or federal ordinance, statute, regulation, or other requirement governing the same or related matter, and where a conflict exists between a provision in this Chapter 12.84 and such other ordinance, statute, regulation, or requirement, the stricter provision shall apply to the extent permitted by law.

12.84.420 Definitions.

The following definitions shall apply to this chapter:

A. "Beneficial Use" means the existing or potential use of receiving waters as designated by the Los Angeles or Lahontan Regional Water Quality Control Boards in their respective basin plans for the County.

B. "Best management practices (BMPs)" are the methods, measures, and/or practices designed and selected to reduce or eliminate the discharge of pollutants to surface waters from point and nonpoint source discharges, including stormwater.

C. "County" means the County of Los Angeles.

D. "Development" means activity requiring discretionary or non-discretionary land use or construction approval from the County that results in the creation, addition,

modification, or replacement of impervious surface area, which replacement is not part of routine maintenance activity. Development includes, but is not limited to, land subdivisions; the construction, installation, addition, or replacement of a building or structure; expansion of a building footprint; and land-disturbing activities related to structural or impervious surfaces. Development shall not include routine maintenance of original lines and grades and/or hydraulic capacity.

E. "Director" means the Director of Public Works.

F. "Drainage system" means a conveyance or system of conveyances, including paths, drives, roads, streets, alleys, catch basins, curbs, gutters, ditches, man-made channels, or storm drains designed or used to collect or convey urban runoff and stormwater.

G. "Excess Volume" means the additional volume of stormwater caused by development; excess volume is determined by calculating the difference in the volume of runoff under undeveloped and post-developed conditions, using the water quality design storm event.

H. "Hardscape" means any durable pervious or impervious surface material, including paving for pedestrians and vehicles.

I. "Hydromodification" means the alteration of a natural drainage system through a change in the system's flow characteristics.

J. "Low impact development ("LID")" means technologies and practices that are part of a sustainable stormwater management strategy that controls stormwater and urban runoff on site.

K. "Natural drainage system" means any unlined or unimproved (not engineered) creek, stream, river, or similar waterway.

L. "Pollutants of concern" means chemical, physical, or biological components of stormwater that impair the beneficial uses of receiving waters, including those defined in the federal Clean Water Act Section 502(6) (33 United States Code Section 1362(6)), and incorporated by reference into California Water Code Section 13373.

M. "Public Works" means the Los Angeles County Department of Public Works.

N. "Softscape" means the horticultural elements of a landscape, such as soil and plants.

O. "Stormwater" means runoff that occurs as the result of rainfall.

P. "Urban runoff" means dry weather surface flows emanating from urban development.

Q. "Water quality design storm event" means any of the volumetric or flow rate based design storm events for water quality BMPs identified in the National Pollutant Discharge Elimination System Municipal Stormwater Permit for the County of Los Angeles.

12.84.430 Applicability.

A. This chapter shall become effective on January 1, 2009, and shall apply to all development within the unincorporated areas of the County after that date except for the following:

1. Any development where a complete discretionary or non-discretionary permit application was filed with the Los Angeles County Department of Regional Planning, Public Works, or any County-controlled design control board, prior to January 1, 2009;

2. Any development involving emergency construction activities required to immediately protect public health and safety; or

3. Public road and flood control infrastructure developments, which shall be subject to Public Works' design standards that incorporate LID principles.

B. Unless excluded by subsection A above, any development that alters an existing impervious surface area shall comply with this Chapter 12.84 as follows:

1. Where the development results in an alteration of at least fifty (50) percent of the impervious surfaces of an existing developed site, the entire site shall be brought into compliance with the standards and requirements of this Chapter; and

2. Where the development results in an alteration of less than fifty (50) percent of the impervious surfaces of an existing developed site, only such incremental development shall meet the standards and requirements of this Chapter; and

3. Where a development results in an alteration of less than fifty (50) percent of the impervious surfaces of an existing developed site consisting of four (4) or fewer residential units, the development shall be exempt from this Chapter.

12.84.440 Low Impact Development Standards.

A. The LID standards of this Chapter are:

1. Mimic undeveloped stormwater and urban runoff rates and volumes in any storm event up to and including the "50-year capital design storm event," as defined by Public Works;

2. Prevent pollutants of concern from leaving the development site in stormwater as the result of storms, up to and including a water quality design storm event; and

3. Minimize hydromodification impacts to natural drainage systems.

B. The Director shall prepare, maintain, and update, as deemed necessary and appropriate, a manual ("LID Standards Manual"), which shall include urban and stormwater runoff quantity and quality control development principles and technologies for achieving the LID Standards described in subsection A of this Section. The LID Standards Manual shall also include technical feasibility and implementation parameters, as well as other rules, requirements and procedures as the Director deems necessary, for implementing the provisions of this Chapter 12.84.

C. To meet the standards described in subsection A of this Section, developments shall install and maintain minimum site design features as follows:

1. A development consisting of four (4) or fewer residential units shall implement at least two LID BMP alternatives listed in the LID Standards Manual, which alternatives include, but are not limited to, disconnecting impervious surfaces, using porous pavement, downspout routing, a dry well, landscaping and irrigation requirements, and a green roof.

2. A development consisting of five (5) or more residential units, or a nonresidential development, shall comply with the following requirements:

a. The excess volume from each lot upon which such development is occurring shall be infiltrated at the lot level, or in the alternative, the excess volume from the entire development site, including streets and public right-of-way, shall be infiltrated in sub-regional facilities. The tributary area of a sub-regional facility shall be limited to five (5) acres, but may be exceeded with approval of the

Director. When infiltration of all excess volume is not technically feasible, on-site storage, reuse, or other water conservation uses of the excess volume is required and shall be implemented as authorized by the Director in accordance with the requirements and provisions in the LID Standards Manual.

b. The runoff from the water quality design storm event associated with the developed site hydrology must be treated to the satisfaction of the Director before discharge.

12.84.450 Site Plan/LID Plan Review.

Compliance with the LID standards of this Chapter 12.84 shall be shown through a site plan review described in subsection A, below, and a LID plan review described in subsection B, below.

A. Site plan review.

1. The County Department of Regional Planning shall conduct a site plan review in accordance with Title 22 of the Los Angeles County Code to determine compliance with this Chapter 12.84. The site plan submitted for the development shall clearly depict any and all LID standards that will be incorporated into the development. Regional Planning shall approve compliance with these standards in concept only, subject to the setback and development standards in Title 22. Final approval of such compliance shall be made by Public Works in conjunction with its review and approval of the LID plan described in subsection B.

2. The same site plan shall be used to show compliance with this Chapter 12.84, the green building requirements of Part 20, Chapter 22.52, and the drought-tolerant landscaping requirements of Part 21, Chapter 22.52, to the extent these other requirements apply to the development.

3. In any case where a site plan for a development has been or will be concurrently filed with an application for a permit, variance, zone change, development agreement, or other discretionary approval under Title 22, or with an application for a subdivision under Title 21, the site plan procedure set forth in this Section 12.84.450 shall not apply and instead, the Exhibit "A," tentative map, or other site plan required for such other approval shall be used to show compliance with this Chapter 12.84.

B. LID plan review.

In addition to the site plan required by subsection A of this Section, the applicant shall also submit a LID plan to the Director for review and approval that provides a comprehensive, technical discussion of how the development will comply with this Chapter 12.84 and the LID Standards Manual. A deposit and fee to recover the costs associated with LID plan review shall be required. The time for obtaining LID plan approval shall be as follows:

1. For subdivisions, the LID plan shall be approved prior to the tentative map approval;

2. For any development requiring a conditional use permit ("CUP") or other entitlement required under Title 22 of the Los Angeles County Code, the LID plan shall be approved prior to the issuance of any such CUP or other entitlement; and

3. For all other development, the LID plan shall be approved prior to issuance of a grading permit for such development, and when no grading permit is required, prior to the issuance of a building permit for such development.

12.84.460 Additional Requirements.

Compliance with this Chapter 12.84 shall also require a development to satisfy the following:

A. All grading and/or site drainage plans for the development shall incorporate the features of the approved LID plan described in subsection B of Section 12.84.450.

B. The development's LID features shall be maintained and shall remain operable at all times and shall not be removed from the development unless and until such features have been replaced with other LID features in accordance with this Chapter 12.84. A covenant or agreement shall be recorded in the office of the Los Angeles County Registrar-Recorder/County Clerk indicating that the owner of the subject development is aware and agrees to the requirements in this subsection B. The covenant or agreement shall also include a diagram of the site indicating the location and type of each LID feature incorporated into the development. The time to record such covenant or agreement shall be as follows:

1. For any subdivision, prior to final map approval; and

2. For any other development, prior to issuance of a grading permit for the development, and when no grading permit is required, prior to the issuance of a building permit for the development.

SECTION 2. Section 21.24.420 of Title 21 of the Los Angeles County Code is hereby added to read as follows:

21.24.420 Low Impact Development.

All subdivisions shall comply with the low impact development requirements of Chapter 12.84 of Title 12 of the Los Angeles County Code, subject to the applicability provisions of said Chapter.

SECTION 3. Part 22 of Chapter 22.52 is hereby added to read as follows:

Part 22

LOW IMPACT DEVELOPMENT

22.52.2210 Applicability.

All development, as defined in Chapter 12.84 of Title 12 of the Los Angeles County Code, shall comply with the low impact development requirements of said Chapter, subject to the applicability provisions of said Chapter.

[LOWIMPACTDEVLHCC]

City of Ventura: Green Streets Matrix

GREEN STREETS MATRIX City of Ventura Department of Public Works, 2008

Level I	**Description**	**Example**	**Cost / Benefits**	**Challenges / Drawbacks**
Storm Inlet Trash Excluders	Trash excluders are screens that are installed inside catch basins or at curb inlets. They prevent trash from entering the storm drain system. Screen size opening is typically around 4 mm. Smaller debris / silt and contaminants such as heavy metals will still pass through the screens.		Low cost/low effectiveness (~$1,500 each)	On-going maintenance is required to clean trash from catch basins. Only prevents trash from entering tributaries (not chemicals, silt). On-going maintenance costs for cleaning catch basins will increase as more are installed.
Planting of medium to large canopy trees in parkways and medians	Plant new or preserve existing medium to large canopy trees in parkways and medians. Tree species should be compatible with adjacent curbs and sidewalks to minimize potential damage that may be caused by roots.		Low upfront cost /high effectiveness (~$400 for 24" box tree). Once mature, larger canopy trees are effective in reducing peak storm run-off rates by capturing rainfall in their canopy. They are also very attractive and can raise property values by $10,000 or more.	Medium to high maintenance cost to control and preserve the trees. Bulbouts or sidewalk realignments may need to be installed in narrower parkways (see *Parkway Tree Bulbouts*). Tree roots can be destructive to buried utilities, sidewalks, curbs and gutters. Residents may not care for the increased maintenance (leaf pickup). Overhead utilities can be problematic for ongoing pruning that can damage trees.
Utilization of recycled materials in new and resurfaced streets	Utilize rubberized asphalt (recycled tires), 15% recycled mix, in-place pulverized asphalt and aggregates in the construction of new streets or in street resurfacing projects		Cost competitive compared to using new materials. Relative costs are likely to decrease due to supply constraints and hauling costs for new materials.	Projects may take longer to construct depending on time-of-year and other factors. Tighter inspections (QA/QC) also required.

GREEN STREETS MATRIX **City of Ventura Department of Public Works, 2008**

Parkway Tree Bulbouts	Parkway bulbouts may be used to preserve shallow roots on large trees that may be damaging curbs and sidewalks. Bulbouts are a localized extension of the curb and gutter at parkways in the immediate vicinity of a tree. They may be used where new trees are planted so that shallow roots are less likely to cause expensive damage to curbs and gutters when they mature. Wider parkways generally make healthier trees.		Medium cost / relatively effective in preserving older trees. May provide the added benefit of traffic calming.	May be difficult to accomplish on flat streets where the bulbout may impede drainage flows along the gutter. Reduces on-street parking, which is problematic in medium to higher density residential developments. Could be difficult to install if underlying utilities are present.
Recycled rubber sidewalks	Rubberized sidewalks are best used at locations where sidewalks have or may continue to buckle from existing tree roots.		Medium to high lifetime cost. 3 times the cost of concrete @ $15 to $20/square foot to install plus reinstallation costs over time. Environmentally friendly by using recycled rubber from tires.	Rubber sidewalks may need to be reinstalled every 5-10 years as tree roots continue to grow and cause uneven surfaces in the sidewalk.

City of Ventura: Green Streets Matrix

GREEN STREETS MATRIX **City of Ventura Department of Public Works, 2008**

Level 2	Description	Example	Cost / Benefits	Challenges / Drawbacks
Permeable concrete sidewalks	Install permeable concrete for sidewalks in new or existing streets – particularly where sidewalks are in close proximity to new trees. As opposed to rubber sidewalks, permeable concrete is better suited at locations where new trees are planted and roots have not yet been established.		Provides storm water detention and treatment. Creates a "barrier" for storm run-off between impervious driveways and streets. Allows rainfall/irrigation to percolate into the ground to feed tree roots. Approximately twice the cost of conventional concrete, not including over excavation and aggregate subgrade.	More stringent QA/QC requirements to insure proper functioning. Surface of concrete is much rougher than traditional concrete and is not as attractive. More feasible if done only around trees to allow infiltration of storm and irrigation run-off to reach tree roots under tree drip lines.
Storm drain biotreatment curb inlets (i.e. Filterra)	Low flow biotreatment units typically come premanufactured and are installed upstream from storm curb inlets or catch basins. They typically remove chemicals, oils, and particulates from initial storm runoffs (which often contain the lions' share of contaminants).		Can be very effective in removing pollutants from storm run-off if sized right for the runoff area and adequately maintained. Cost to install is anywhere from $10,000 to $35,000 per unit. There is an on-going annual maintenance cost which is uncertain at this time.	Need an existing storm drain system to be in place. Larger units can only treat about 0.5 acres of impervious street. If there is only one curb inlet on a 5-acre street, the unit's effectiveness is substantially diminished. The units are better suited for relatively small watershed areas.
Stormwater detention and percolation curb inlets	– same as above without special media and no connection to storm drain system is made. Storm water percolates naturally into the ground.	Similar appearance to above without the tree	Can be very effective in removing pollutants from storm run-off if sized right for the runoff area and adequately maintained. Cost to install is anywhere from $10,000 to $35,000 per unit. There is an on-going annual maintenance cost, which is not known.	Similar to the biotreatment units. Does not require an existing underground storm drain system. The bottom of the unit is broken out and allows water to percolate into the ground.

City of Ventura: Green Streets Matrix

GREEN STREETS MATRIX **City of Ventura Department of Public Works, 2008**

Sidewalk "bridges" and realignments to preserve mature trees	Sidewalk bridges and realignments may also be used to preserve shallow roots on trees that may be damaging sidewalks. Bridges allow roots to continue to grow without causing the adjacent sidewalk to buckle.		Medium to high cost (estimated at $2,250 each / very effective. Low maintenance if proper materials and construction techniques are used.	Bridges may pose tripping, slipping and similar hazards unless careful attention is made in the design. Maintenance can be high if weather/rot resistant materials are not used. Realignments as depicted may require obtaining easements onto private property.

GREEN STREETS MATRIX **City of Ventura Department of Public Works, 2008**

Level 3	**Description**	**Example**	**Cost / Benefits**	**Challenges / Drawbacks**
Bioswales in existing developed neighborhoods	Install bioswales within the street right-of-way of existing developments. Bioswales are typically rock or grass-lined depressions that detain and treat storm water prior to flowing into a storm drain system.		Very high upfront and on-going maintenance cost. Provides storm water detention, percolation and treatment and improved street aesthetics. Can be very effective at treating storm run-off and reducing peak storm run-off rates. More cost effective if installed as part of new developments.	Will be difficult to maintain without an on-going funding commitment such as a Maintenance Assessment District. Eliminates on-street parking. The need to remove or relocate underground utilities will increase upfront costs significantly.
Permeable parking lane via asphalt, concrete, pavers or turfcrete	Install permeable material in the parking lane only for existing streets.		Very high upfront cost but lower life-cycle cost than the installation of a bioswale in an existing street. On-street parking would not be lost. Provides storm water detention and treatment but to a lesser extent than bioswales.	Upfront cost will be high if done along the entire stretch of a street (as opposed to pockets). Subgrade will likely need to be dugout 2-feet. Will require off-hauling large amounts of in-situ soil and importing large amounts of aggregate for underlying base. Will significantly increase truck/hauling traffic on local City Streets. Can't be done on streets with grades exceeding 5%. Vacuum cleaning may be required every several years to remove trapped particles.

City of Ventura: Green Streets Matrix

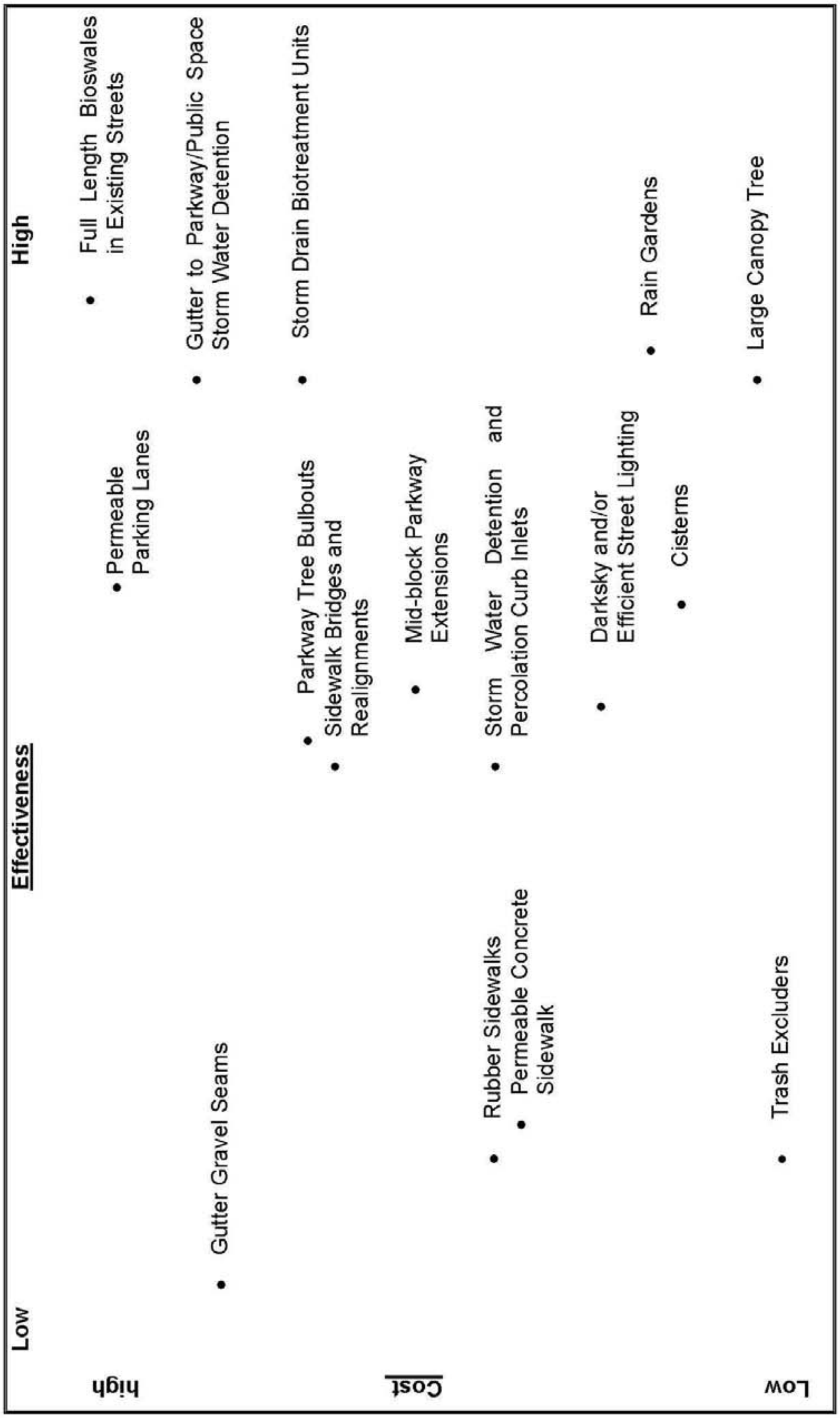
GREEN STREETS MATRIX **City of Ventura Department of Public Works, 2008**

Mid-block parkway extension for bioswales/stormwater detention	A mid-block and/or end-of-block parkway extension can provide detention for storm run-off, percolation and treatment. The design would consist of 50 to 100-foot long extensions in the parkway. The concept could be extended to intermittent locations along a stretch of road.		This is a less expensive alternative than running a bio-swale down the entire length of a street. Relatively small upfront costs and medium lifetime costs for on-going maintenance. Provides some detention and percolation, provides traffic calming and improved street aesthetics.	On-going maintenance costs can be an issue without a Maintenance Assessment District. Loss of parking in the street is also a concern, especially for the property owners that are directly impacted.
Cisterns/rainbarrels at individual private properties	Home owners would install cisterns that collect storm water from roof tops for later use as irrigation water. This is an inexpensive alternative to modifications within the street right-of-way for reducing peak storm run-off rates.		Low upfront and maintenance cost/high effectiveness (~$140 per barrel). Conserves drinking water used for irrigation purposes and reduces peak storm run-off rates.	Would need to set up an incentive/subsidy/ educational program to implement. Cisterns that prevent mosquito breeding are available. Program could be on a citywide or street resurfacing project basis. They cannot be funded with gas tax since they are on private property.
Rain gardens at individual private properties	Home owners would install rain gardens that consist of “depressed” areas on private property that collect rainwater from roof tops. This is an inexpensive alternative to modifications within the street right-of-way for reducing peak storm run-off rates.		Potentially low upfront cost/high effectiveness (cost can vary). Conserves drinking water used for irrigation purposes and reduces peak storm run-off rates.	Would need to set up an incentive/subsidy/ educational program to implement. Program would be on a citywide or street resurfacing project basis. Rain gardens require more maintenance than cisterns. They cannot be funded with gas tax since they are on private property.

GREEN STREETS MATRIX City of Ventura Department of Public Works, 2008

Gutter to parkway/public space stormwater detention	This design concept provides some detention, percolation and treatment without actually extending or widening the parkway into the street. Different from rain gardens in that runoff is diverted from street to a "rain garden".		Low to medium upfront cost but potentially high lifetime costs for on-going maintenance. Can provide good detention and percolation and improved street aesthetics if properly maintained.	On-going maintenance costs can be an issue without a Maintenance Assessment District.
Gravel Gutter Seams	Install a 12-inch to 24-inch wide band of gravel along curbs in streets to capture and percolate storm water.	PICTURE NOT AVAILABLE	Relatively high upfront cost and potentially high on-going maintenance cost.	Gravel would likely spill out and cause tripping / roadway hazards. Only recommended for rural and unpaved streets/roadways.
"Dark-sky" and/or energy efficient (LED) street lighting	Dark sky streetlights are designed so that lighting is directed downward onto the street surface and not into the sky. This allows stars to remain visible at night and eliminates wasted energy. LED-type light fixtures are a highly energy efficient type of "bulb" that may be combined with Dark Sky housing.		Medium to high upfront cost (~$5,000) including the pole. Existing poles can be retrofitted but spacing may not be adequate. Lifetime cycle costs are anticipated to be much less than traditional high pressure sodium or metal hallide lights. The costs for LEDs is expected to decrease substantially in coming years.	To obtain adequate spacing, new poles, conduit and wiring may be required which may significantly increase cost. Most lights in the City are owned and maintained by Edison, which will require interagency cooperation for replacement.

City of Ventura: Green Streets Matrix



Appendix III:

Research on the Costs of LID

EPA Fact Sheet: Reducing Costs Through LID

"Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices" This fact sheet provides additional information about EPA's report Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices, EPA publication number 841-F-07-006, December 2007. Available online at http://www.epa.gov/owow/nps/lid/costs07/documents/factsheet-reducingstormwatercosts.pdf

EPA Fact Sheet: Reducing Costs Through LID

Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices

This fact sheet provides additional information about EPA's report *Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices*, EPA publication number 841-F-07-006, December 2007.

BACKGROUND

Stormwater has been identified as a major source of pollution for all waterbody types in the United States, and the impacts of stormwater pollution are not static; they usually increase with land development and urbanization. The addition of impervious surfaces, soil compaction, and tree and vegetation removal result in alterations to the movement of water through the environment. As interception, evapotranspiration, and infiltration are reduced and precipitation is converted to overland flow, these modifications affect not only the characteristics of the developed site but also the watershed in which the development is located.

Parking lot runoff is allowed to infiltrate through a vegetated bioretention area

Low Impact Development (LID) is a stormwater management strategy that seeks to mitigate the impacts of increased runoff and stormwater pollution. LID comprises a set of site design approaches and small-scale stormwater management practices that promote the use of natural systems for infiltration, evapotranspiration, and reuse of rainwater. These practices can effectively remove nutrients, pathogens, and metals from stormwater, and they reduce the volume and intensity of stormwater flows.

COST ANALYSIS

This report is an effort to compare the projected or known costs of LID practices with those of conventional development approaches. Traditional approaches to stormwater management typically involve hard infrastructure, such as curbs, gutters, and piping. LID-based designs, in contrast, are designed to use natural drainage features or engineered swales and vegetated contours for runoff conveyance and treatment. In terms of costs, LID techniques can reduce the amount of materials needed for paving roads and driveways and for installing curbs and gutters. Other LID techniques can eliminate or reduce the need for curbs and gutters, thereby reducing infrastructure costs. Also, by infiltrating or evaporating runoff, LID techniques can reduce the size and cost of flood-control structures. Note that in some circumstances LID techniques might result in higher costs because of more expensive plant material, site preparation, soil amendments, underdrains and connections to municipal stormwater systems, as well as increased project management costs. Other considerations include land required to implement a management practice and differences in maintenance requirements. Finally, in some circumstances LID practices can offset the costs associated with regulatory requirements for stormwater control.

EPA Fact Sheet: Reducing Costs Through LID

FINDINGS

Table 1. Cost Comparisons Between Conventional and LID Approaches

Project[a]	Conventional Development Cost	LID Cost	Cost Difference[b]	Percent Difference[b]
2nd Avenue SEA Street	$868,803	$651,548	$217,255	25%
Auburn Hills	$2,360,385	$1,598,989	$761,396	32%
Bellingham City Hall	$27,600	$5,600	$22,000	80%
Bellingham Bloedel Donovan Park	$52,800	$12,800	$40,000	76%
Gap Creek	$4,620,600	$3,942,100	$678,500	15%
Garden Valley	$324,400	$260,700	$63,700	20%
Kensington Estates	$765,700	$1,502,900	–$737,200	-96%
Laurel Springs	$1,654,021	$1,149,552	$504,469	30%
Mill Creek[c]	$12,510	$9,099	$3,411	27%
Prairie Glen	$1,004,848	$599,536	$405,312	40%
Somerset	$2,456,843	$1,671,461	$785,382	32%
Tellabs Corporate Campus	$3,162,160	$2,700,650	$461,510	15%

[a] Some of the case study results do not lend themselves to display in the format of this table (Central Park Commercial Redesigns, Crown Street, Poplar Street Apartments, Prairie Crossing, Portland Downspout Disconnection, and Toronto Green Roofs). [b] Negative values denote increased cost for the LID design over conventional development costs. [c] Mill Creek costs are reported on a per-lot basis.

Seventeen case studies were evaluated for this report. In general, the case studies demonstrated that LID practices can reduce project costs and improve environmental performance. Although not all the benefits of the projects highlighted in the case studies were monetized, with a few exceptions, LID practices were shown to be both fiscally and environmentally beneficial to communities. In a few case studies, initial project costs were higher than those for conventional designs; in most cases, however, significant savings were realized due to reduced costs for site grading and preparation, stormwater infrastructure, site paving, and landscaping. Total capital cost savings ranged from 15 to 80 percent when LID methods were used, with a few exceptions in which LID project costs were higher than conventional stormwater management costs. (Table 1)

A rain garden manages runoff from impervious surfaces such as roofs and paved areas.

In all cases, LID provided other benefits that were not monetized and factored into the project bottom line. These benefits include improved aesthetics, expanded recreational opportunities, increased property values due to the desirability of the lots and their proximity to open space, increased total number of units developed, increased marketing potential, and faster sales. The case studies also provided other environmental benefits such as reduced runoff volumes and pollutant loadings to downstream waters, and reduced incidences of combined sewer overflows.

CONCLUSIONS

This report summarizes 17 case studies of developments that include LID practices and concludes that applying LID techniques can reduce project costs and improve environmental performance. In most cases, LID practices were shown to be both fiscally and environmentally beneficial communities. In a few cases, LID project costs were higher than those for conventional stormwater management projects. However, in the vast majority of cases, significant savings were realized due to reduced costs for site grading and preparation, stormwater infrastructure, site paving, and landscaping. Total capital cost savings ranged from 15 to 80 percent when LID methods were used, with a few exceptions in which LID project costs were higher than conventional stormwater management costs.

Green roofs capture rainfall, promote evapotransporation, and offer energy savings. This is a photo of a green roof on the EPA Region 8 building in Denver, CO.

EPA has identified several additional areas that will require further study. First, in all cases, there were benefits that this study did not monetize and did not factor into the project's bottom line. These benefits include improved aesthetics, expanded recreational opportunities, increased property values due to the desirability of the lots and their proximity to open space, increased total number of units developed, increased marketing potential, and faster sales. Second, more research is also needed to quantify the environmental benefits that can be achieved through the use of LID techniques and the costs that can be avoided. Examples of environmental benefits include reduced runoff volumes and pollutant loadings to downstream waters, and reduced incidences of combined sewer overflows. Finally, more research is needed to monetize the cost reductions that can be achieved through improved environmental performance, reductions in long-term operation and maintenance costs, and/or reductions in the life cycle costs of replacing or rehabilitating infrastructure.

AVAILABILITY

The full report is available for download at www.epa.gov/nps/lid.

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