1 Well Maintenance Program Implemented

10 Lessons Learned

County of Los Angeles
Department of Public Works
Waterworks Division
Well Maintenance & Efficiency Program
So, you don’t have a Well Maintenance Program?

Then *try one of these suggestions*?

- Don’t fix what ain’t broke…
  - or
  - Run what ya brung!
    - or maybe…
- If you have a good horse…Whip it!
Alluvial Aquifers and Groundwater

Confined Aquifer
- Often pressurized
- Separated by a confining layer of material with low hydraulic conductivity
- Water surface is a potentiometric surface – meaning the elevation to which the water rises in a well that taps a confined aquifer.

Unconfined Aquifer
- Water Table conditions
- Water surface is at atmospheric pressure
Well Construction - Breakdown

access tube for water level reading
gravel feed pipe
pump motor housing
conductor casing
gROUT seal
pump shaft
(blank) casing
pump bowl
gravel pack
well screen
sump
bottom plate
Lesson #1 of Well Maintenance

Develop a Complete Well Inventory

- Identify Well’s Purpose
  - Water Supply
  - Agriculture
  - ASR
  - Emergency / back-up

- Database & Records
  - Begin with “Drillers log”
  - Current Well Structure
  - Capacity vs. Demand
  - Water levels
  - Electrical Usage
    - Pump Efficiency
  - Maintenance Records
  - Case studies of work
Lesson #2 - You can’t do it alone!
It takes a cohesive network / team

- Regulatory
  - Compliance Samples
- Technical
  - Engineering, videos
- Analytical
  - Independent testing
- Well Contractors
  - Drilling and Repairs
- Field Staff
How Important are the Contractors and Field Staff?

• What are your contractors’ abilities/limitations?
  • Do their suggestions show research & thought?

• Will your partners “buy into” your Program?
  • Meet, explain, and develop common goals.

• Who is listening……who is talking?
  • Staff, contractors, Division engineers, and administration ALL need to listen to each other.
What’s Wrong with our Wells?
You Must Identify the Problems!

– Loss of capacity and efficiency
– Reduced water quality
– Breakdowns and/or Corrosion
– Complaints
– Bacterial presence

What are the rehabilitation processes?
– Mechanical, chemical, disinfection
OK…Problems are identified. What are some of the Causes?

- Bad Construction or a Poor Site
- Poor Well Development
- Fouling: Mineral, Biological, & Physical
- Idle Wells

Special Antelope Valley Concerns

Scaling and Corrosion

Two Aquifers with Blue Clay Formations

Idle Time is Trouble Time
Lesson #3 – Always Be Investigative

- Down-hole Video
  - Provides a snapshot of the well’s interior

- Down-hole Caliper Log
  - Provides the true diameter and plumbness

- Water Chemistry Reports
  - Profiles the water and provides recommendations

- Electricity Provider’s Efficiency Reports
  - Provides the potential efficiency and savings

- Create a Case Study Library
  - Documents all results for future reference
Lesson #4 - Get the Water Analysis!
It Solves the Mystery about the Water

• The “Casing Sample” – take a sample of the well’s water after being idle.
  – This represents constituents from the well casing.
  – This may also show effects of an “idle well”.

• The “Aquifer Sample” - take the sample after running the well.
  – This represents water from beyond the casing.
  – This is representative of your water quality.
Recommended Analysis

• Precipitation Potential (Saturation Index) – *Predicts corrosion & scale*

• TDS - Total Dissolved Solids – *Water may have a metals/mineral taste*

• Oxidation / Reduction Potential – *A solution’s ability to gain/lose electrons*
Well 4-55 – Scaling (precipitation) with nodule Wire-wrap screen at 532’ – 07/27/2010
Lesson #5 - Potential Mineral Deposits

• Calcite or Carbonate Formation
  \[ \text{pH} \geq 7.0 \quad \text{Alk} \geq 150 \text{ mg/l} \quad \text{Hd} \geq 180 \text{ mg/l} \]
  Good potential for carbonate deposit, neutralizes acid

• Oxides or hydroxides
  \[ \text{Iron} \geq 1.0 \text{ mg/l} \quad \text{Magnesium/calcium ratio} \geq 1:1 \]
  \[ \text{Manganese} \geq 0.1 \text{ mg/l} \quad \text{Hardness level} > 180 \text{ mg/l} \]
  If present, Fe & Mn oxidizing bacteria accumulation results.

• Sulfates
  \[ \text{pH} \geq 7.0 \quad \text{Alk} \geq 150 \text{ mg/l} \quad \text{Hd} \geq 100 \text{ mg/l} \quad \text{SO}_4 \geq 100 \text{ mg/l} \]
  Occurs with carbonate scales. Very difficult to remove. Requires careful attention to chemicals used.
Well 4-55 @ 533’ - Scaling (precipitation) removed - Wire-wrap screen – 09/20/10
Precipitation in cave = good

Precipitation in pipe = bad
Lesson #6 – WARNING SIGNS

- Langelier Saturation Index (LSI)
- *Formula used to predict the potential of formation of mineral deposits or corrosion.*

<table>
<thead>
<tr>
<th>Negative Values</th>
<th>Positive Values</th>
</tr>
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<tbody>
<tr>
<td>- 6</td>
<td>+ 6</td>
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**Increased Corrosion Potential**

**Increased Precipitation Potential**
Carbonate Scale from a Well
Lesson #7 - Precipitation Rehab

- **Pre-treatment Mechanical Agitation**
- **Chemical** *(MUST Mix in tank above ground NOT in well)*
  - HCl w/ Rodine (Hydrochloric Acid & Corrosion inhibitor)
  - NW 310 Bio-dispersant (penetrates the biomass)
  - Potable Water (Blending and Specific Weight change)
  - Use Tremie Pipe (Then Agitate using a Brush or Bailer)
- **Disinfection**
  - Sodium Hypochlorite *(12%)*
  - NW 410 chlorine enhancer
  - Potable Water *(for blending)*
- **Evacuation of Chemicals** *(Baker Tank & neutralize)*
Cable Tool Rig
Cable Tool Rig
Lesson #8 - Bacteria

• 80% of all well blockage

• Planktonic (free swimming) or sessile (attached to a surface)

• Bacterial formation entraps minerals and sediment

• Most Bacteria reproduce by dividing into like cells evolving to 1000 times their weight in slime
Plugged Gravel Pack and Screen

screen

gravel pack

formation interface

water flow

© 1997 Water Systems Engineering, Inc.
The Exponential Growth of Bacteria

In slightly more than 3 hours each bacteria has multiplied 1000X

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Common Bacteria Types

• Slime Formers
• Anaerobic Bacteria
• Iron Oxidizers
Corrosion Potential

What is happening to my investment?

- Prevention of Corrosion
  - Dissimilar metals should not be connected in wells (metals at the bottom of the Galvanic Series become anode and suffer corrosion. The ones at the top are cathode and free).
  - High temps increase corrosion.
  - Higher fluid velocities increase corrosion.
  - Stressed metals corrode faster.
Corrosion is material deterioration due to environmental interaction.
Column Piping

Iron Oxide Scraping
Lesson #9 - Cavitation

- Occurs when the pressure on the liquid falls below the liquid's vapor pressure. If this continues, the liquid starts to vaporize forming vapor pockets. These vapor pockets move with the flow until they reach an area of higher pressure then collapse violently causing pitting.
Lesson #10 - For a Successful Program
Stay Focused on the Goal

• Regular field inspection
• Routine pump tests and maintenance
• Regular water testing
• Bi-Annual efficiency testing

Goal: Identify problems early
       Identify type of problem
       Identify cause of problem
       Identify treatment choice
       Compare Results