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!

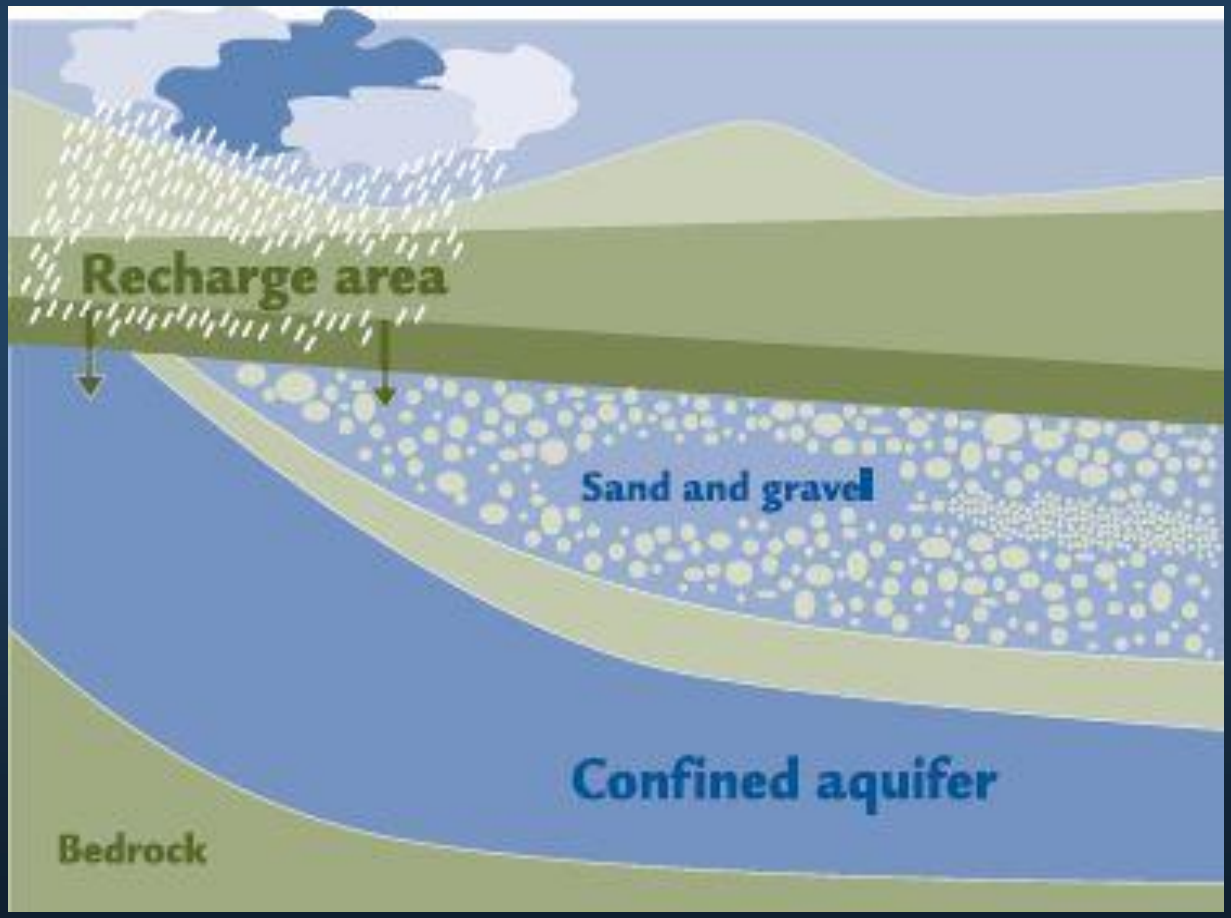
Alluvial Aquifers and Groundwater

Confined Aquifer

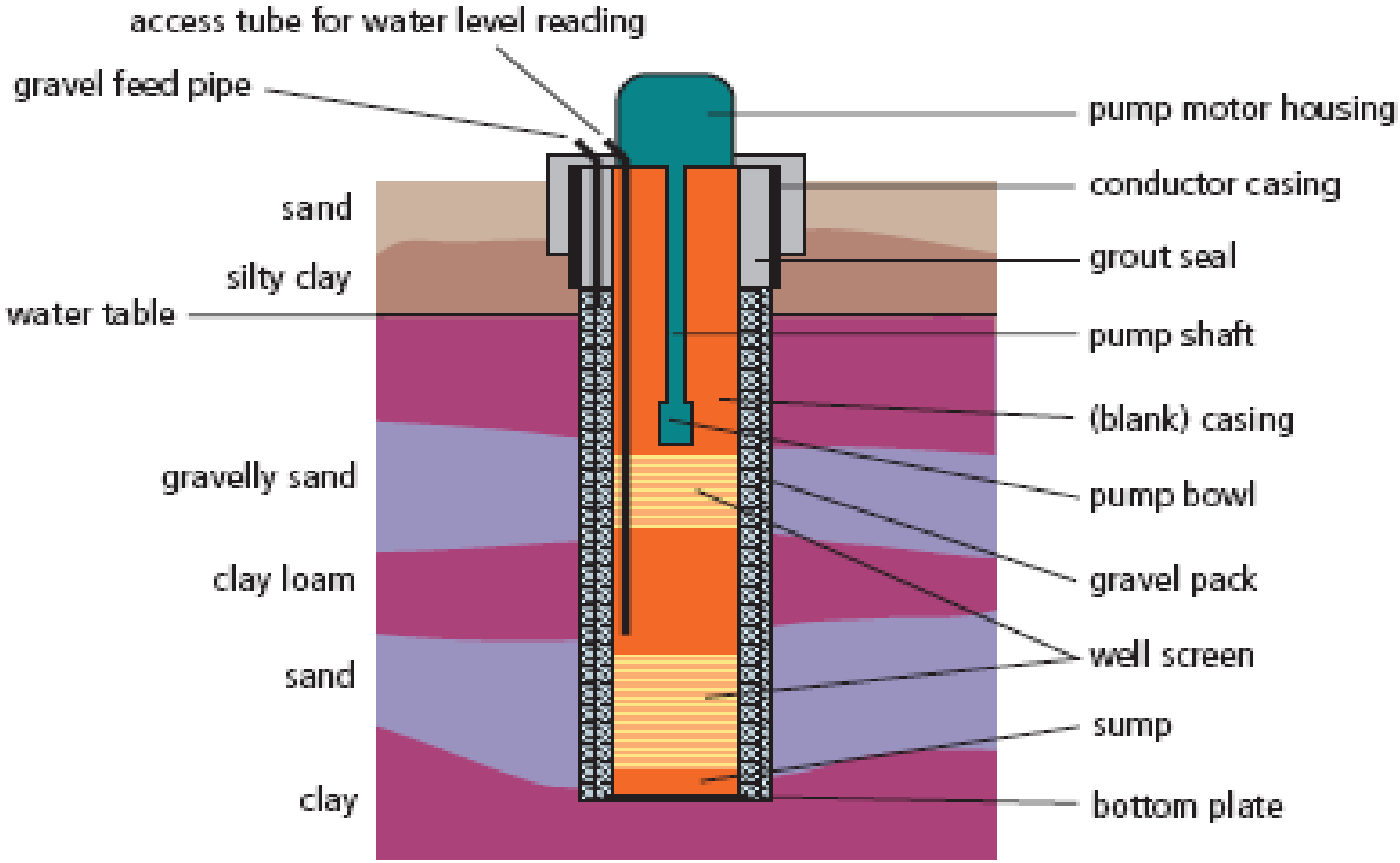
- Often pressurized
- Separated by a confining layer of material with low hydraulic conductivity
- Water surface is a potentiometric surface – meaning the elevation to which the water rises in a well that taps a confined aquifer .

Unconfined Aquifer

- Water Table conditions
- Water surface is at atmospheric pressure



Well Construction - Breakdown



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

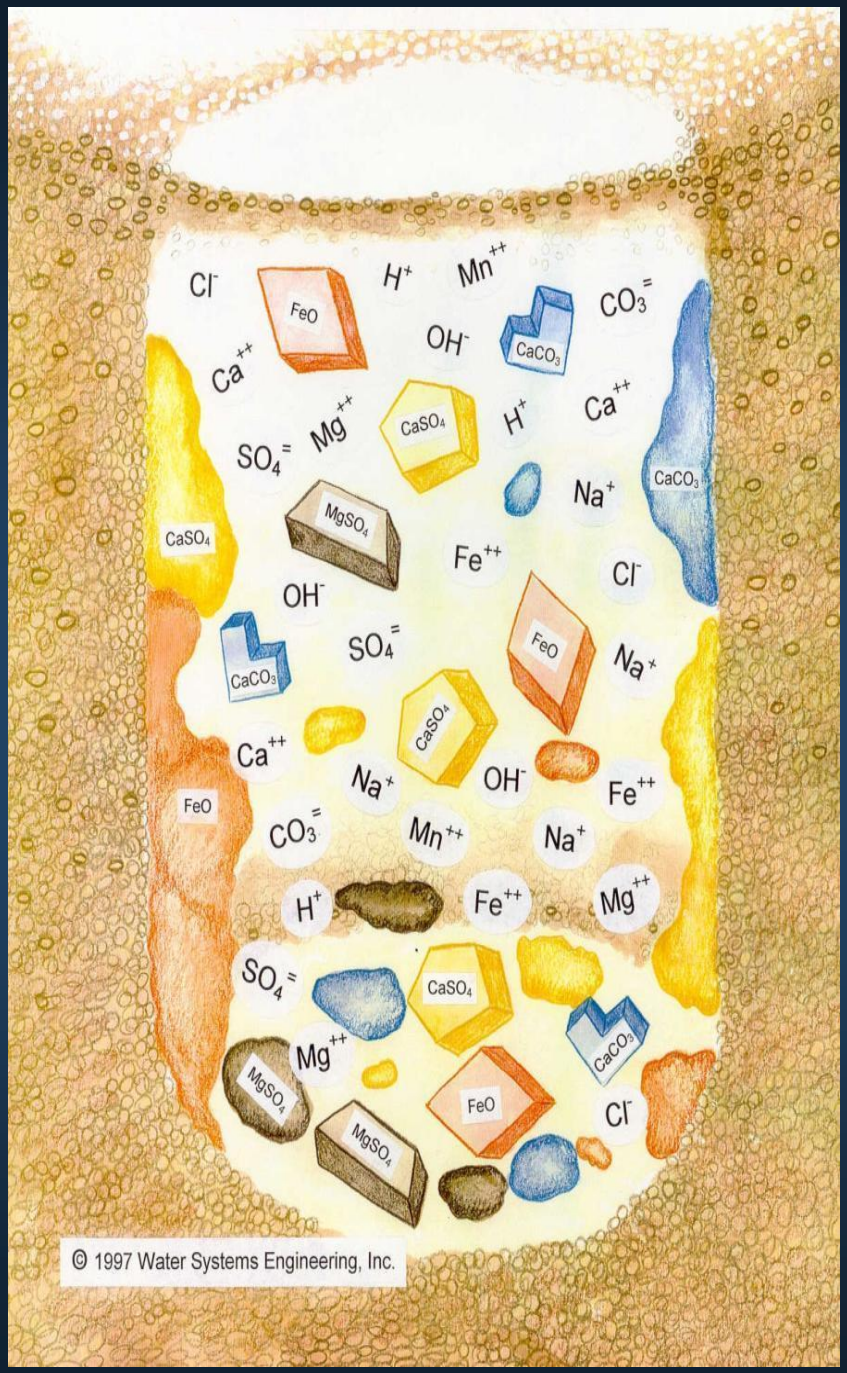
- Down-hole Video
  - Provides a snapshot of the well's interior
- Down-hole Caliper Log
  - Provides the true diameter and plumbness
- Water Chemistry Reports
  - Profiles the water and provides recommendations
- Electricity Provider's Efficiency Reports
  - Provides the potential efficiency and savings
- 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

pH ≥ 7.0 Alk ≥ 150 mg/l Hd ≥ 180 mg/l

Good potential for carbonate deposit, neutralizes acid

- Oxides or hydroxides

Iron ≥ 1.0 mg/l Magnesium/calcium ratio ≥ 1:1

Manganese ≥ 0.1 mg/l Hardness level > 180 mg/l

If present, Fe & Mn oxidizing bacteria accumulation results.

- Sulfates

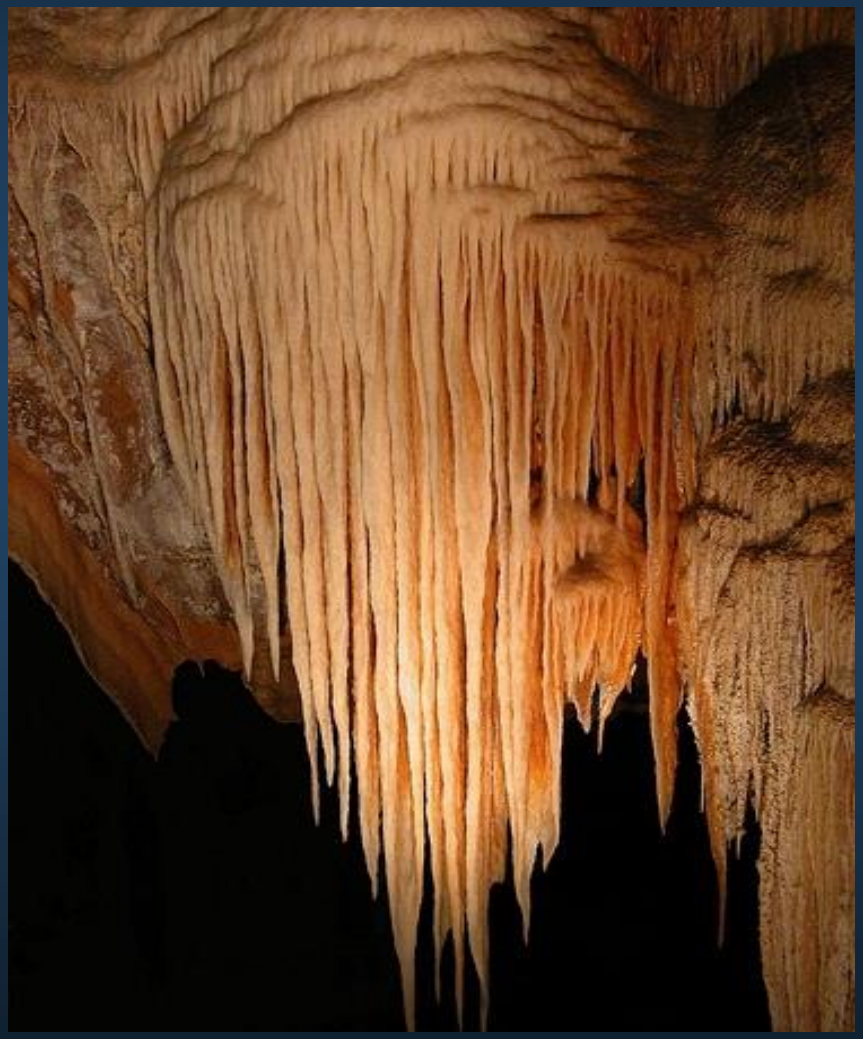
pH ≥ 7.0 Alk ≥ 150 mg/l Hd ≥ 100 mg/l SO_4 ≥ 100 mg/l

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

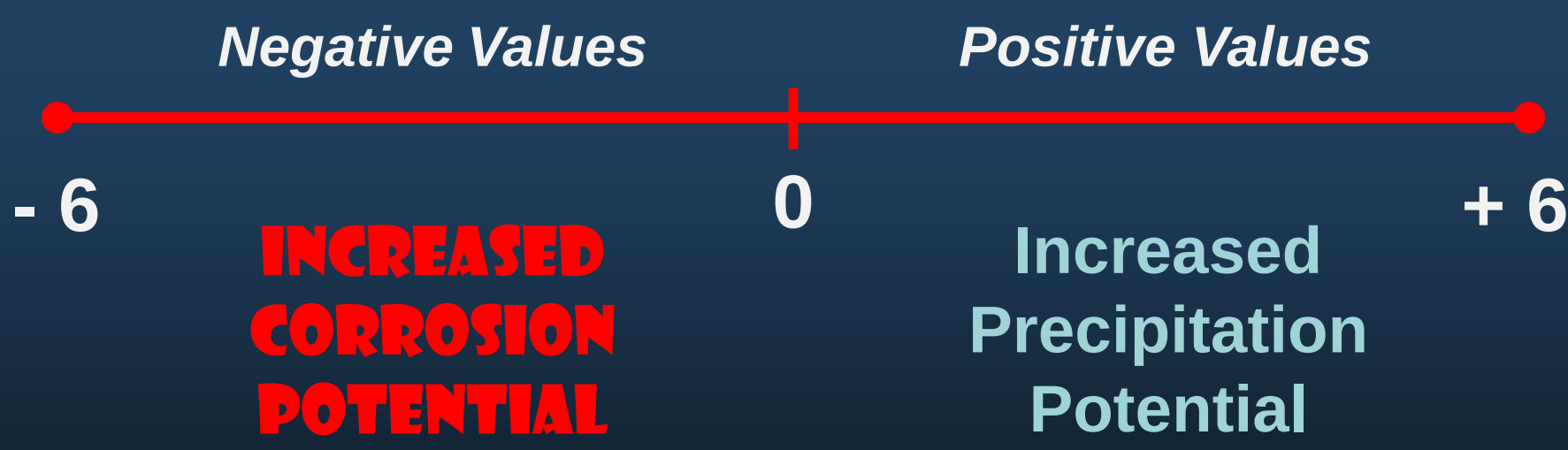
Precipitation in cave = good



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.*



Carbonate Scale from a Well

Lesson #7 - Precipitation Rehab

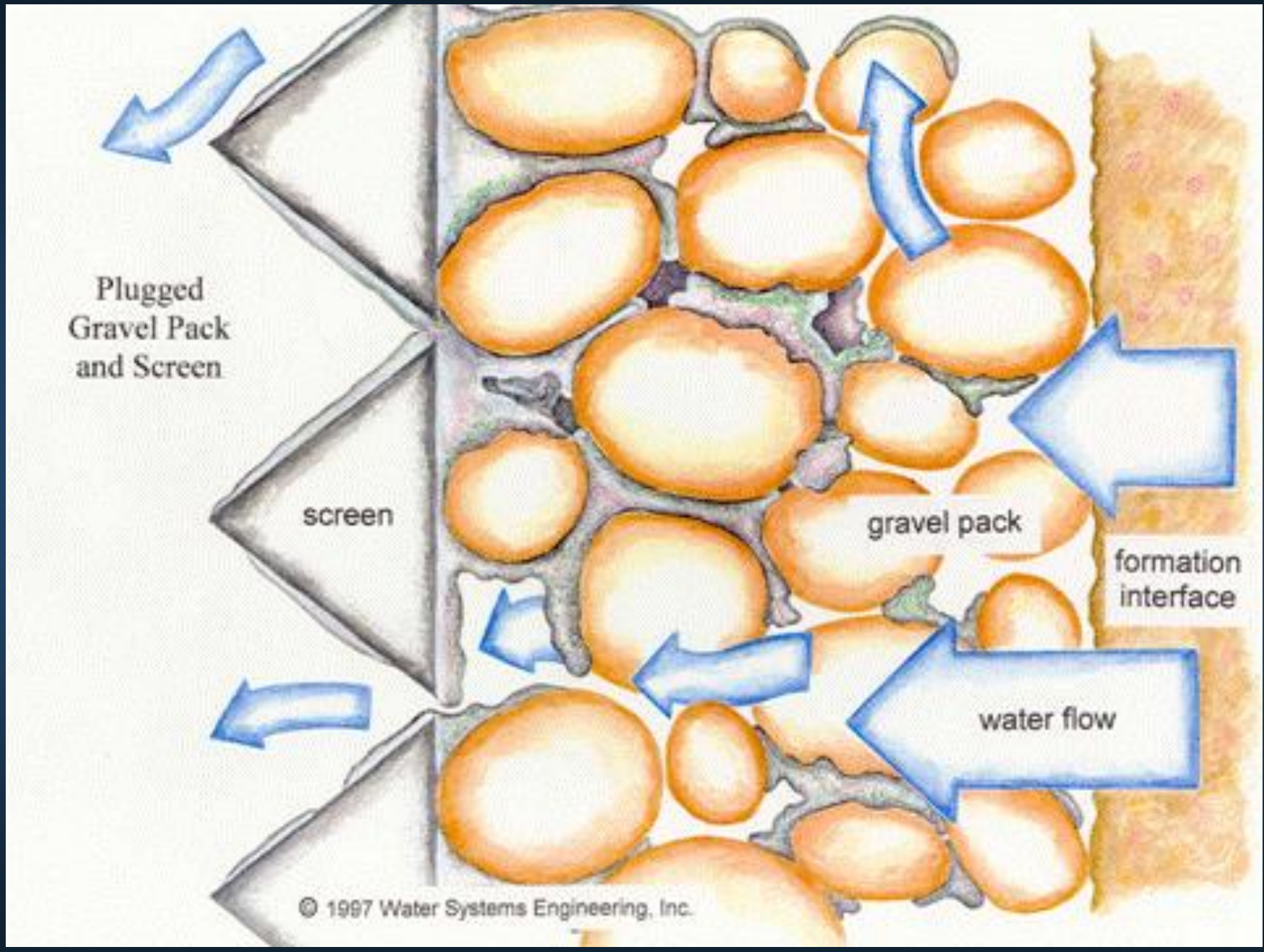
- Pre-treatment Mechanical Agitation
- Chemical (MUST Mix in tank above ground NOT in well)
  - HCl w/ Rodine (Hydrochloric Acid & Corrosion inhibitor)
  - NW 310 Bio-dispersant (penetrates the biomass)
  - Potable Water (Blending and Specific Weight change)
  - Use Tremie Pipe (Then Agitate using a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

Cable Tool Rig

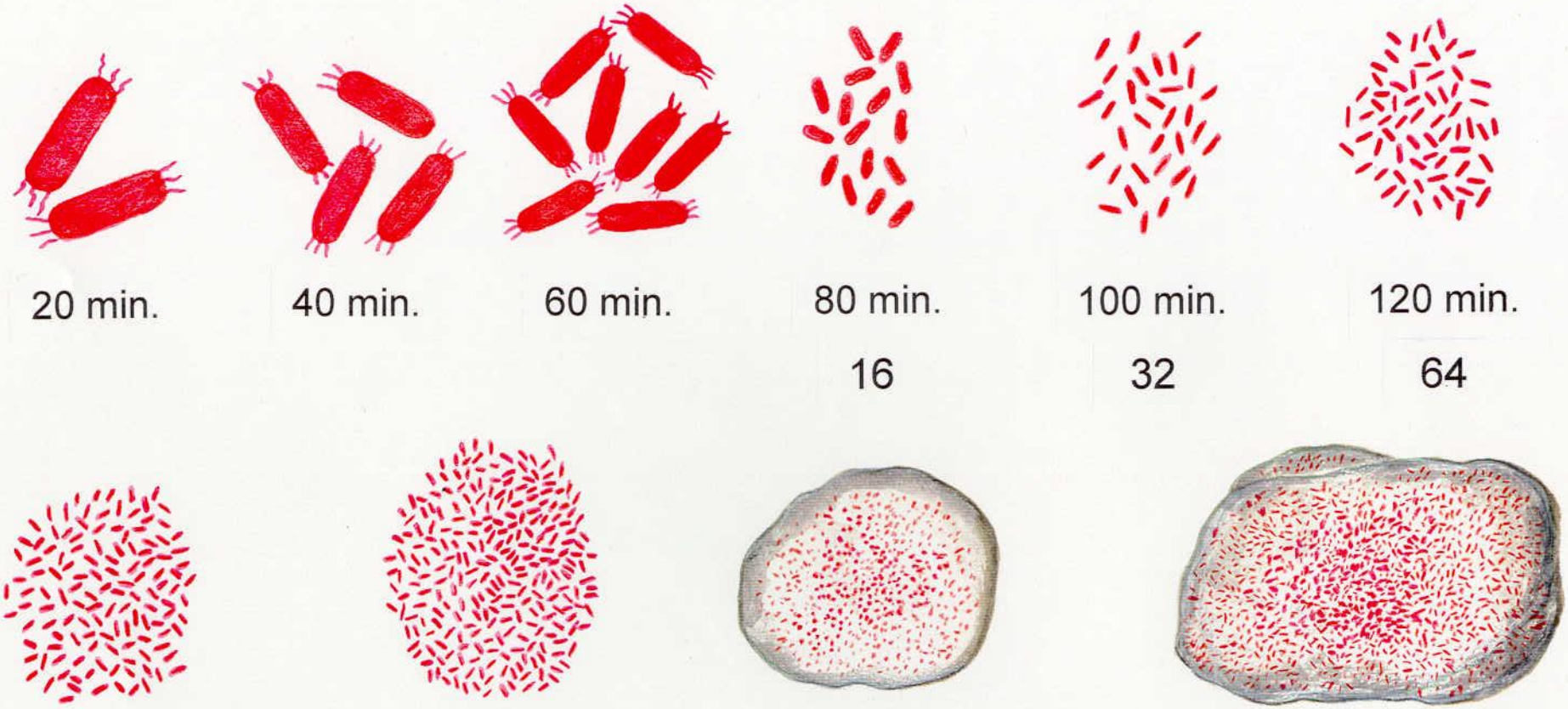
Cable Tool Rig

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.

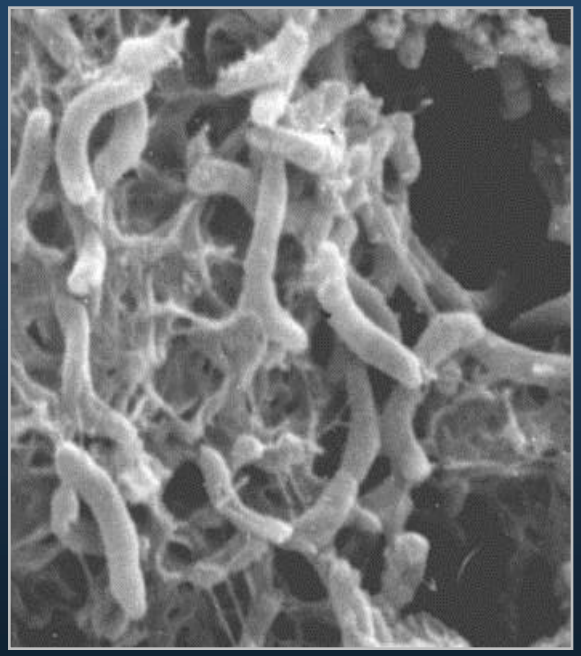
The Exponential Growth of Bacteria

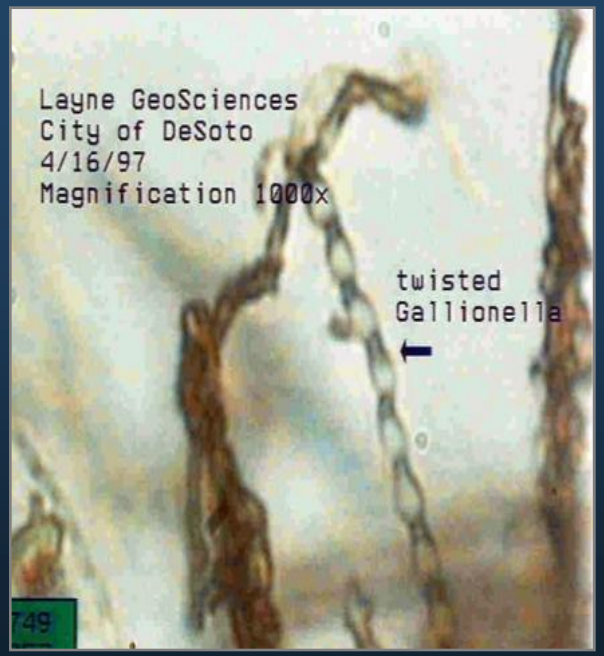


In slightly more than 3 hours
each bacteria has multiplied 1000X

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