## Water Supply Well Condition Assessments

**Real-World Applications and Results** 



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PNWS-AWWA Annual Conference May 3-5, 2023





## Introduction

- Purpose: Describe an Approach to Assessing Well Conditions and Look at Case Studies with Different
  - Outcomes
- Outline:
  - Where are we
  - Types of wells
  - Methodology
  - Case studies
  - Take homes





# Project Locations



#### The Wells

- 7 recent/ongoing well projects
- 6 are CRBG wells
- 6 are > 30 yrs
- 3 are open basalt completions
- 3 have long-term WL declines



2 not purpose-built for municipal supply





## Methodology: Background

- Records Review:
  - Pumping
  - Water level
  - Chemistry
  - Well logs
  - Rebuild logs
  - What's been done; History

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## Methodology: Background

- Wellhead Visit
  - Physical layout
  - Can we do what we want to do?
  - How are we going to do it

5



## Methodology: Biogeochemical Profile

- Water Systems Engineering, Inc.
- WQ Sampling: Pump-on (in-well), 1 hr (aquifer)
- Biology:
  - Aerobic, anaerobic, genus/species
  - Activity
- Geochemistry:
  - Mechanical
  - Natural





## Methodology: Biogeochemical Profile

- Geochemistry:
  - ORP/LSI/Hardness
  - Iron
  - TOC/Silica
- Biology:
  - Heterotrophic plate count
  - ATP (initial/growth)
  - Anerobic/aerobic (sulfate reducing/iron oxidizing species)
  - E-coli/coliform/protozoa
- Interpretation:
  - Surface/in-well/aquifer
  - Food source(s)
  - Rehab/disinfection options





## Methodology: Physical Assessment

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- Specific Capacity; current vs past
- Pull pump; column/pump conditions
- Video; What's there and where is it





## Methodology: Analysis

- Goal: Simple cleanout, aggressive rehab/rebuild, or replace?
- Can well be rehabbed?
- Cleaning:
  - Chlorine or Acid
  - Swab/Brush
  - Pulse/Energy
- Reconstruction; if needed is it feasible?
- WQ improvement potential
- Risk/cost/benefit rehab vs replace decision







### Case studies; Recent/Ongoing projects

- Grouped wells based on outcome
  - WW-7, WR-10
  - WW-5, Lind 7
  - WR-2, WR-3, MF-9

#### For each examine

- Current conditions
- Construction history
- Evaluation Findings
- Outcomes and why



- 50 y.o., unused for 30 years
- History of warm water with H2S
- Power surcharge to start motor, so not exercised
- Building demolition required to pull pump
- PP&L Requested system test late 2022



- The motor ran, and water was pumped (2,700 gpm)
- Biological profile showed low activity
- H2S was not noted
- Water cleared in 5 minutes
- Specific capacity had not declined



 Take-Away: Even though this well seemed like problems were likely, it remains in good operational condition

(casing not inspected)



- CRBG Well:
  - Drilled 2006, replaced failed well (2005)
  - 452 ft deep, screened 402-430 ft bgs
  - >1,000 gpm
- History/Issue

Northwest

Groundwater

Services, LLC

- Failed well was grouted
- Quickly start on 10
- Soon developed WQ problems
- Left in stand-by mode 15 yrs
- In 2020, will ASR bubble push bad water away?



- Findings: (1) Water quality had improved, (2) Screens clean, (3) Well productive, (4) Brush and disinfection only
- Outcome: (1) ASR is feasible, (2) City still needs to meet peak demand





- Emergency use only
- Aging infrastructure
- Suitable for ASR?
- Condition Assessment:
  - Collected Samples
  - Measured SC
  - Pulled Pump
  - Video Inspection









- Well moderately active
- Significant MIC (corrosion)
- Casing required cleaning prior to condition evaluation
- Cleaning process caused casing failure
- Well was re-built with new casing and seal
- Water was clean post-disinfection
- Well is now suitable for ASR





#### Case Studies: Lind 7

- CRBG Well:
  - Drilled 1980
  - 1020 ft deep, open below 515 ft bgs
- History/Issue
  - 750 gpm loss
  - 135 ft static drop
  - WQ degradation



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## Case Studies: Lind 7

	Casing	Aquifer
Plate Ct (colonies/ml)	>1,500	>1,500
Anerobic growth (%)	<10	<10
Sulfate reducing bac	Neg	Neg
Fe/Mn oxidizing bac	Neg	Neg
E. Coli	Neg	Neg
Bac ID	Acintobacter venetianus Bacillus cereus; B. thuringiensis	
Microbe	Protozoa	

- Findings: oil feed, surface biology
- Outcome: keep it running, sample supply system, plan for new well in a few years





#### Alluvial/CRBG Well:

- Drilled 1962: 250 ft bgs; perfed 100-125 ft bgs in alluvial aquifer; open in basalt (>177 ft bgs)
- Rebuild 2005: liner, screen, and perfs
- 1,000 gpm
- History/Issue
  - Pre-Rebuild; sanding
  - Post-Rebuild; sanding, nitrate-N
  - 1,000 gpm to <250 gpm





- Basalt Well
  - Shallow well in developed area, WQ
  - Water Rights allow deeper completion
  - Downsizing to case, seal, advance = too small
- Outcome Decomm/Replace







- Basalt well with interbeds
  - Drilled 1981: 585 ft deep; perfed 276-316 ft bgs; open 399 to BOH (irrigation)
  - Rebuild 2001: screen and filter pack installed 238-574 ft bgs; perfed 269-394 ft bgs
- History/Issue
  - Pre-Rebuild; sanding, lower borehole collapse
  - Post-Rebuild; sanding, WA degraded
  - 2,500 gpm to <500 gpm





- Findings: corroded, debris, last rebuild, options limited
- Outcome: decomm/replace





egend: 1 – well location; 2 – drill rig; 3 – pipe rack; 4 – compressor(s); 5 – circ tank/frac tank (as needed); 6 – cuttings and water collection pit; 7 access; 8 – Conveyance line onto land application area for discharge water.

and water collection pit; 7 GEOENGINEERS

GURE: Approximate drilling site and equipment layout. Actual locations and equipment determined by selected drilling contractor in onsultation with City.

#### Case Studies: MF 9

- Basalt well
  - Drilled 1951: 915 ft deep; cased to 294 ft; seal (?); open to BOH (industrial)
  - Rebuild 1999: 12-inch blank liner to 460 ft; sealed (294 ft); 10-inch slotted liner to 690 ft; 12- to 10-inch bell reducer (solid pipe)
- History/Issue
  - Pre-Rebuild: 1500 gpm; 90 ft DD;
    Static 205 ft; some borehole collapse
  - Post-Rebuild: gradual prod and WL decline
  - Currently: <450 gpm, H<sub>2</sub>S odor





#### Case Studies: MF 9

- Findings
  - ORP positive; LSI positive (high CaCO<sub>3</sub> ppt); highly active with Fe-Mg oxidizing bacteria
  - Liner broken and offset
  - Slots extremely overgrown
  - Lower borehole filled with debris and not plumb
- Outcome
  - Can't fix (broken/displaced liner) or clean (slots)
  - Replace well at better location in City





### Take Homes

- Decide: maintain or run-to-failure?
- Problems are manageable if diagnosed correctly and addressed early
- Multiple rebuilds may be a Red Flag
- Original construction:
  - Avoid Slots
  - Telescope
  - Don't screen/perf shallow: prevent cascading water
- M&O:
  - Measure dynamic and static WL annually
  - Periodic SC measurement to track changes
  - Sample and/or physical inspection if SC drops or WQ changes occur

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Like a 20 y.o. car, sometimes you just have to call it a day.

#### Thank You for Your Time

- Kevin Lindsey, Principal Hydrogeologist, GeoEngineers, 509-209-2848
- Phil Brown, Principal Hydrogeologist/Owner, Northwest Groundwater Services, 503-313-5195



