The Los Alamos National Laboratory WATER campaigns | Los Alamos National Laboratory |

Drilling and Installation of Deep Groundwater Monitoring Wells: Los Alamos National Laboratory, New Mexico

Mark Everett
2017 NGWA Groundwater Summit

December 4, 2017

LA-UR-17-23451

The Los Alamos National Laboratory WATER campaigns | Los Alamos National Laboratory |

Goals

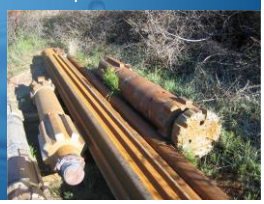
- Drilling Program at Los Alamos National Laboratory (LANL)
  - Collect representative groundwater samples to meet project area monitoring objectives
  - Hydrogeologic characterization

Representative
- Qualitative measure
- At LANL
  - Stable field parameters
  - High DO
  - Low [Fe] and [Mn]
  - Low TOC

The Los Alamos National Laboratory WATER campaigns | Los Alamos National Laboratory |

Setting

- Unique Challenges
  - Complex Geology
  - Perched groundwater occurrences
  - Depth and associated well development limitations



The Los Alamos National Laboratory WATER campaigns | Los Alamos National Laboratory |

The western Española basin: An active rift margin

The Los Alamos National Laboratory WATER campaigns | Los Alamos National Laboratory |

The LANL site

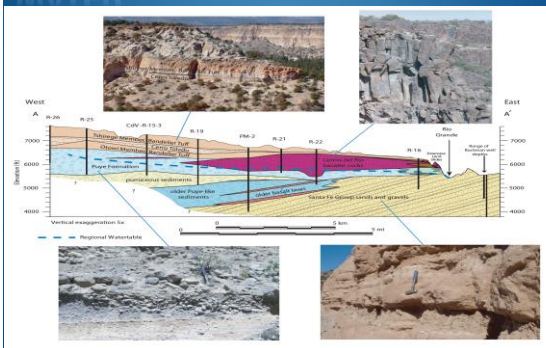
Dacitic domes and lavas that extend beneath the plateau

The LANL site is located on the Pajarito Plateau, with a typical landscape of finger-like mesas separated by narrow, deep canyons

Canyons provide drainage and can be recharge areas

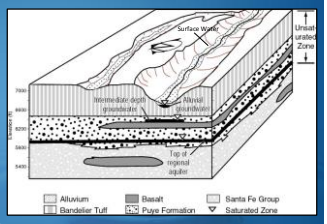
The Los Alamos National Laboratory WATER campaigns | Los Alamos National Laboratory |

Complex Stratigraphy



Groundwater Occurrences

- Alluvial gw occurs generally ~20-40 ft below ground surface. Recharged by snowmelt, stormwater, and effluent
- Perched-intermediate groundwater known to occur predominantly beneath wet canyons generally 150 – 800 ft bgs
- Deep or regional groundwater generally occurs from 700-1300 ft bgs
- Monitor well flow rates in regional aquifer typically below 10 gpm



Drilling Approach

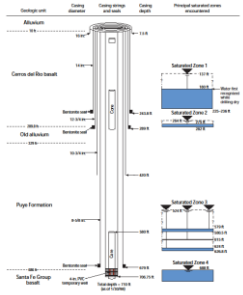
- How do we address this hydrogeologic complexity?
  - Physical challenges drilling a monitoring well to 1,000'+
  - Challenges associated with potential impacts of drilling fluids on groundwater chemistry

Current Practices

- Where we are with the groundwater monitoring program today
  - Dual-rotary casing advance
  - Air and potable water only within aquifer
  - Optimized borehole annulus and screen slot size
  - Single screen set near the top of the regional (main) aquifer
  - Extensive well development

Vadose Zone Challenges

- Lost circulation
- Flowing Sands
- Detection of low productivity zones
- Discrete gw samples
- Perching horizons
- Isolating perched zones during drilling

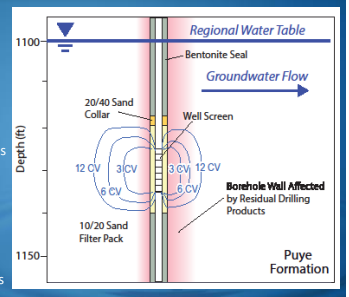


Drilling Fluids

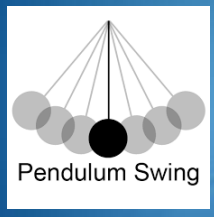
- Foam (organic carbon source)
- Long-chain Polymers (organic carbon source)
- Bentonite-based mud (rare)

Influence of Additives

- Original approach
  - Fluid additives to TD
  - Small screen slot (10 slot)
- Result
  - Small amounts of organic-based additives left behind after development
  - Food source for microbial activity - Reducing conditions resulting in non-representative samples



Response to use of Additives



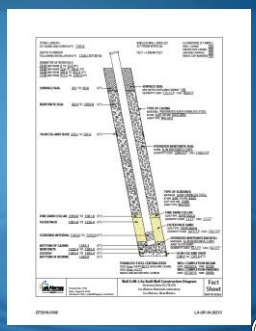
The pendulum swung
- Stop use of additives 100 ft above aquifer
- Had to increase air volume and pressure to clean out the borehole
- Result: can cause effervescent groundwater (bubbly)
  - High apparent turbidity
  - Low apparent specific capacity
  - Challenges for development

Current Approach: Well Design

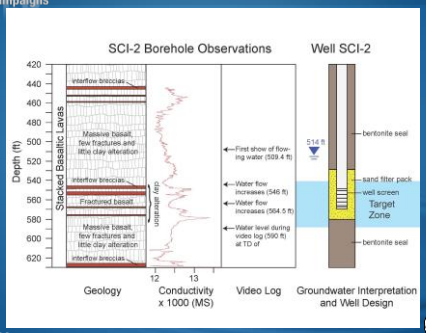
- Dual-rotary casing advance
- Air and potable water only within aquifer
- Optimized borehole diameter and screen slot size
- Single screen set near the top of the regional (main) aquifer
- Improves ability to conduct extensive well development

Recent Advances

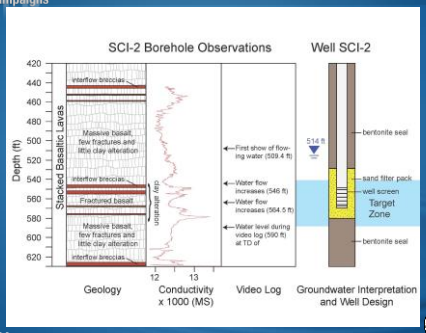
- Three recently installed wells at up to 25° from vertical
- Response to ground surface constraints
  - Topography
  - Cultural resources



Well Design Using Multiple Lines of Evidence



Case Study- Using Multiple Lines of Evidence



Future Challenges

- Directional drilling, targeting 900 ft bgs
- Multiple installations (from the same drill pad?)
- Enable thorough deployment of amendments into groundwater plume
- 300-500 ft horizontal screened interval

Lessons Learned

- Keep it simple: single screen completions are much easier to develop
- Well design (slot size and annular thickness) optimizes well development
- Well development: spend more time than you think to ensure data quality