SAND2016-9292C

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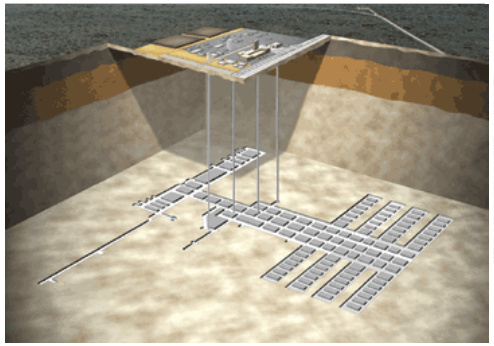

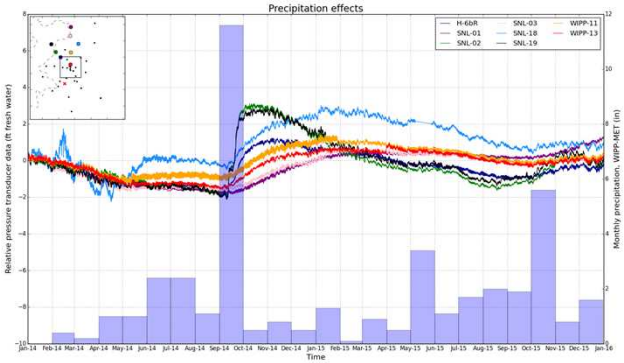

Anthropogenic influences on groundwater in the vicinity of the Waste Isolation Pilot Plant, southeastern New Mexico, USA

Matthew A. Thomas[1], Kristopher L. Kuhlman[2], and Anderson L. Ward[3]

[1]Sandia National Laboratories, 4100 National Parks Highway, Building A, Mail Stop 1395, Carlsbad, New Mexico, 88220-9006

[2]Sandia National Laboratories, PO Box 5800, Mail Stop 0747, Albuquerque, New Mexico, 87185-0747

[3]United States Department of Energy, 4021 National Parks Highway, Carlsbad, New Mexico, 88220-9082

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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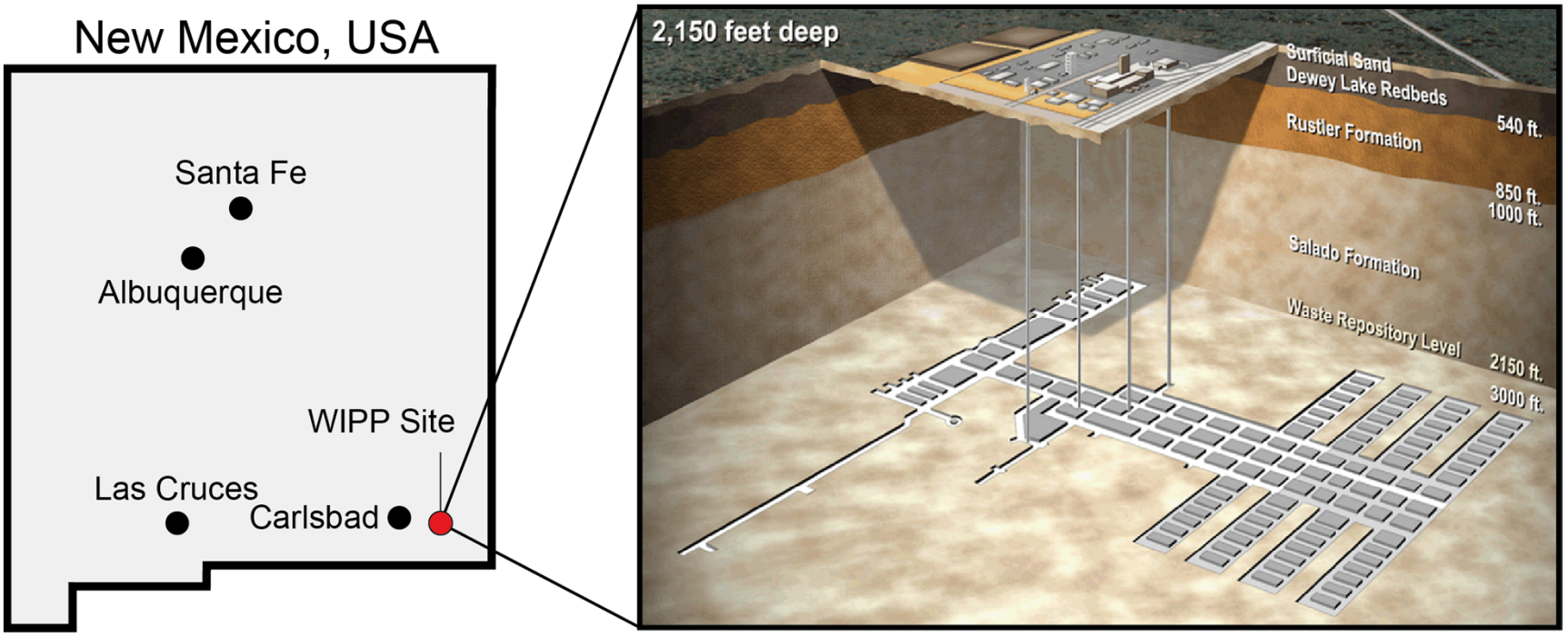
Waste Isolation Pilot Plant (WIPP)

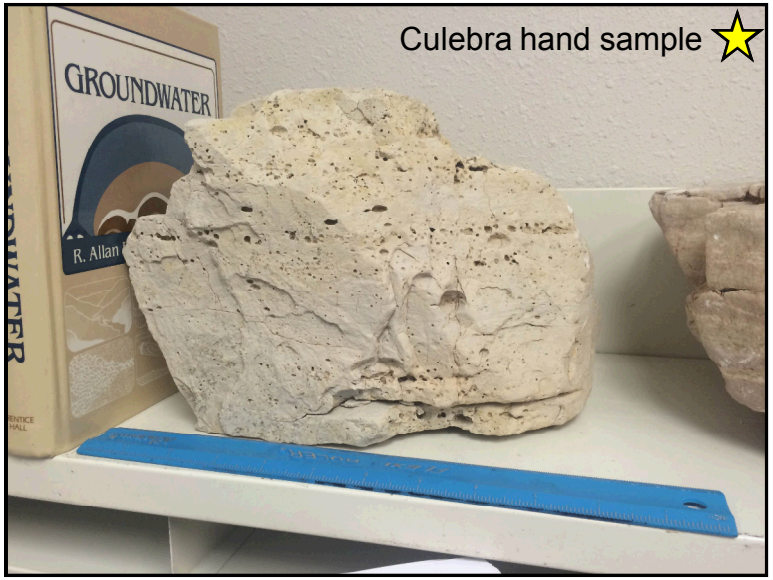


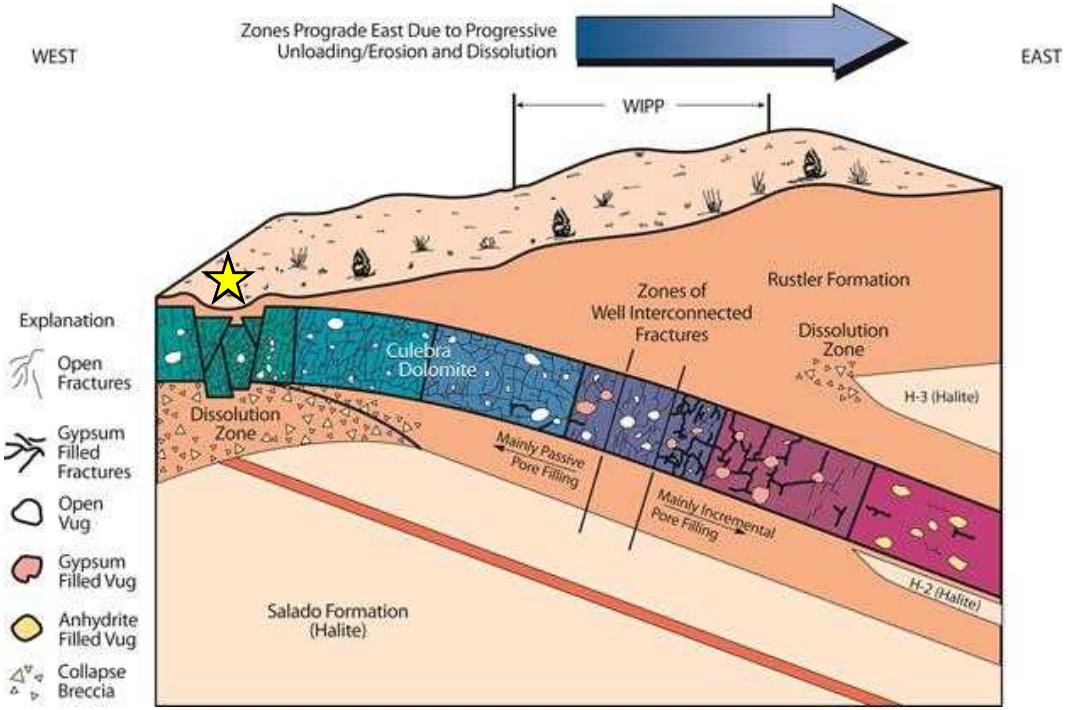
U.S. Department of Energy

Culebra Dolomite (Rustler Fm.)

Powers and Holt (1999)

PERMIAN	Ochoan	Rustler	Forty-niner
			Magenta Dolomite
			Tamarisk
			Culebra Dolomite
			Los Medaños (proposed formal name for "unnamed lower member")
		Salado	
		Castile	

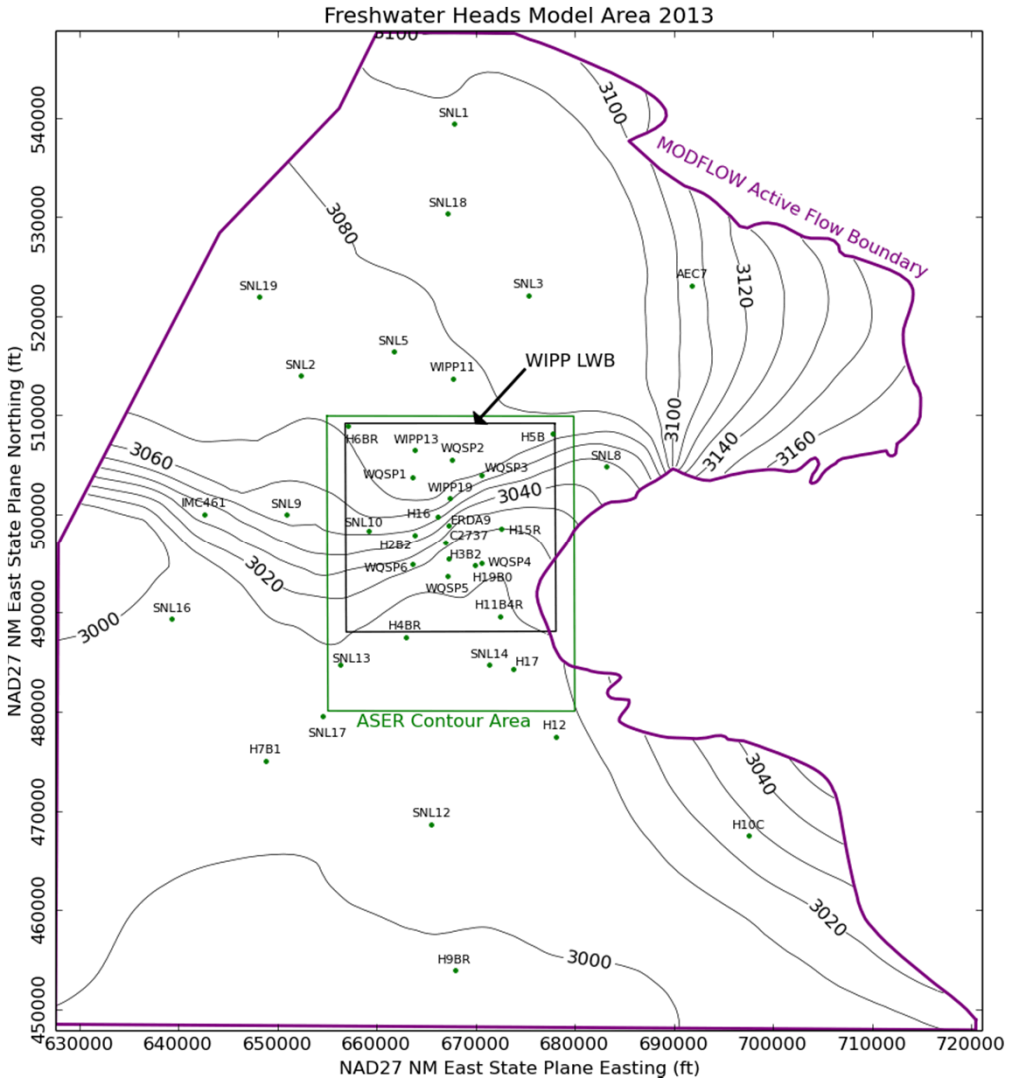




Beauhiem and Holt (1990)

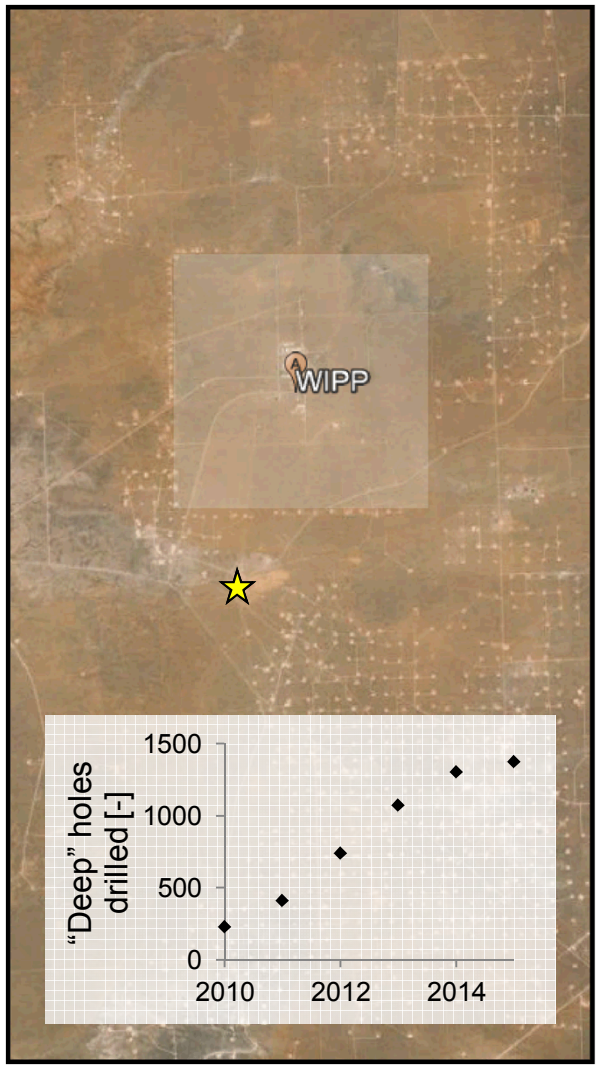
Groundwater monitoring network

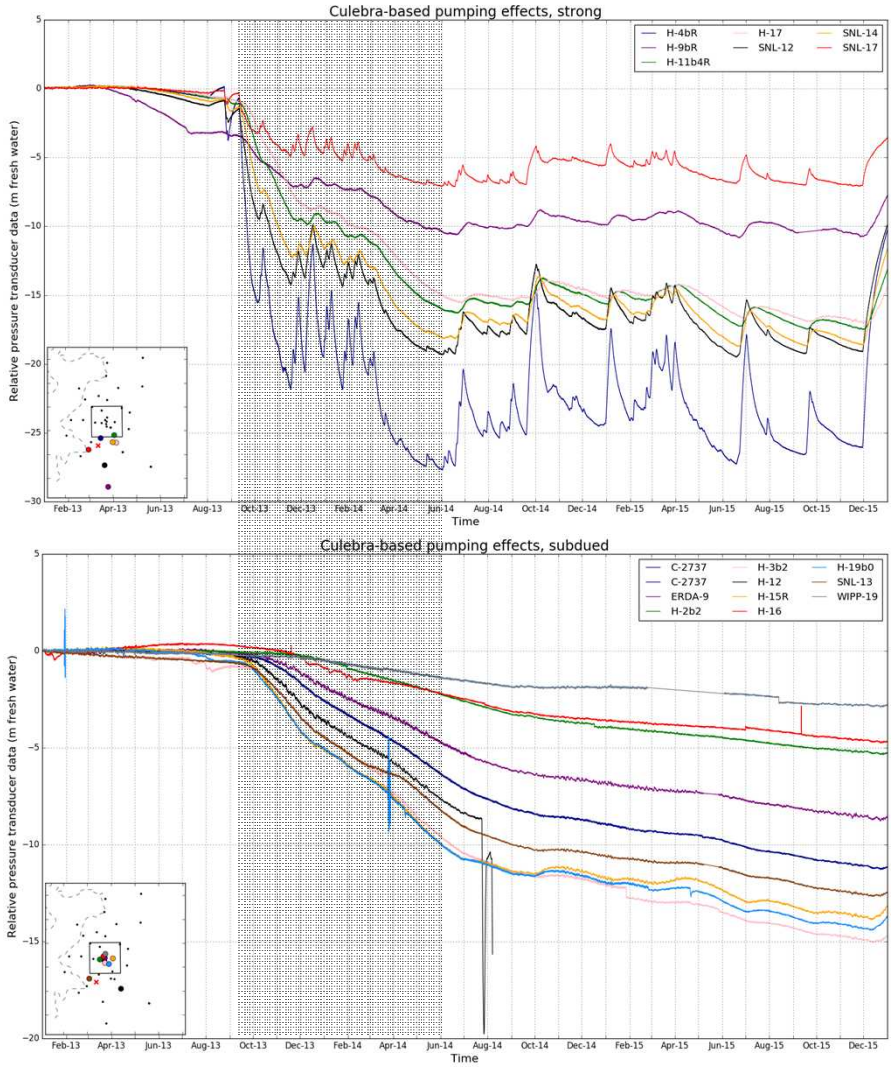
- Culebra is the most transmissive and laterally extensive saturated zone above the Salado.
- Flow is ~N-S inside Land Withdrawal Boundary.
- Long-term, high-frequency monitoring network
  - Began in 2003
  - 40 Culebra wells
  - Recording fluid pressure
  - Collected at 15-minute intervals, downloaded monthly



Kuhlman (2014)

Pressure transducer data





Imagery: Google Earth (2016) | Drilling data: Wagner and Thomas (2016)

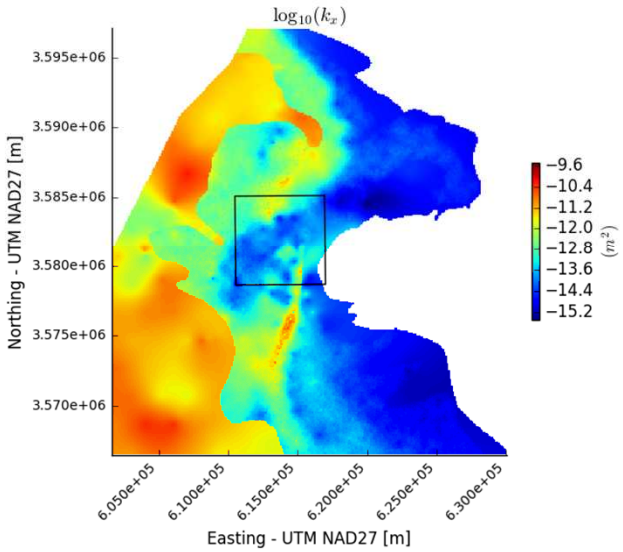
Thomas (2016)

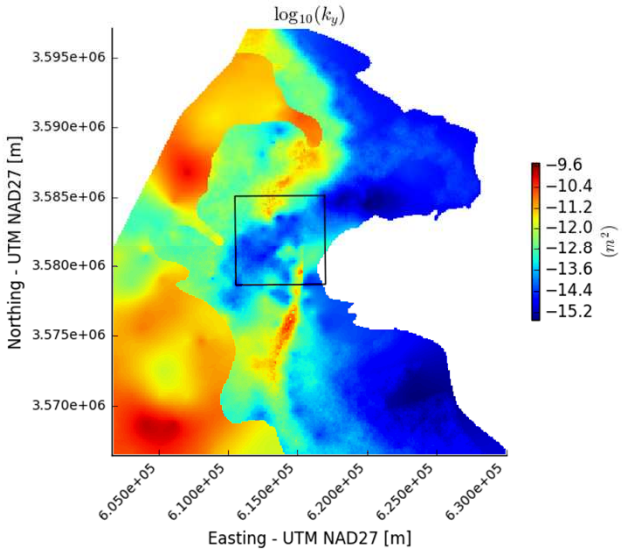
Study objective(s)

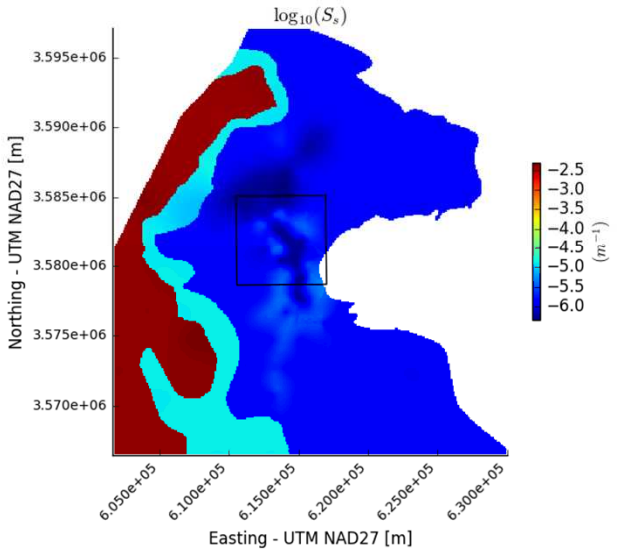
- Within a preliminary, simulation-based framework:
  - Estimate a pumping rate for the well.
  - Simulate drawdown associated with the pumping.
  - Simulate and compare advective particle travel paths/times for cases with and without pumping.
  - Consider what the pumping tells us about the system in light of how it is has traditionally been modeled.
    - 100 base-case (calibrated) realizations
    - 2D, steady state, heterogeneous, and anisotropic

Culebra flow modeling, setup

- Code: PFLOTRAN
- Ensemble-averaged 2D realization; constant head and no-flow boundaries; initial conditions from steady-state simulation; sink term (pumping well); nine-month period

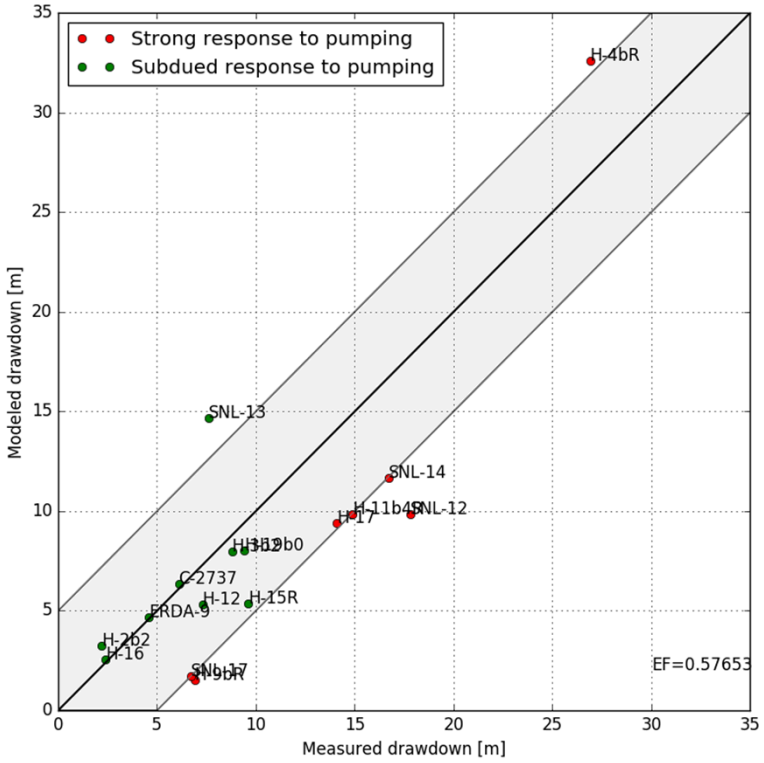


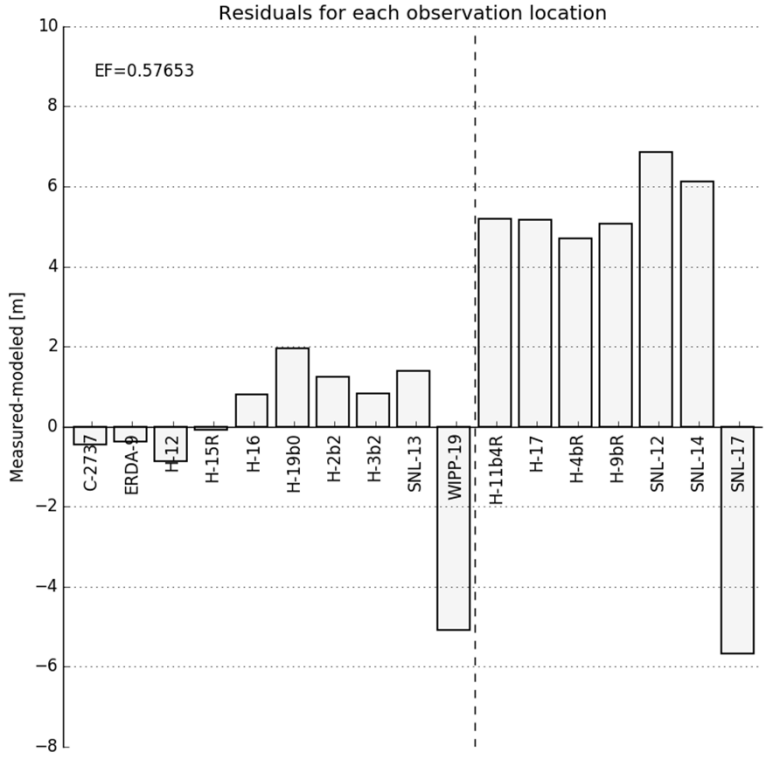




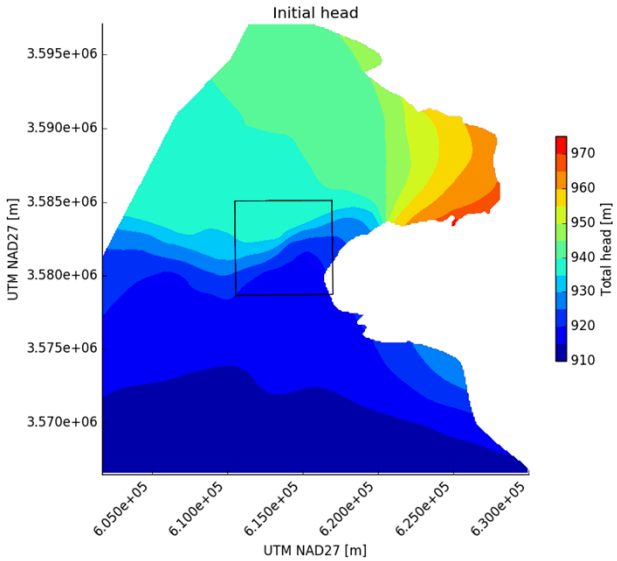
Culebra flow modeling, targets

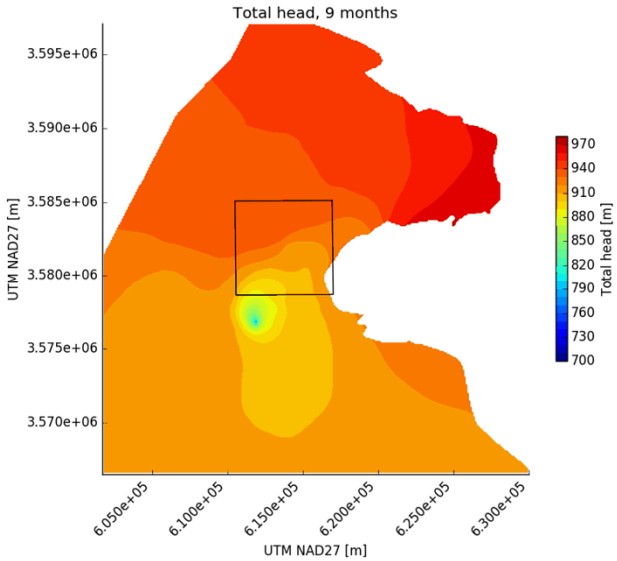
- Iterate for sink term that minimizes Modeling Efficiency (EF).
- Two observation groups; strong vs. subdued response
- Best-fit pumping rate: 1.8E-03 m^3s^{-1} (28.5 gpm)

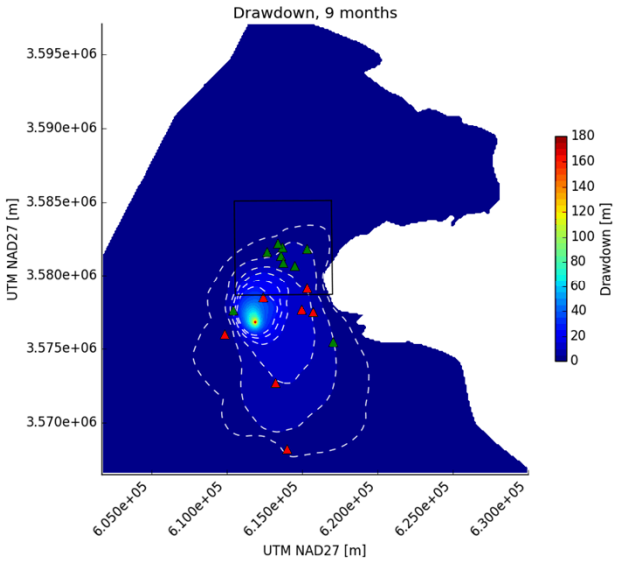




Culebra flow modeling, drawdown

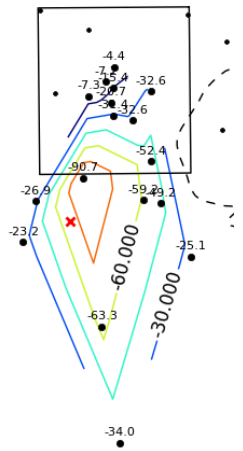






- Qualitative similarities between observed and simulated drawdown field
  - North-south lobe
  - Drawdown opens to the south

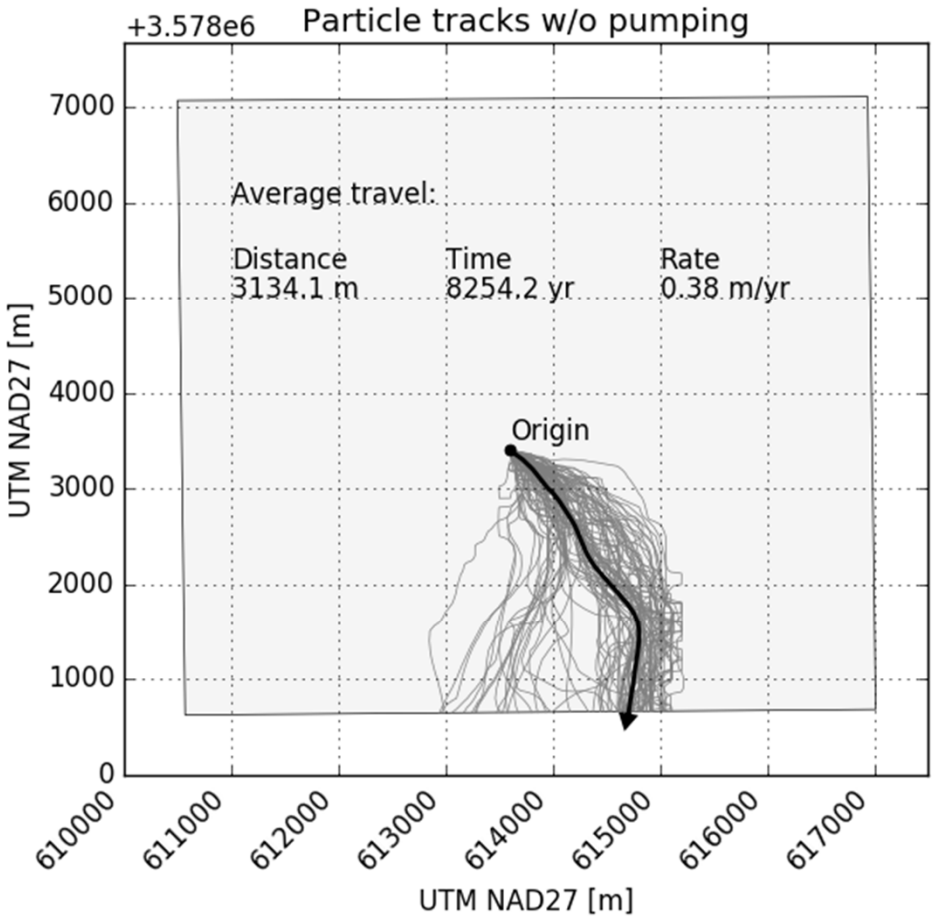
June 2014

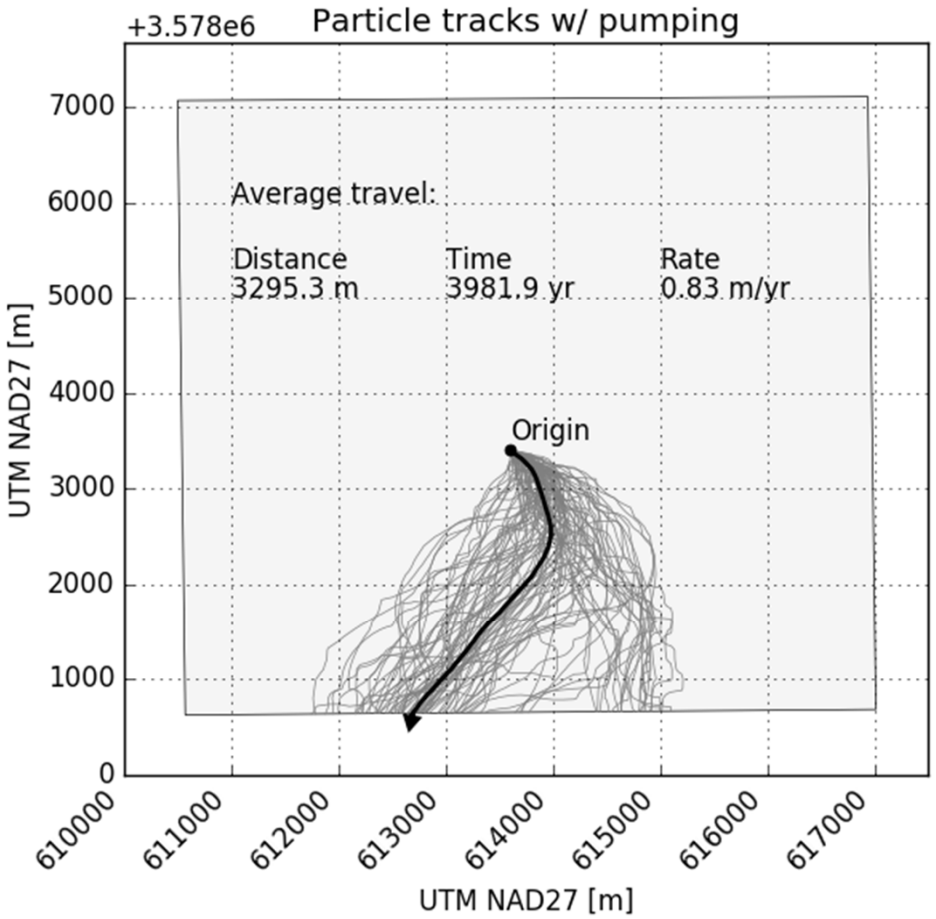


Culebra particle tracking, setup

- Codes: PFLOTRAN, DTRKMF
- PFLOTRAN:
  - Apply best-fit sink term from ensemble-averaged model to the 100 realizations that comprise the ensemble-average model.
    - Constant head and no-flow boundaries; initial conditions from steady-state simulation; sink term (pumping well); nine-month period
- DTRKMF:
  - Calculate conservative (i.e., non-dispersive and non-reactive) particle track each realization.

Culebra particle tracking, results





Summary

- Findings
  - The Culebra-based pumping in the vicinity of the WIPP halves “snap-shot based” estimates of particle travel time across the site.
  - The effects (i.e., change in travel time and path) associated with the pumping period are unimportant relative to the WIPP performance period.
- Food for thought
  - What did we learn about the system?
  - What could transient forcings looking like in the future?
  - What is the best way to increase confidence in a transient simulation conducted on the geologic timescale when it is calibrated with observations made on the human timescale?

Funding statement

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