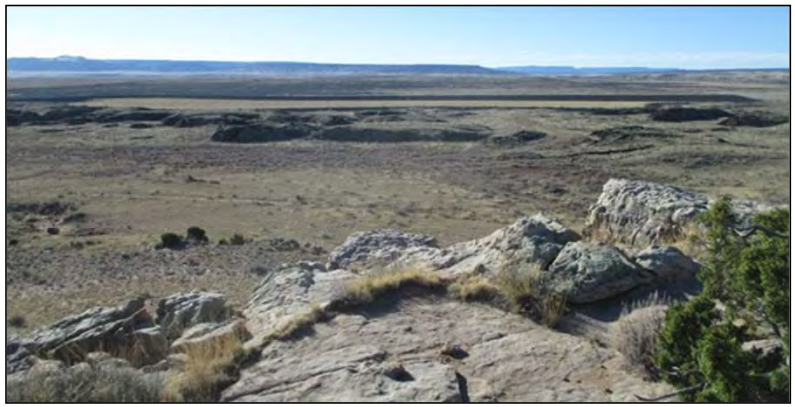
U.S. DEPARTMENT OF ENERGY | Legacy Management

Status of the Bluewater, New Mexico, UMTRCA Title II Disposal Site



Bernadette Tsosie, Site Manager
U.S. Department of Energy (DOE)
Office of Legacy Management (LM)

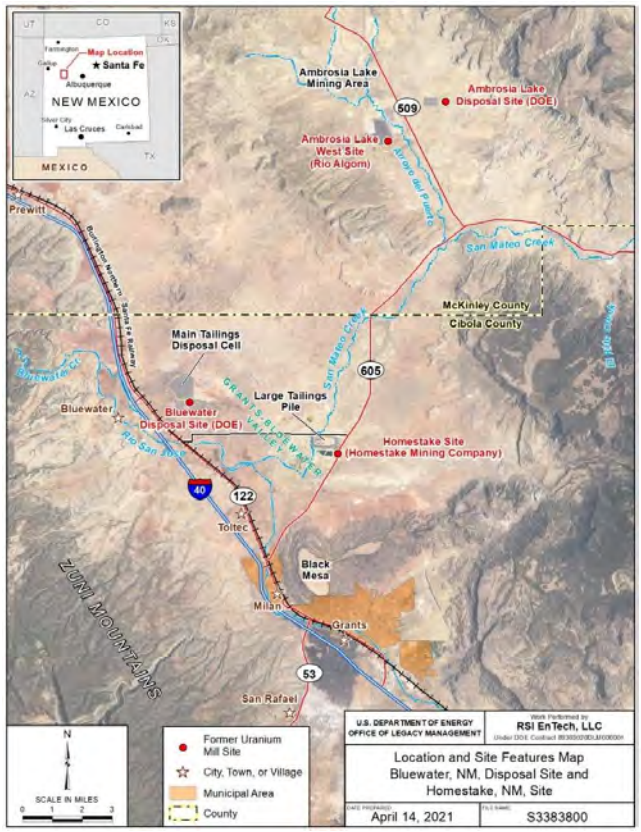
May 5, 2021

Bluewater Site Updates

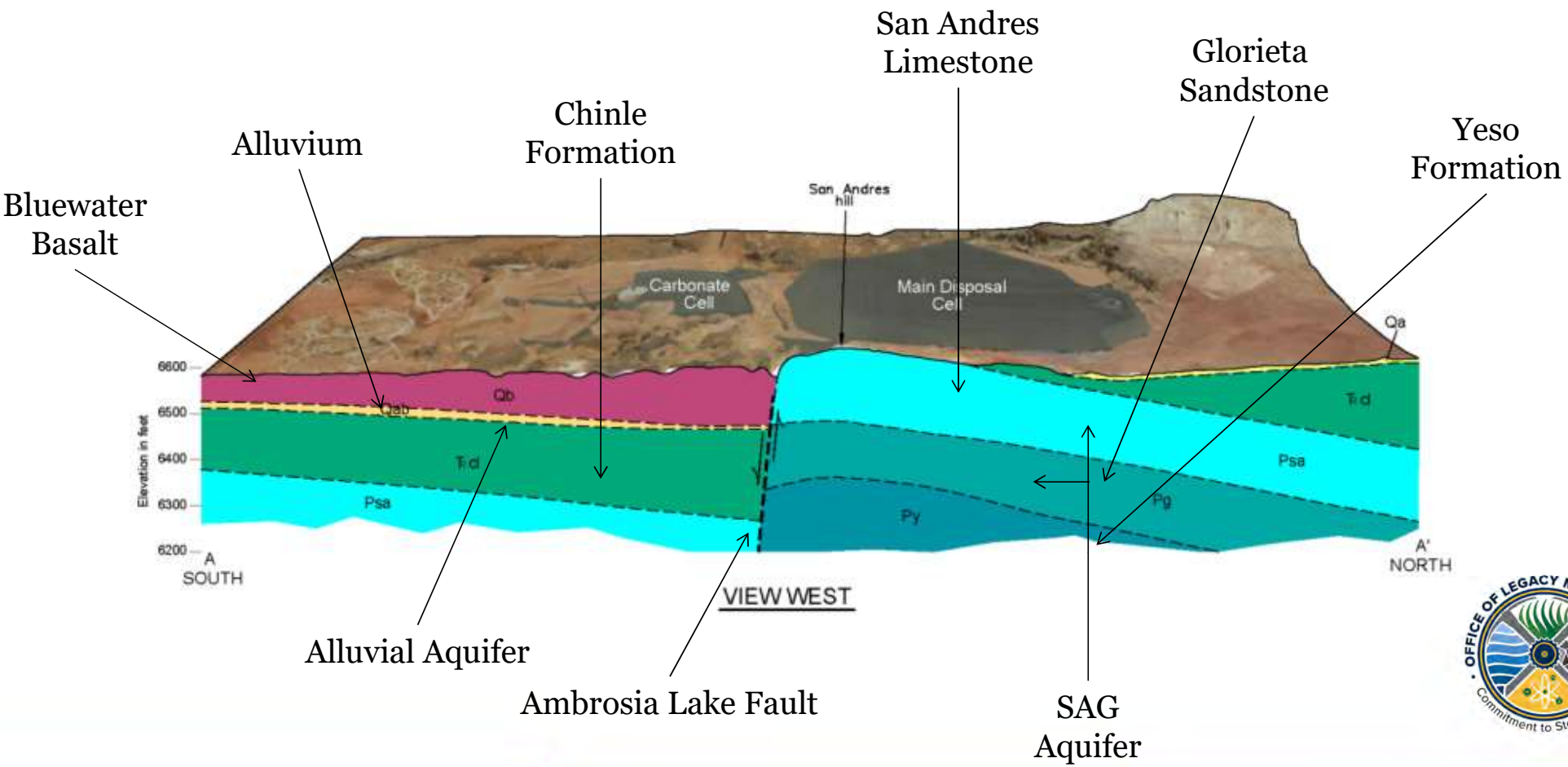
- Site background
- Site conceptual model
  - Uranium and sulfate San Andres-Glorieta Aquifer (SAG) aquifer plume configurations as of 2019
  - Uranium and sulfate SAG aquifer plume statistics
- *Influences of High-Production Pumping Report* (Aug. 2020)
  - Concentrations outside the plume do not appear to be impacted
- New Mexico Environment Department (NMED) Cooperative Agreement activities
- National Laboratory Network collaboration
- Update on the main tailings disposal cell repair project
  - Partnering with the U.S. Army Corps of Engineers to repair the depressions on the main tailings disposal cell
- Other site projects
- Video tour
- Questions

Bluewater Site Management

- The site was transferred to DOE in 1997 for long-term surveillance and maintenance
- LM conducts:
  - Annual inspections
  - Semi-annual groundwater monitoring
  - Site maintenance
- U.S. Nuclear Regulatory Commission (NRC) regulates the site



Block Diagram



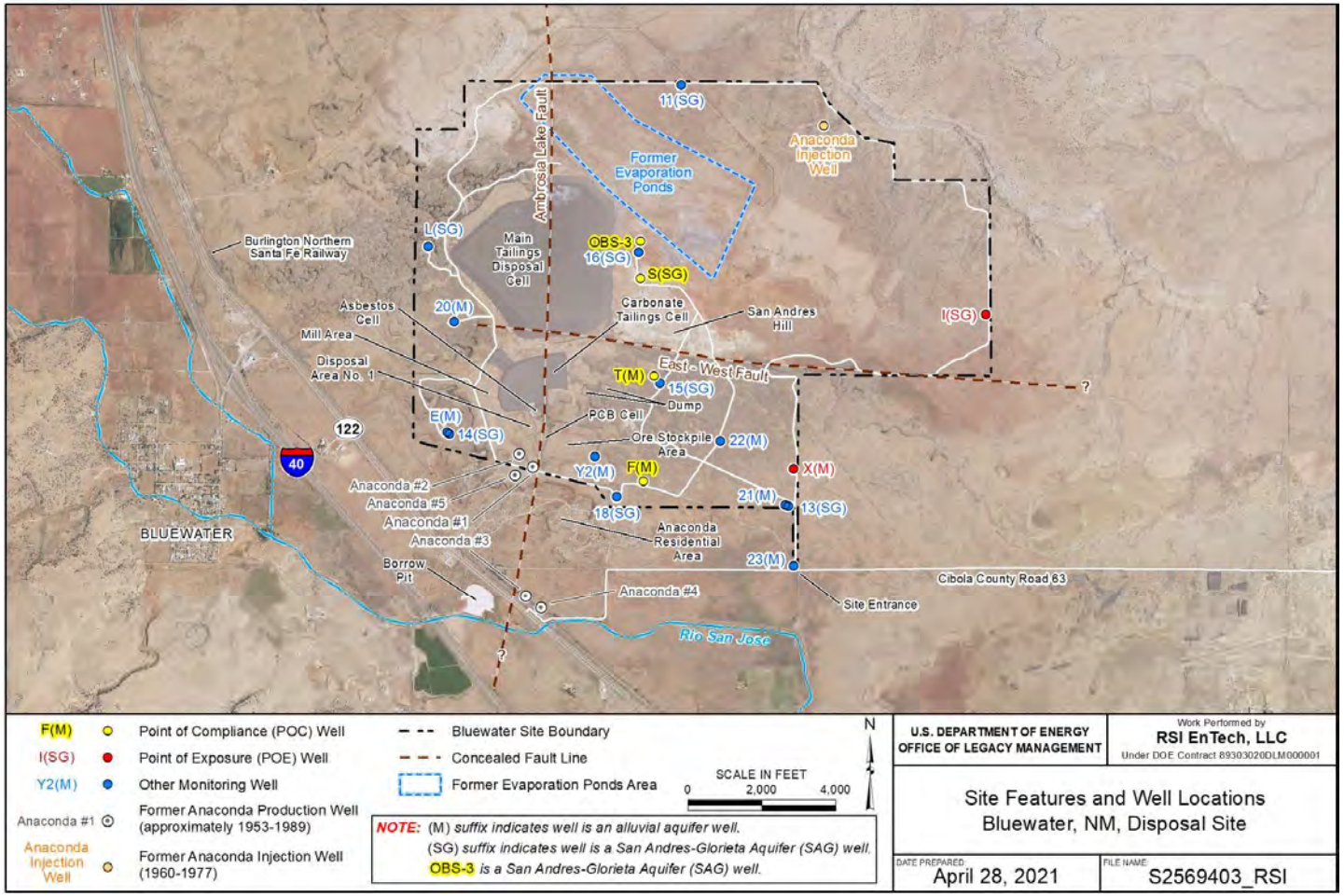
Bluewater Site During Operations

Anaconda Mill (1959)

Bluewater Site During Operations (continued)

Anaconda Mill (August 1971)

Monitoring Well Network and Site Features



Visualization Model for the Bluewater, New Mexico Disposal Site, and SAG Aquifer Groundwater Plume Trends

Outline

- Why Build a Visualization Model?
- Site Monitoring History and Key Question
- Geologic Model for the Bluewater Site
- SAG Aquifer Monitoring Well Network
- SAG Aquifer Plume Geometry and Trends since 2013
- Revisiting the Key Question

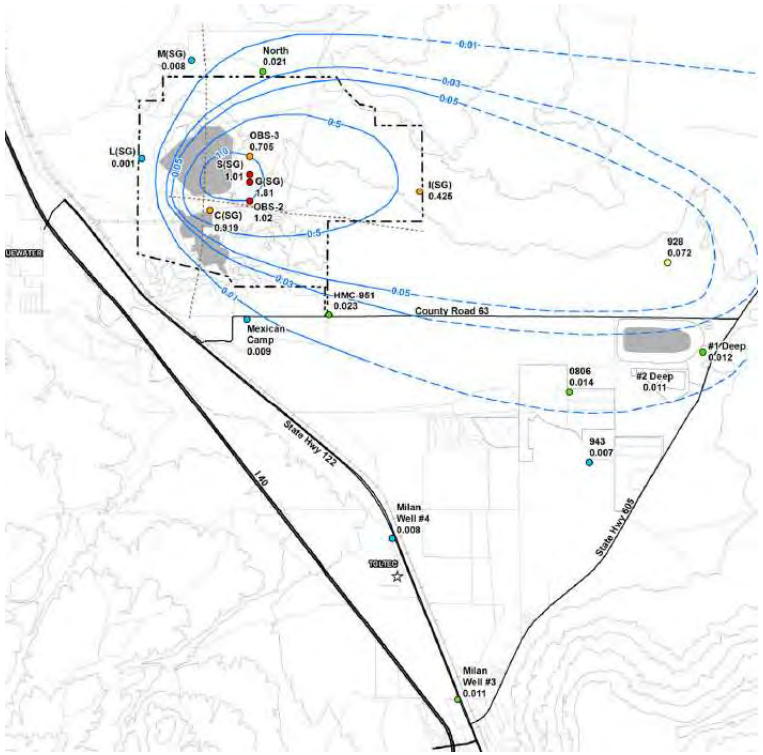
Why Build a Visualization Model?

- The visualization model is being developed to:
  - Build the Conceptual Site Model and investigate key questions about the Bluewater Site
  - Aid understanding of monitoring well locations and where they have screened/open intervals in the regional groundwater aquifers
  - Evaluate historical and current groundwater contaminant plume extents
  - Calculate statistical trends of plume metrics to better understand plume behavior over time
  - Better identify uncertainties in our data

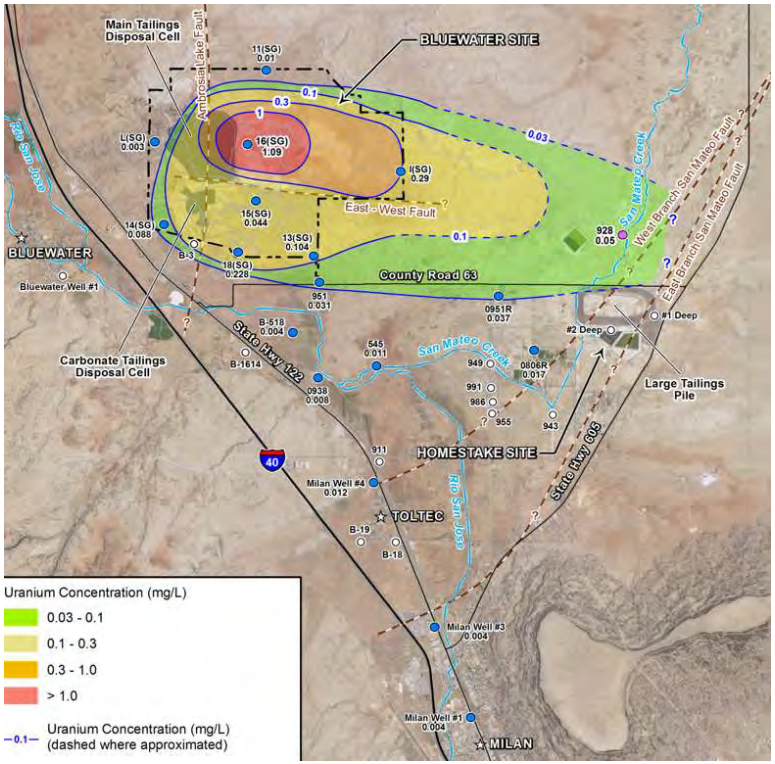
- The DOE-National Laboratory Network Collaboration consensus recommended continued development of the Earth Volumetric Studio (EVS) model for future risk reduction actions

Going from Hand-drawn Plume Maps . . .

1996-1997 Uranium Plume

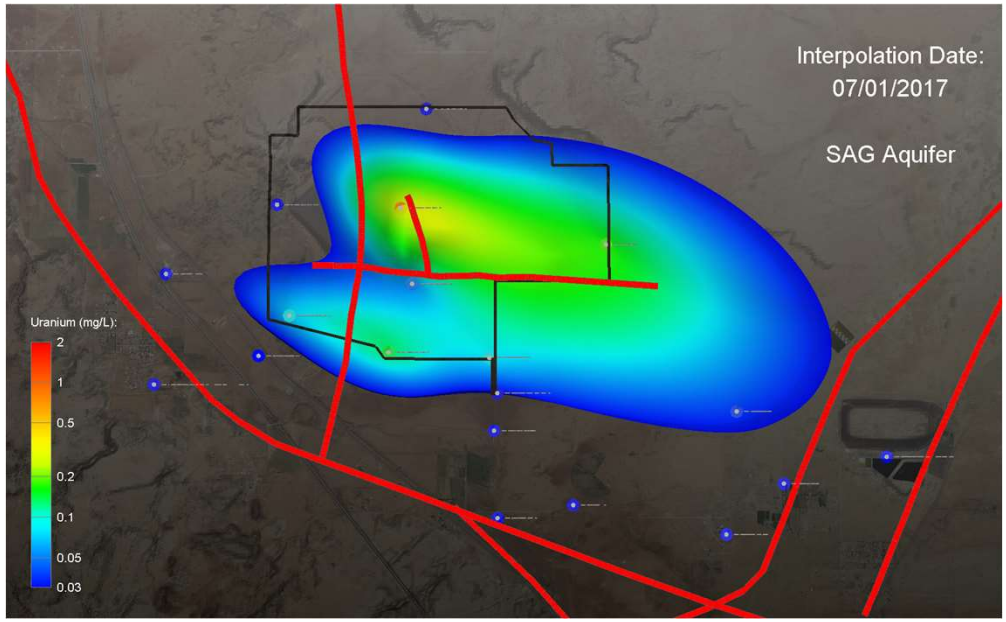


2017 Uranium Plume

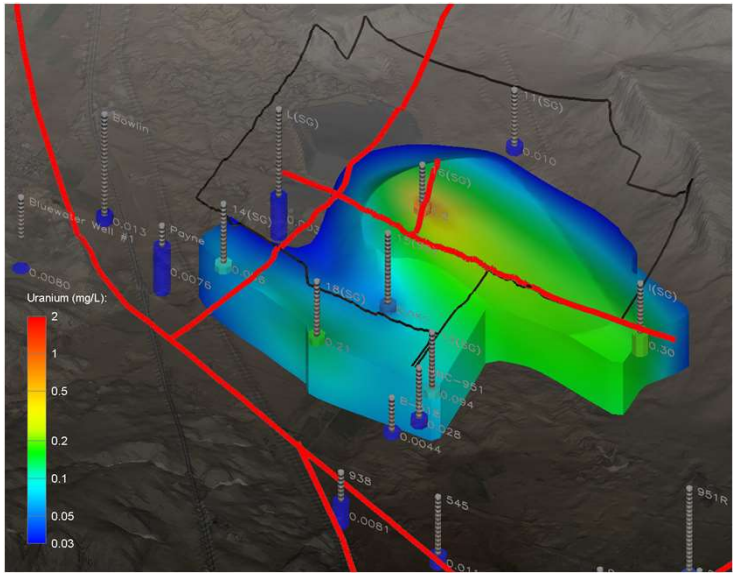


To 3-D Statistical Plume Maps Compared Over Time

EVS Plume Interpolation - 2017



EVS Plume Interpolation
Volume Within Bluewater Site Boundaries, 2017



Bluewater Site Monitoring History (1997-present)

- **1997** – Site transitioned to DOE custody
- **2010** – Increasing uranium found in monitoring well 951
- **2011** – Semi-annual sampling frequency begins
- **2012** – Installation completed for 10 new on-site monitoring wells
- **2015-present** – Yearly sampling of 20 off-site wells through DOE-NMED Cooperative Agreement

Groundwater Contamination at the Bluewater Site

- Two aquifers
  - Rio San Jose alluvial aquifer
  - San Andres/Glorieta (SAG) aquifer (hydraulically connected limestone and sandstone formations)
- Contaminants of concern include:
  - Uranium
  - Sulfate
  - Chloride
  - Nitrate as nitrogen (N)
  - Molybdenum
  - Selenium
- Other indicators of Bluewater Mill-originated contamination:
  - Total dissolved solids (TDS)
  - Waters relatively low in pH

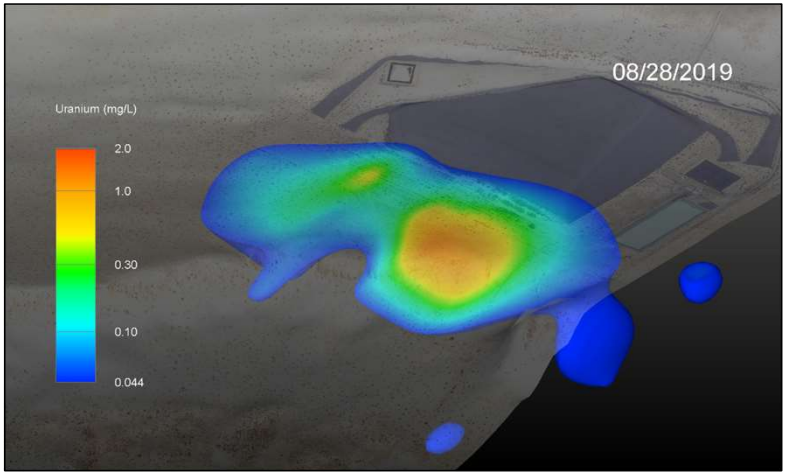
Key Question

- Have groundwater contaminant plumes originating from Bluewater site activities been growing, shrinking, or stable since DOE took over custody of the site in 1997?

Introduction to the Visualization Model

- Earth Volumetric Studio (EVS) visualization modeling tool used to support groundwater plume evaluations at other LM sites
  - Monument Valley, AZ
  - Green River, UT
  - Riverton, WY
  - Shiprock, NM
  - Tuba City, AZ

- Why we use it
  - Convenient workspace to assemble data
  - Mathematical analyses
  - Visualization and presentation of data and interpretations



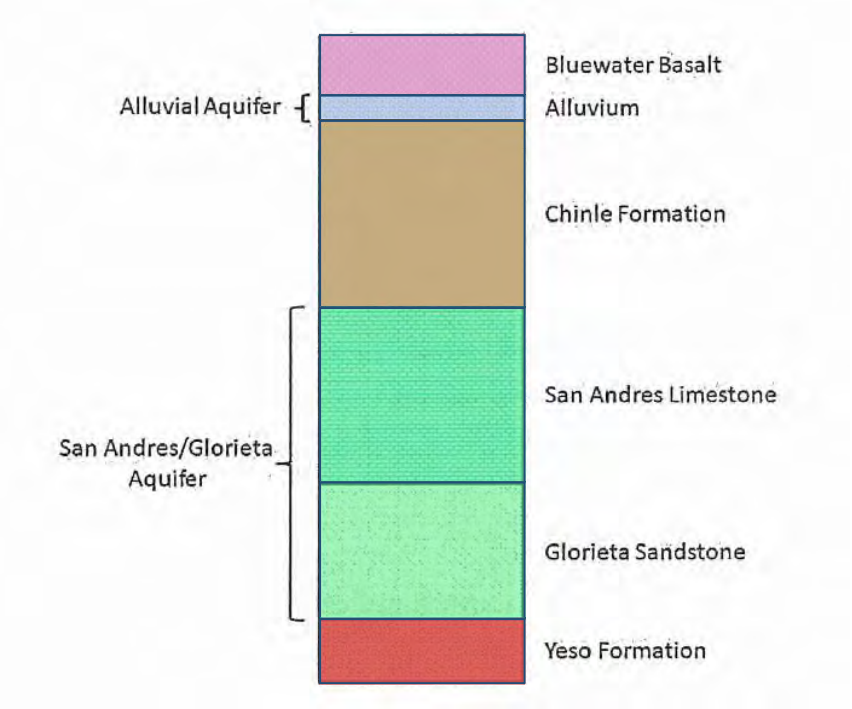
Tuba City, AZ, Disposal Site EVS Model

Regional Map (EVS)

Site Geology and Structure (EVS)

Geologic Formations in the Grants-Bluewater Valley

- Bluewater Basalt
  - 30-70 feet thick
- Ancestral Alluvial Aquifer
  - A few feet to 30 feet thick
- Chinle Formation
  - 0-900 feet thick
- San Andres Limestone
  - 116 to 190 feet thick
- Glorieta Sandstone
  - 130-200 feet thick
- Yeso Formation
  - 877 feet thick at Anaconda Injection well (West 1972)



Site Hydrogeology

SAG Aquifer (EVS)

Groundwater Monitoring Network

SAG Aquifer (EVS)

SAG Aquifer Plume Mapping

Assumptions for Consistent Plume Mapping

- Plume maps that honor the hydrogeological conditions of a site require assumptions

- Assumptions are informed by:
  - Site history
  - Dominant groundwater flow direction (direction plume water generally moves)
  - Recorded screened well depths or open-hole depths
  - Background contaminant levels
  - Well integrity

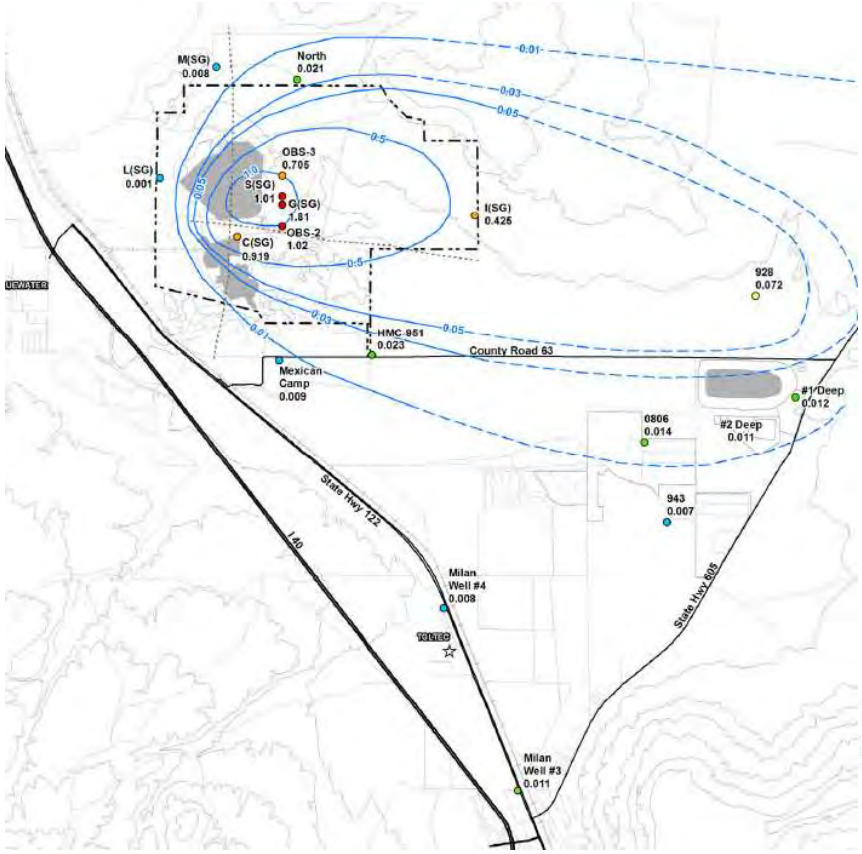
- Consistency is key when comparing plume maps from two or more time periods

Why Use EVS for Plume Mapping?

- Previous hand-drawn maps used different:
  - Assumptions
  - Plume extents (minimum concentration levels)
  - Sampling periods
  - Monitoring well networks

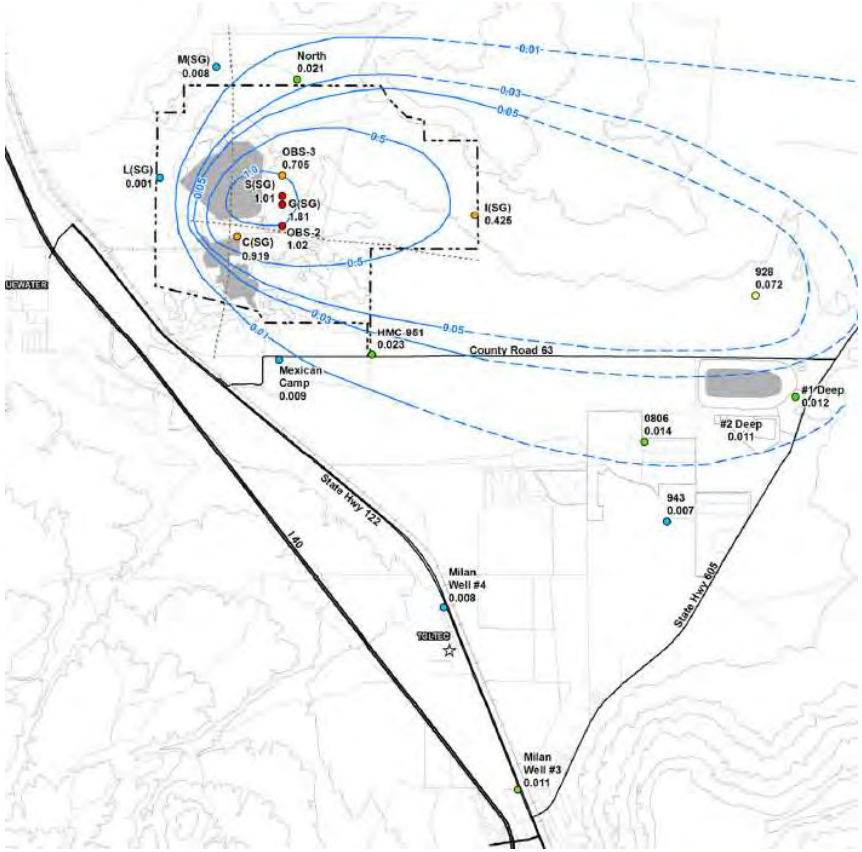
- The EVS tool allows comparison of plumes over time, using the same assumptions, etc.

1996-1997 Uranium Plume

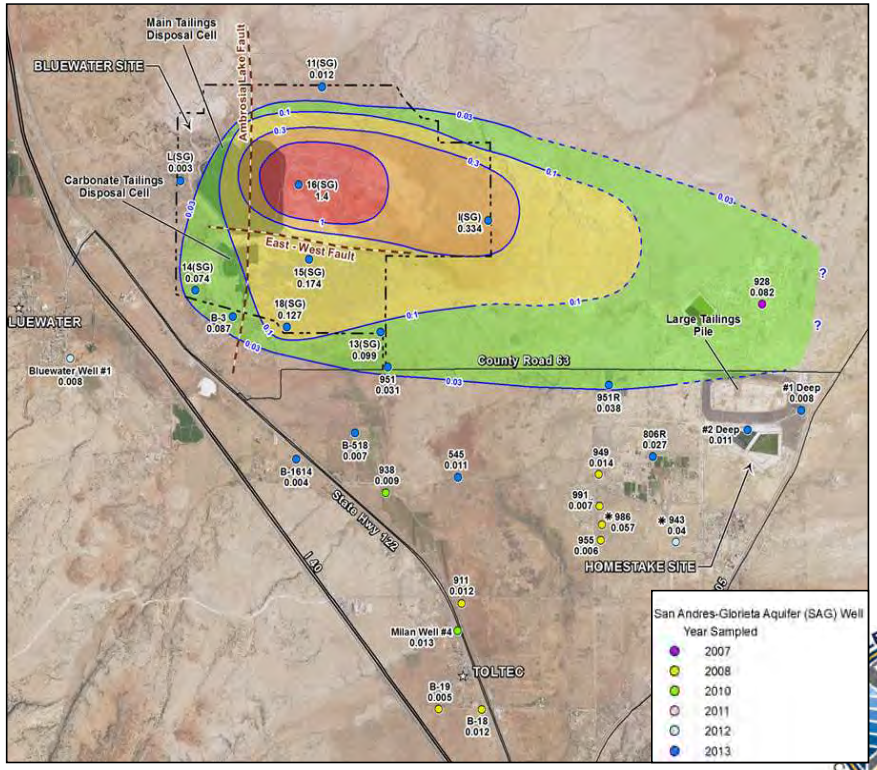


Plume Mapping – Hand Drawn Maps

1996-1997 Uranium Plume



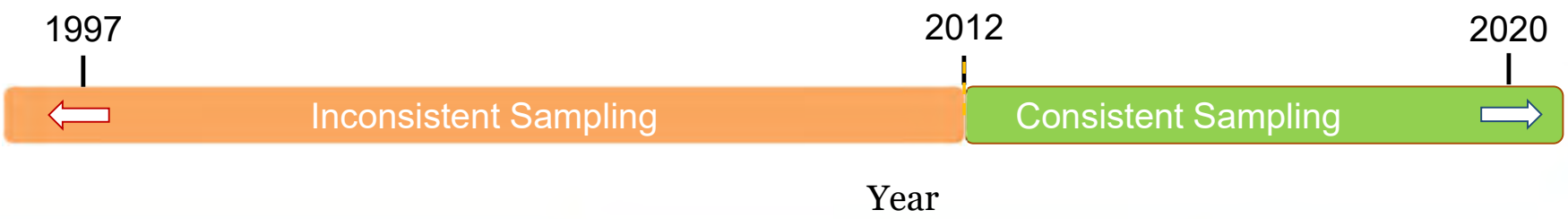
2013 Uranium Plume



Monitoring Network Timeline – SAG Aquifer

- On-site sampling every 3 years in very few wells
  - until ~2010
- Off-site sampling inconsistent and in few wells
  - Consistently sampled wells were mainly HMC
  - Many of these wells later deemed leaky/compromised

- 10 on-site wells installed in 2012
  - Sampled biannually with existing wells
- NMED Cooperative Agreement in 2015
  - Expanded off-site sampling with yearly frequency coinciding with DOE fall sampling



Assumptions for Consistent Plume Mapping

- Wells only sampled before 2012 were not used, with the exception of certain upgradient wells that previously and consistently measured below standards:
  - Bowlin
  - Bluewater_Well_#1
  - Payne
  - Berryhill_Sec5
  - M(SG) (for Sulfate only)

- Honors hydrogeological conditions, and in locations where site impacts were minimal

Assumptions for Consistent Plume Mapping

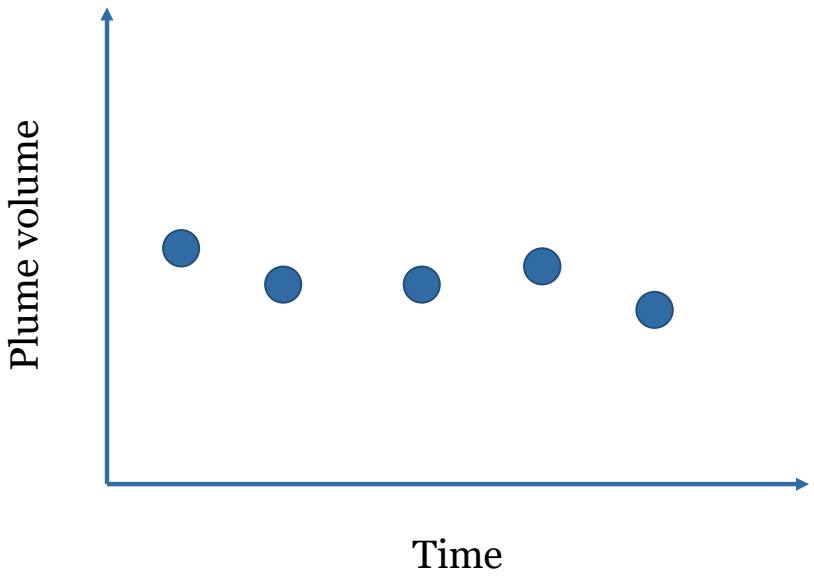
- Wells found to be leaky or compromised were not used
  - HMC wells 928, Deepwell 1 and Deepwell 2, 943 and 806
- Onsite wells deemed not representative of groundwater conditions in the SAG were not used
  - OBS-3 and S(SG) – well screens were corroded and measured contaminant concentrations were unusually low
- NMED-sampled BSAG wells determined to be most likely screened in the Chinle Formation were not used (NMED 2021)
- Wells with logs that had no recorded screened, or open-hole depths were not used

SAG Aquifer

Uranium Plume (EVS)

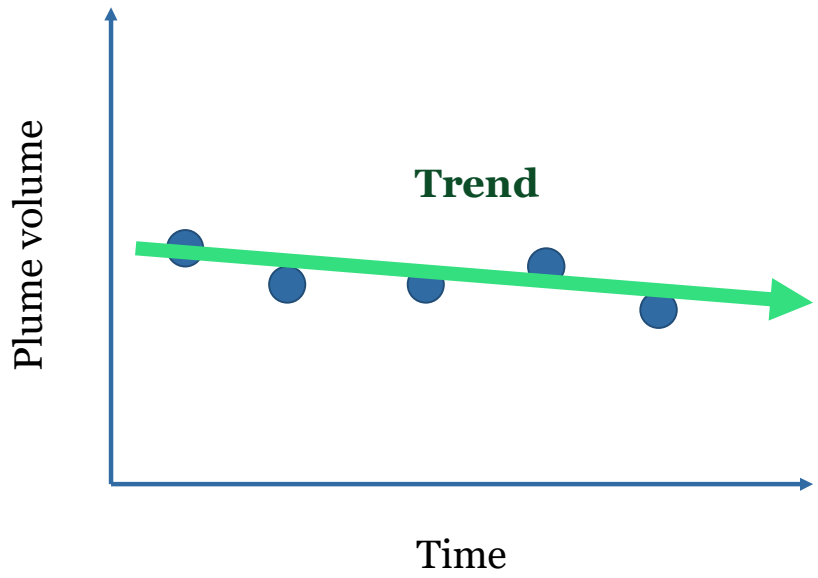
SAG Aquifer Uranium Bulk Plume Metrics

- What are “bulk plume metrics”?
  - Calculate meaningful data from the plume maps to compare over time
- EVS enables consistent, numerical calculation of bulk plume metrics for comparison
  - Historically
  - For future assessments



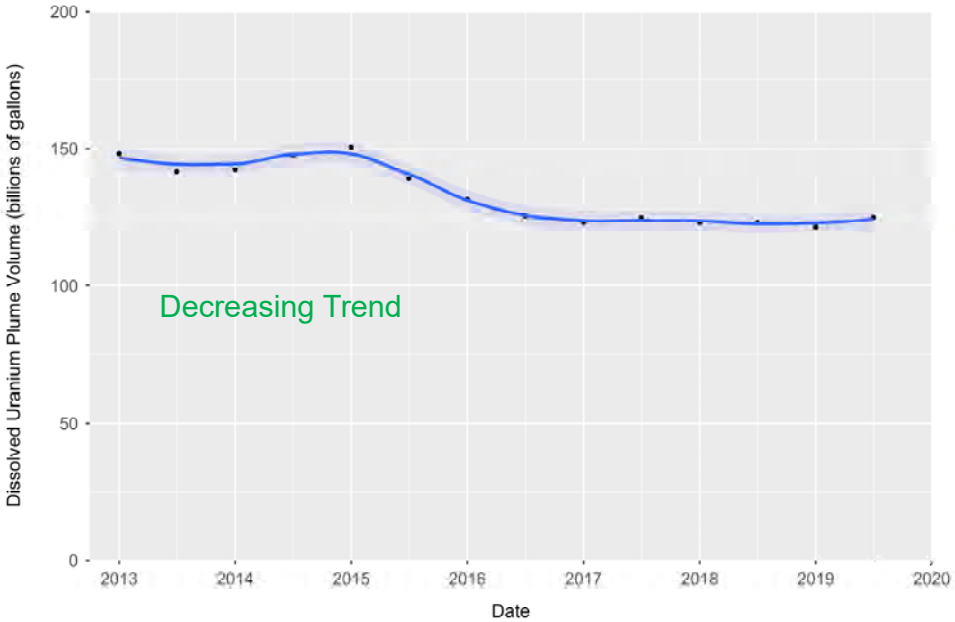
SAG Aquifer Uranium Bulk Plume Metrics

- Allows for numerical trend analysis of plume behavior (Mann-Kendall Trend Analysis)
  - Decreasing trend = plume contraction
  - Increasing trend = plume expansion
  - No trend = stable plume

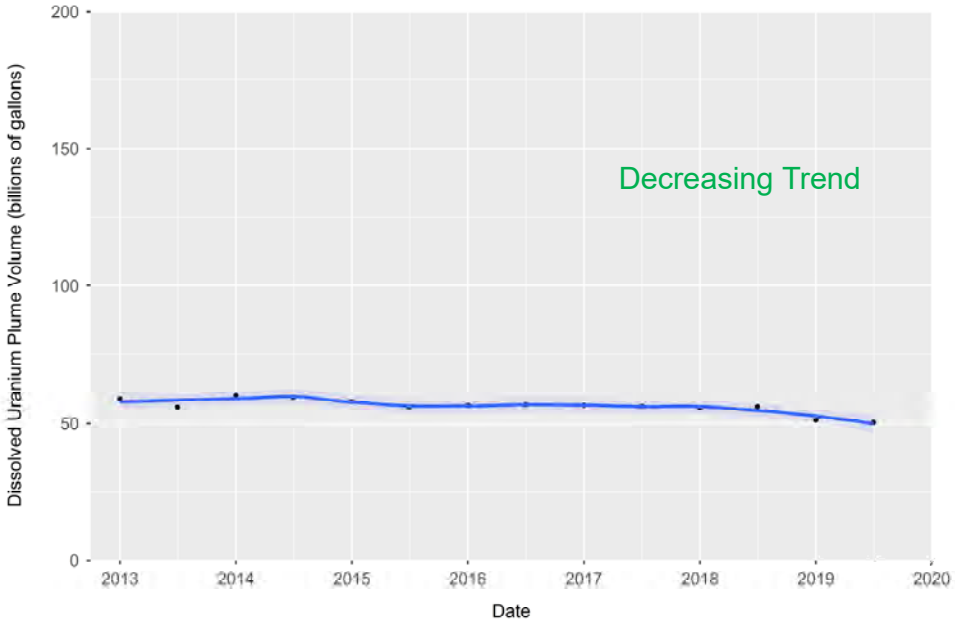


SAG Uranium Bulk Plume Volume

Entire plume

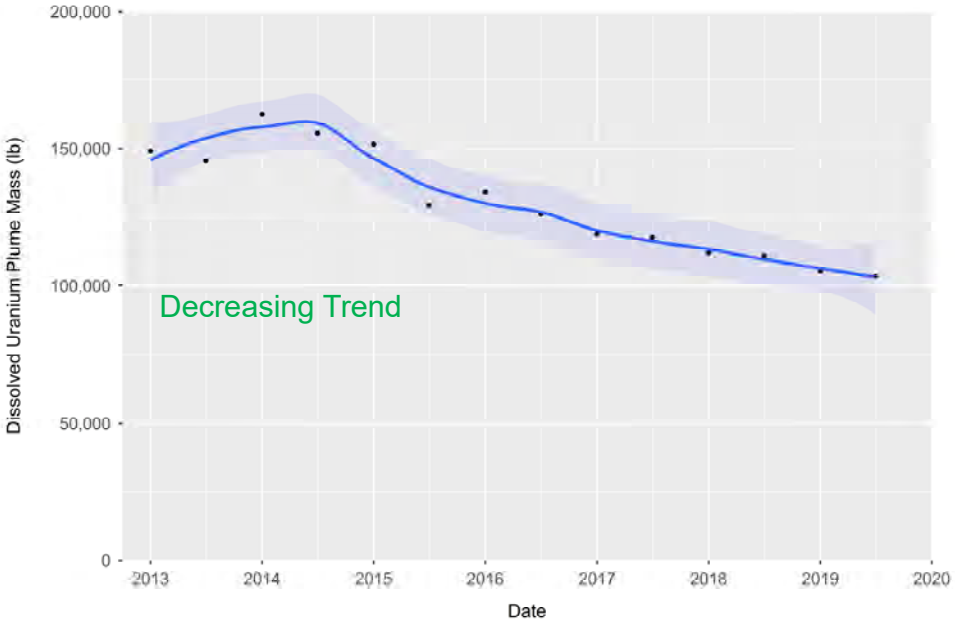


Plume Within Site Boundaries

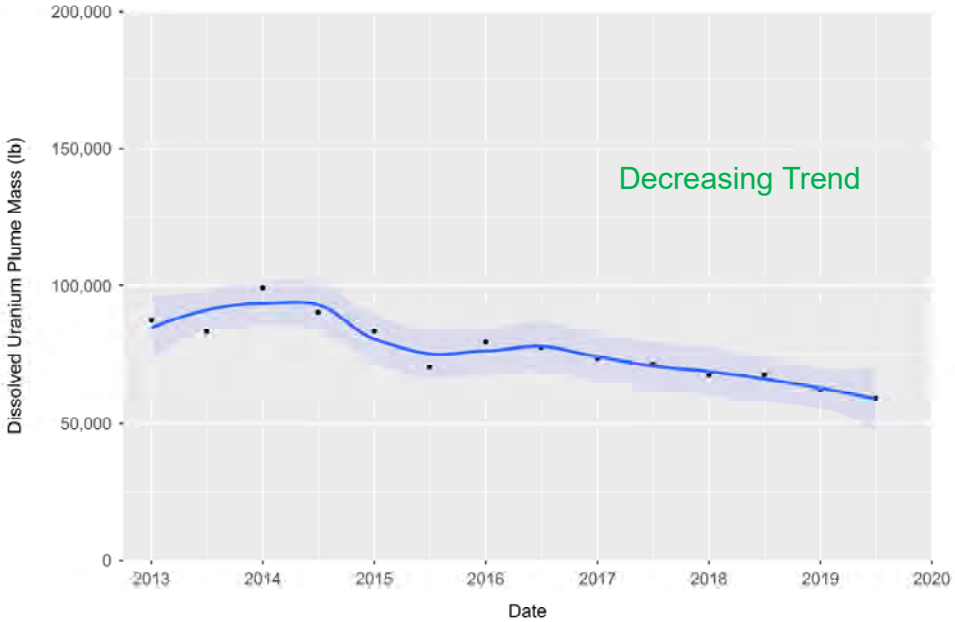


SAG Uranium Bulk Plume Mass

Entire plume



Plume Within Site Boundaries

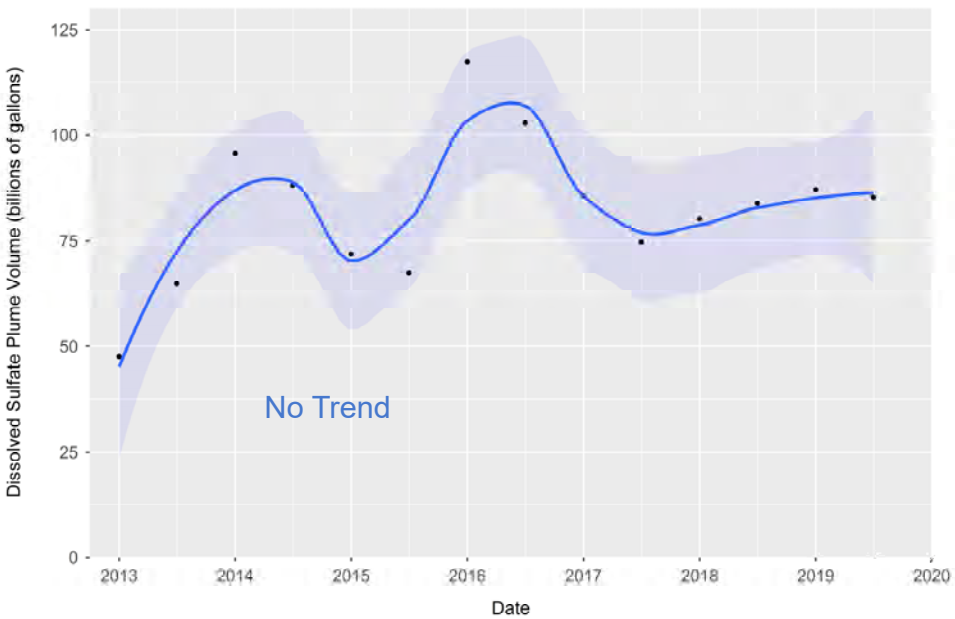


SAG Aquifer

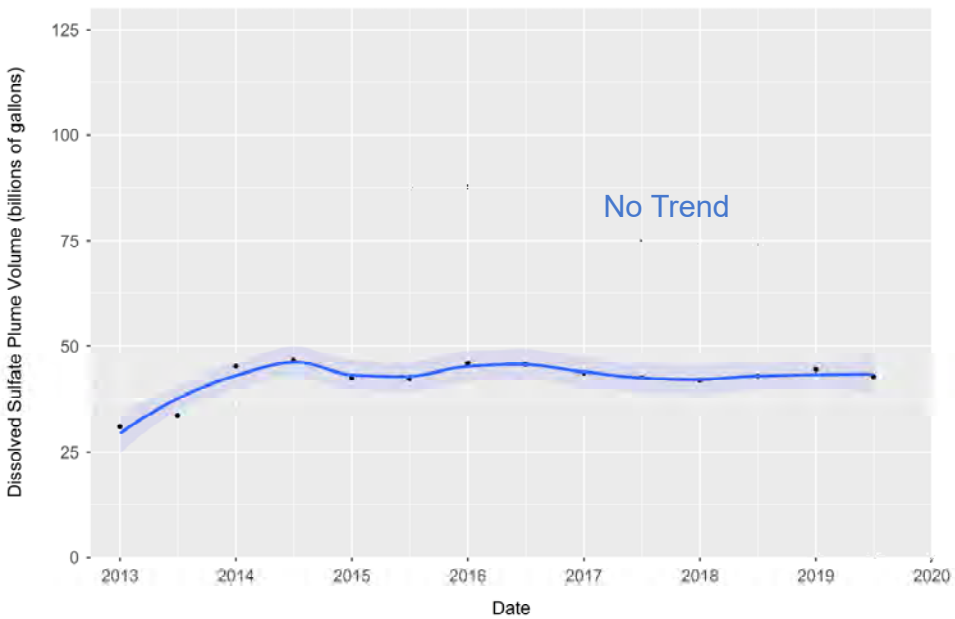
Sulfate Plume (EVS)

SAG Sulfate Bulk Plume Volume

Entire plume

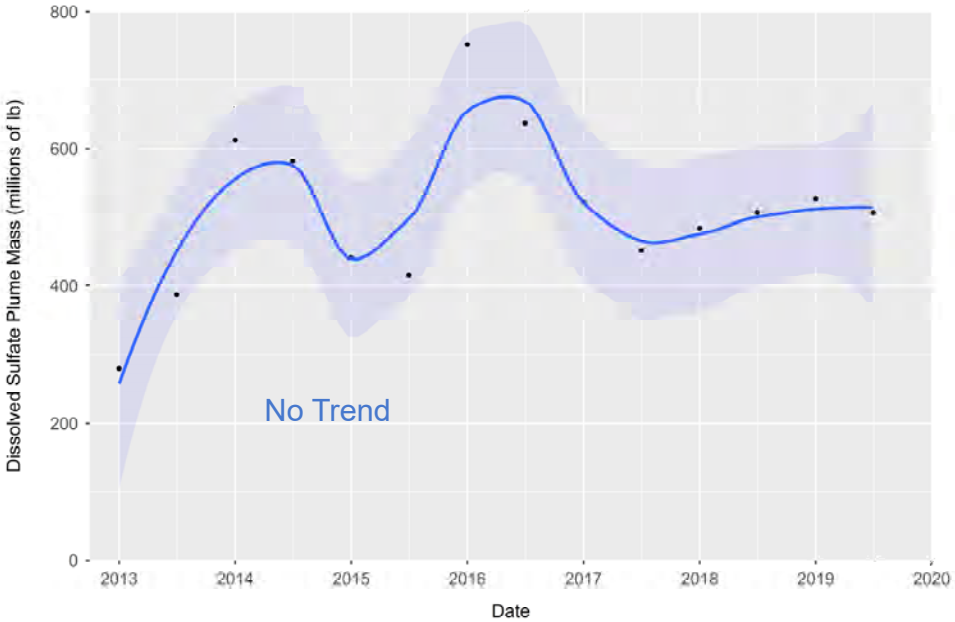


Plume Within Site Boundaries

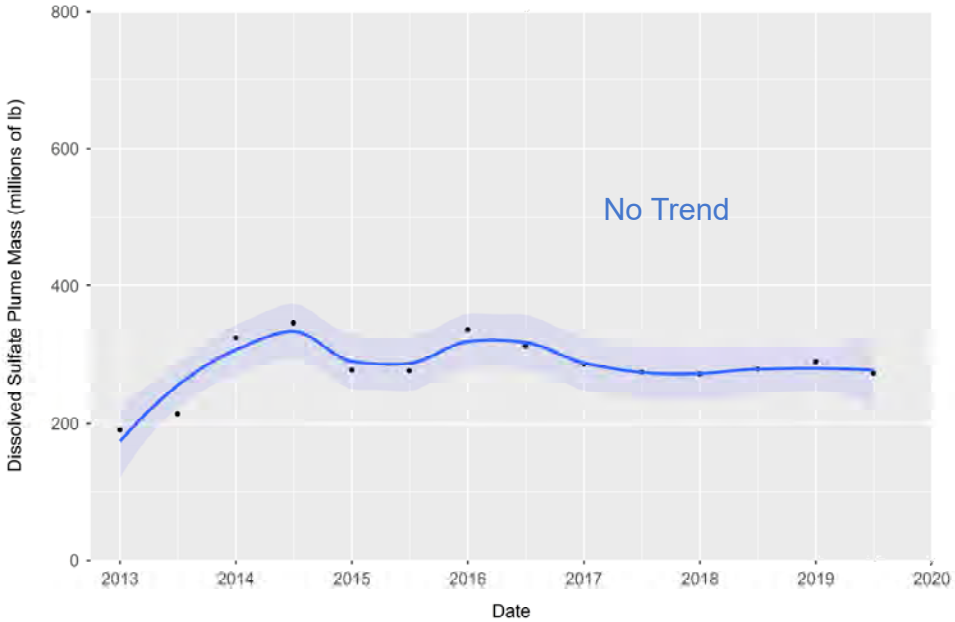


SAG Sulfate Bulk Plume Mass

Entire plume



Plume Within Site Boundaries



Key Questions Revisited

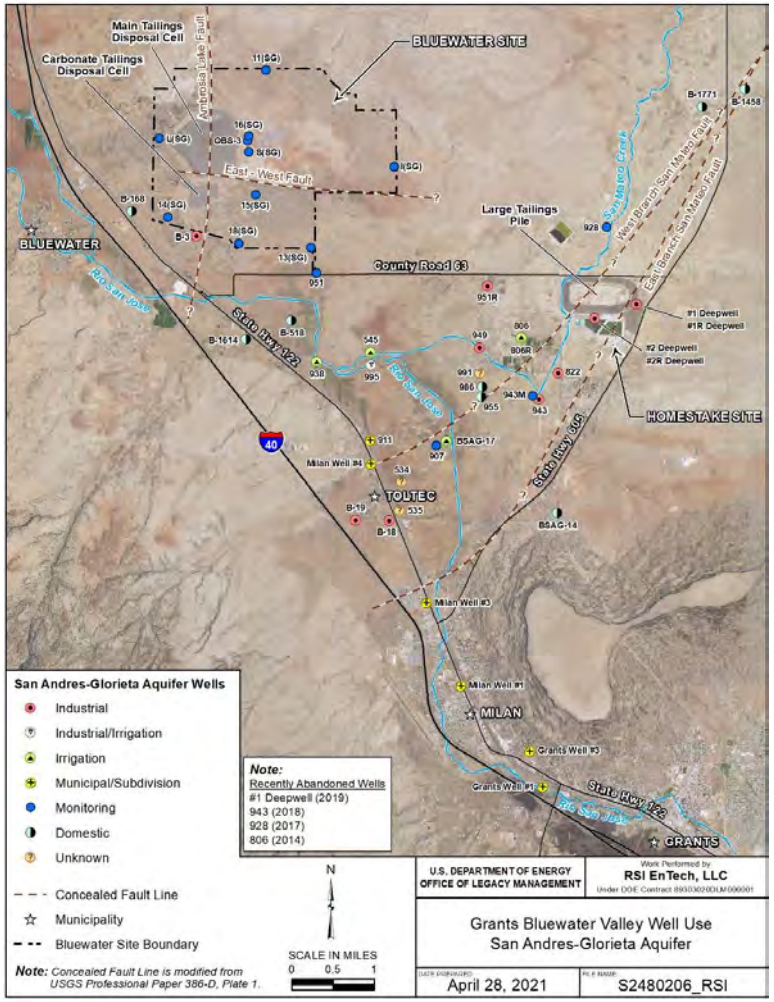
- Have groundwater contaminant plumes originating from Bluewater site activities been growing, shrinking, or stable since DOE took over custody of the site in 1997?
  - All uranium bulk plume metrics from 2013 to 2019 were statistically significant decreasing trends, suggesting that the uranium plume is shrinking
  - All sulfate bulk plume metrics from 2013 to 2019 had no statistically significant trend, suggesting that the sulfate plume is relatively stable
  - Monitoring data from 1997 to 2013 was too inconsistent to calculate consistent plume maps in EVS; plume trends for this time period are unknown
  - Horizontal plume extents in the SAG continue to be interpolated a great distance downgradient from the site boundaries due to a lack of monitoring wells between well I(SG) and 951R

Influences of High-Production Pumping Report

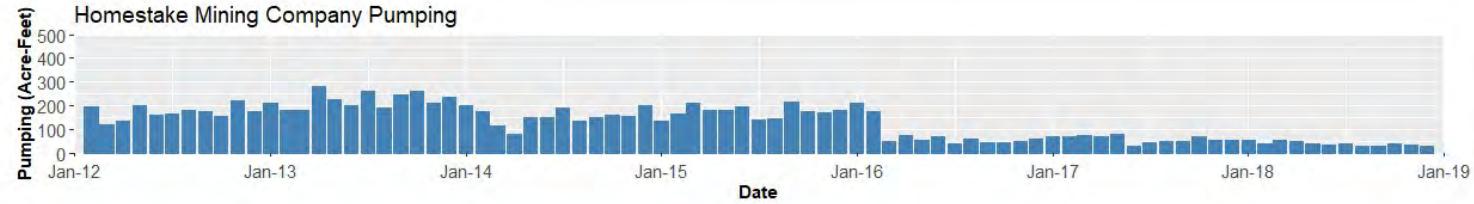
High-Production Pumping Report (August 2020)

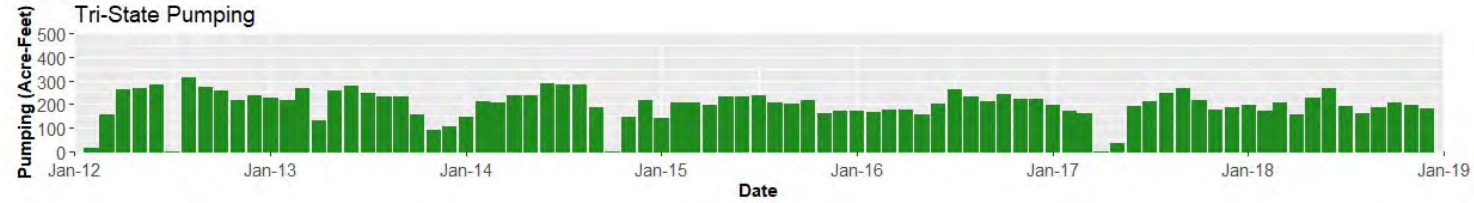
- Groundwater levels and flow directions at the Bluewater site suggested that high-volume pumping southeast of the site influenced site groundwater levels and flow directions
- Contaminant trend data suggested high-volume pumping was not negatively impacting water quality at wells located outside the 2017 uranium SAG plume
  - No increasing trends were observed off-site
- Evaluated the influence of the high-production pumping wells on the flow and transport of the contaminated groundwater in the SAG aquifer
  - Used continuous groundwater-level monitoring data to evaluate patterns and calculate flow directions and gradients
  - Statistical trend analysis conducted for uranium, sulfate, and total dissolved solids (TDS) in on-site and off-site wells

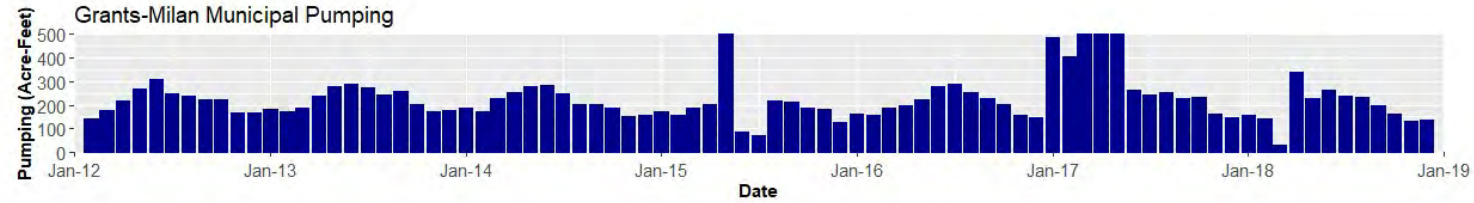
Wells Near the Site

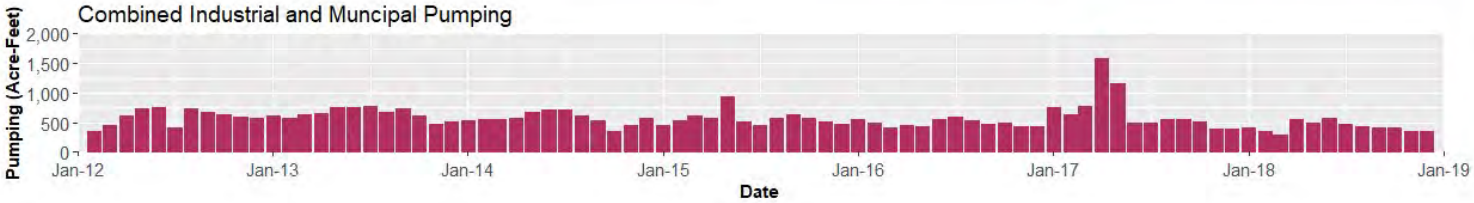


Pumping Records

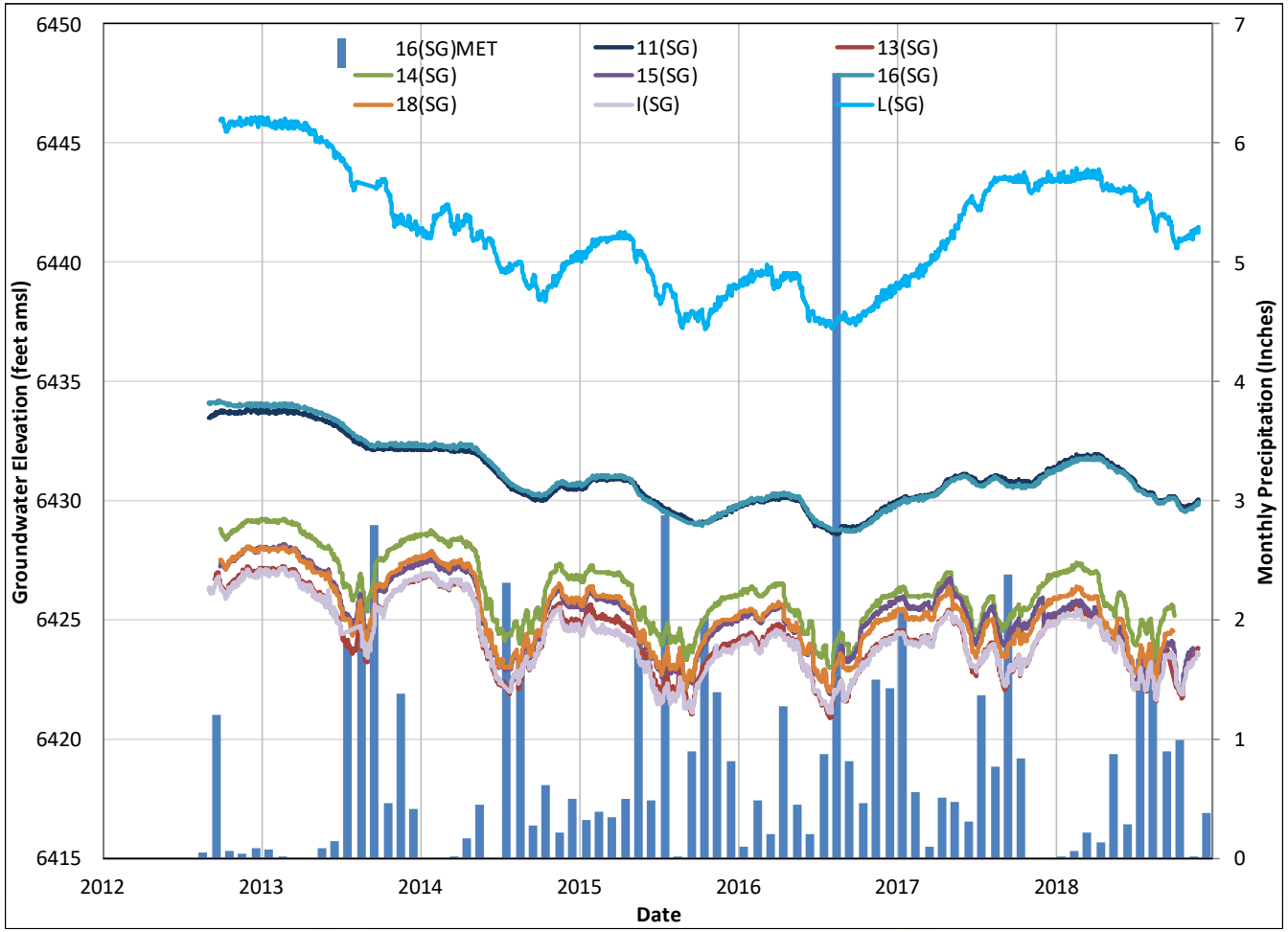




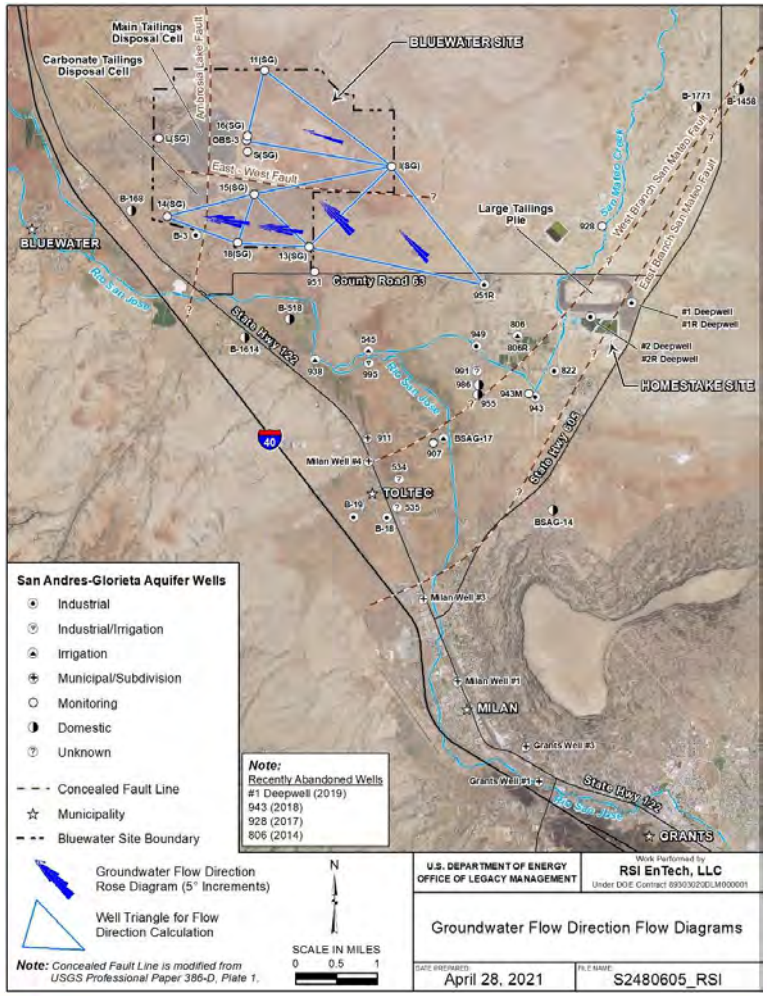




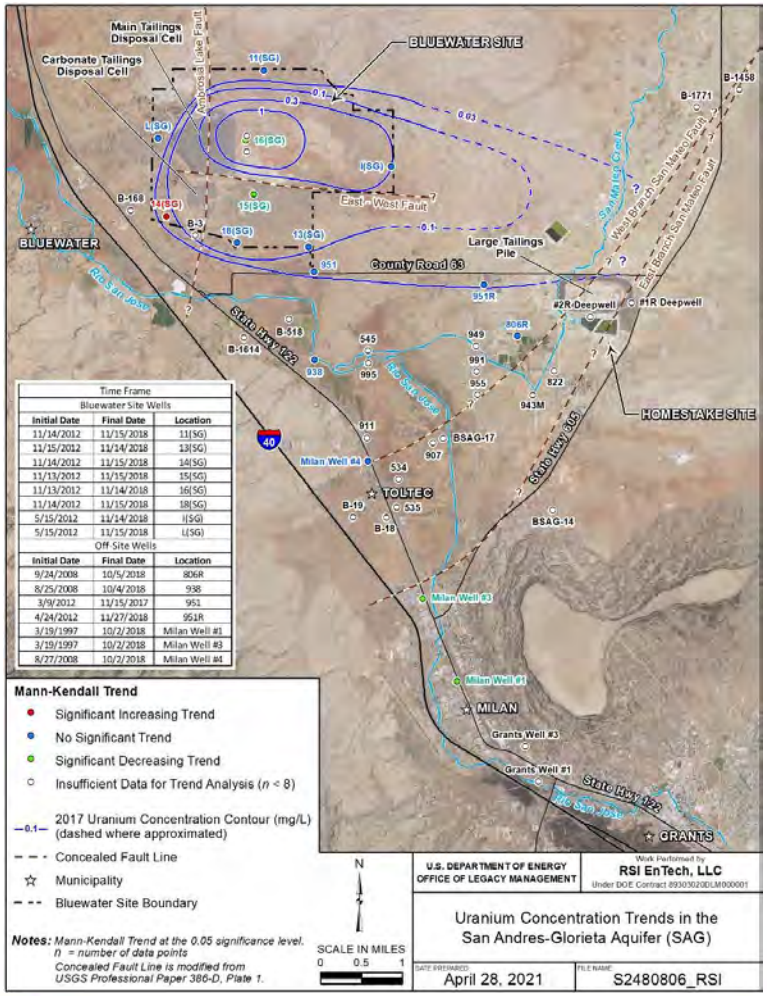
Onsite Groundwater Levels and Monthly Precipitation



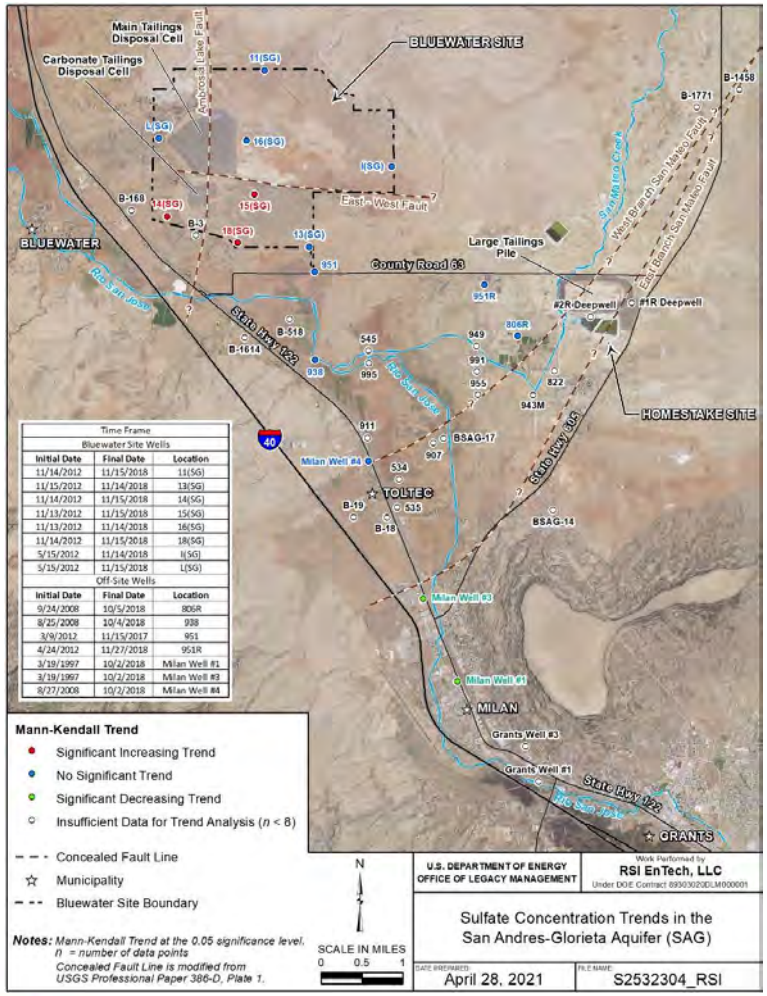
Groundwater Flow Direction Flow Diagrams



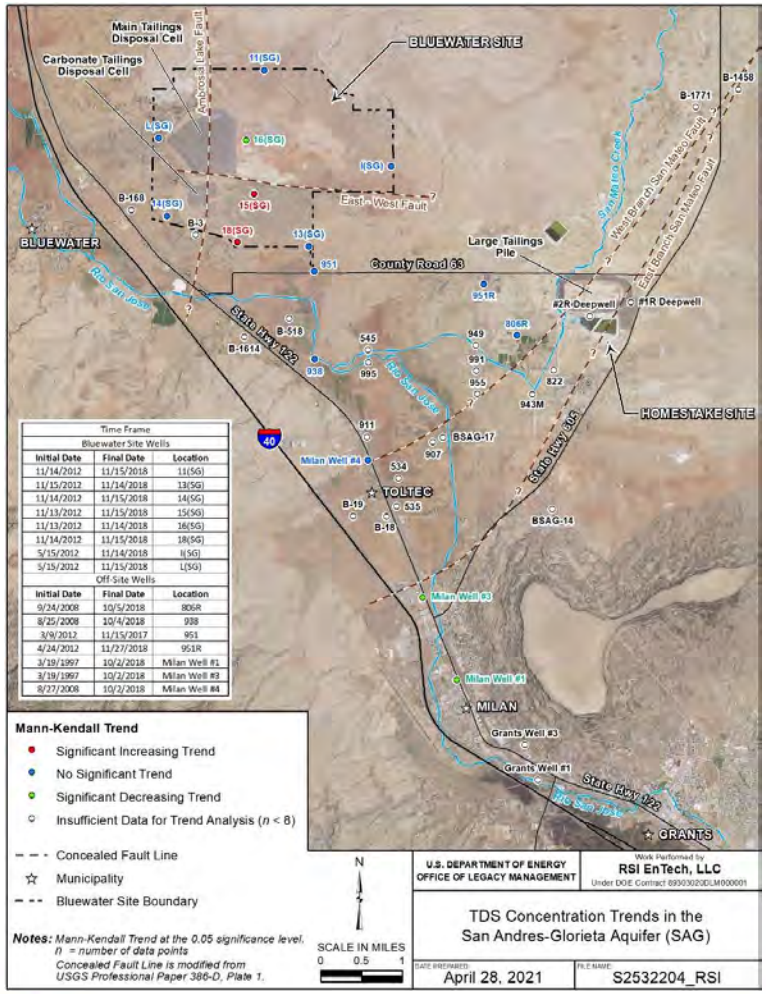
Uranium Concentration Trends by Well



Sulfate Concentration Trends by Well

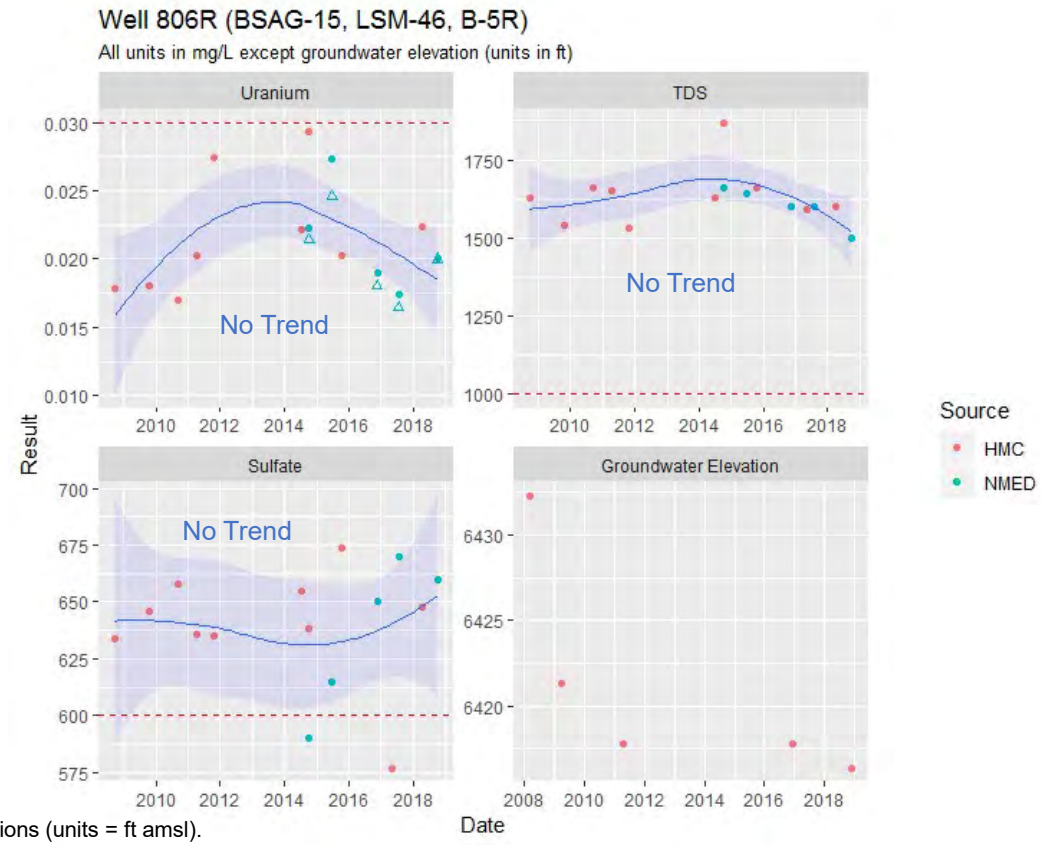


Total Dissolved Solids Trends by Well



Time Frame		
Bluewater Site Wells		
Initial Date	Final Date	Location
11/14/2012	11/15/2018	11(SG)
11/15/2012	11/14/2018	13(SG)
11/14/2012	11/15/2018	14(SG)
11/13/2012	11/15/2018	15(SG)
11/13/2012	11/14/2018	16(SG)
11/14/2012	11/15/2018	18(SG)
5/15/2012	11/14/2018	I(SG)
5/15/2012	11/15/2018	L(SG)
Off-Site Wells		
Initial Date	Final Date	Location
9/24/2008	10/5/2018	806R
8/25/2008	10/4/2018	938
3/9/2012	11/15/2017	951
4/24/2012	11/27/2018	951R
3/19/1997	10/2/2018	Milan Well #1
3/19/1997	10/2/2018	Milan Well #3
8/27/2008	10/2/2018	Milan Well #4

Well-Specific Data and Mann-Kendall Results: 806R



All units in mg/L, except groundwater elevations (units = ft amsl).
——Blue line is a LOESS locally weighted regression line.
Shaded area is the corresponding 95% pointwise confidence interval.
- - - State of New Mexico groundwater standard in mg/L (uranium = 0.03; TDS = 1000; sulfate = 600), included as reference point, not intended to imply compliance requirement.
Fraction: ● Total Δ Dissolved
Regression line and confidence band not shown for groundwater elevation because of insufficient data.
* For well 806R, HMC's most recent (5/4/2017) uranium result (0.114 mg/L) is not shown. Value is anomalous and inconsistent with the historical record.

Summary

- Groundwater levels and flow directions at the Bluewater site suggested that high-production pumping southeast of the site seasonally influenced site groundwater levels and flow directions
- Contaminant trend data suggested there was no clear evidence that high-production pumping was impacting groundwater quality at wells outside of the 2017 uranium plume
  - Geochemical conditions appeared to be stable based on the available data
- The groundwater level and contaminant concentration data used for this evaluation were limited in both the number of wells sampled and the frequency at which they were sampled
  - Routine, comprehensive sampling would better inform long-term contaminant concentration trends at nearby, high-production pumping wells
  - To allow for additional collection of data, the next updated assessment of site conditions is suggested for 2024

New Mexico Environment Department (NMED) Cooperative Agreement activities

New Mexico Environment Department

Amber Rheubottom, Ground Water Quality Bureau
Amber.rheubottom@state.nm.us
505-660-2379

Photo credit Rhett Zyla #IamNMED

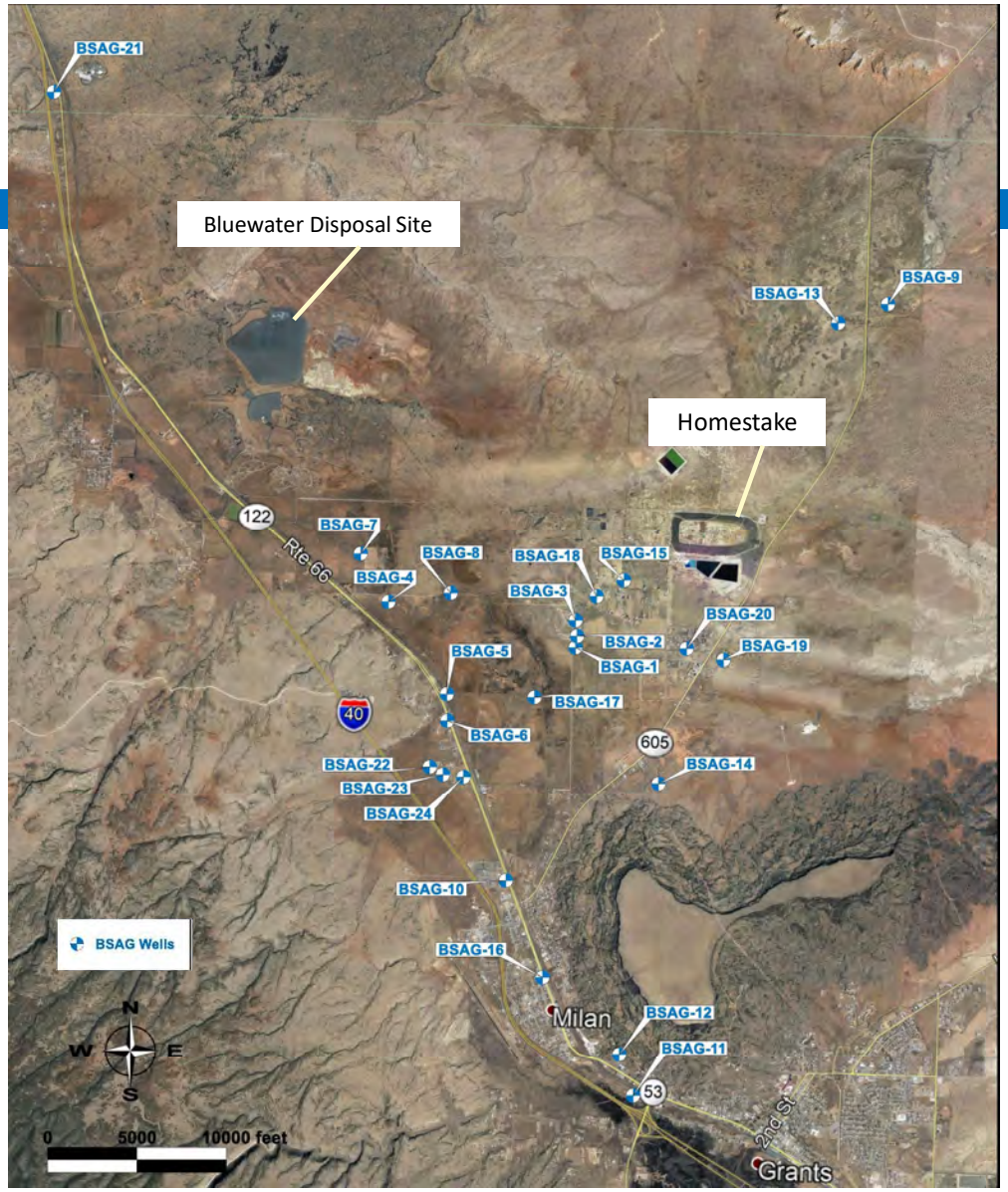
Cooperative Agreement Activities

General

- Participation in site visits
  - Inspections, sampling
  - Repair
- Review of technical documents
- Mechanism for the installation of new wells

Offsite Well Sampling Program

- 24 wells
  - Private, municipal, irrigation
- Water quality results provided to owners & DOE
  - General chemistry & metals
  - No radiochemistry
- No sampling in 2020 due to Covid-19
- Next sampling event is planned for fall 2021


Bluewater Disposal Site
Homestake
BSAG-21
BSAG-13
BSAG-9
122
Rte 66
BSAG-7
BSAG-8
BSAG-18
BSAG-15
BSAG-4
BSAG-3
BSAG-20
BSAG-2
BSAG-19
BSAG-1
BSAG-5
BSAG-17
40
BSAG-6
605
BSAG-14
BSAG-22
BSAG-23
BSAG-24
BSAG-10
BSAG Wells
BSAG-16
Milan
BSAG-12
BSAG-11
53
2nd St
Grants
N
W
E
S
0
5000
10000 feet

National Laboratory Network Collaboration

National Laboratory Network Collaboration

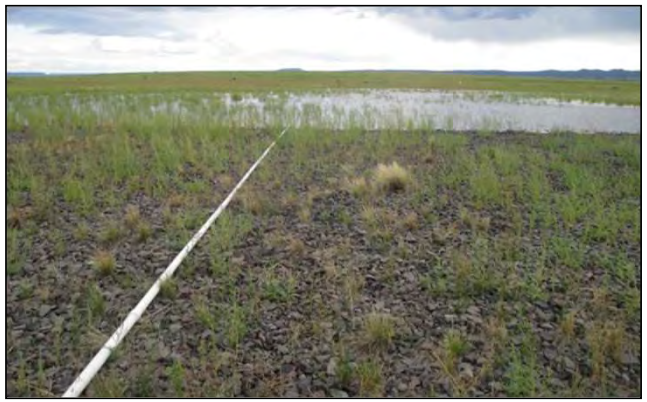
- LM collaborated with the National Laboratory Network in 2020 to develop recommendations for addressing concerns related to the site, including defining the extent of the plume
- In 2021 and 2022, LM will be working with the U.S. Environmental Protection Agency, NRC, NMED, and the New Mexico Office of State Engineer (NMOSE) to further refine the recommendations
- LM will develop a workplan for addressing groundwater concerns at the site within its regulatory authority

Main Tailings Disposal Cell Repair Project

Background

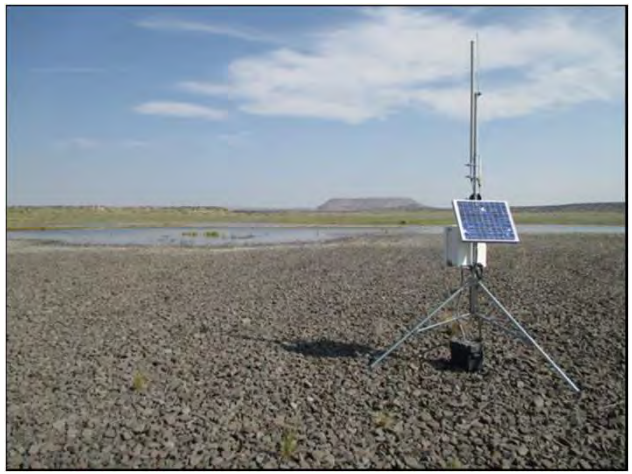
- Shallow depressions were noted during the first DOE inspection in 1998
- Depressions continued to enlarge (area and depth)
- Settlement is caused by continued consolidation of clay-rich tailings
- Ponds form during the monsoon season and after major precipitation events
  - Small ponds form into one large pond after significant storms
- Main risk from the depressions: Large storm events filling the ponds to the point of overflowing, potentially causing localized erosion of the main tailings disposal cell cover

Mitigation and Monitoring



Siphon on the main disposal cell

Ponding on the main disposal cell



Web camera on the main disposal cell

Actions to Date and Next Steps

- In 2018 and 2019, LM worked with a subcontractor to develop several options to repair the depressions and return the main tailings disposal cell to a condition where stormwater is effectively shed
- In 2019, LM entered into an Interagency Agreement with the U.S. Army Corps of Engineers (USACE) to design repair to the main tailings disposal cell and construct the repair
  - NRC and NMED will be involved in reviewing the designs
- In 2020 and 2021, LM and USACE have been:
  - Developing a project management plan
  - Conducting an aerial survey of the main tailings disposal cell in April 2021 to provide updated topographic information
  - Planning for a geotechnical investigation of the main tailings disposal cell to occur in 2022

Other Site Projects

Other Upcoming Site Projects

- Pollinator study to occur in August 2021
  - Focus on Monarch butterflies, currently under consideration by U.S. Fish and Wildlife Service (USFWS) for protection under the Endangered Species Act
- Installation of game cameras to monitor for the presence of the Gunnison prairie dog, listed as sensitive species by the U.S. Bureau of Land Management and USFWS

Monarch caterpillar on horsetail milkweed on the main disposal cell

Virtual Site Tour

Additional Site Information

Site Resources

- Bluewater site website: www.lm.doe.gov/bluewater/Sites.aspx
- GEMS website with Bluewater site data: gems.lm.doe.gov/#site=BLU

Questions?