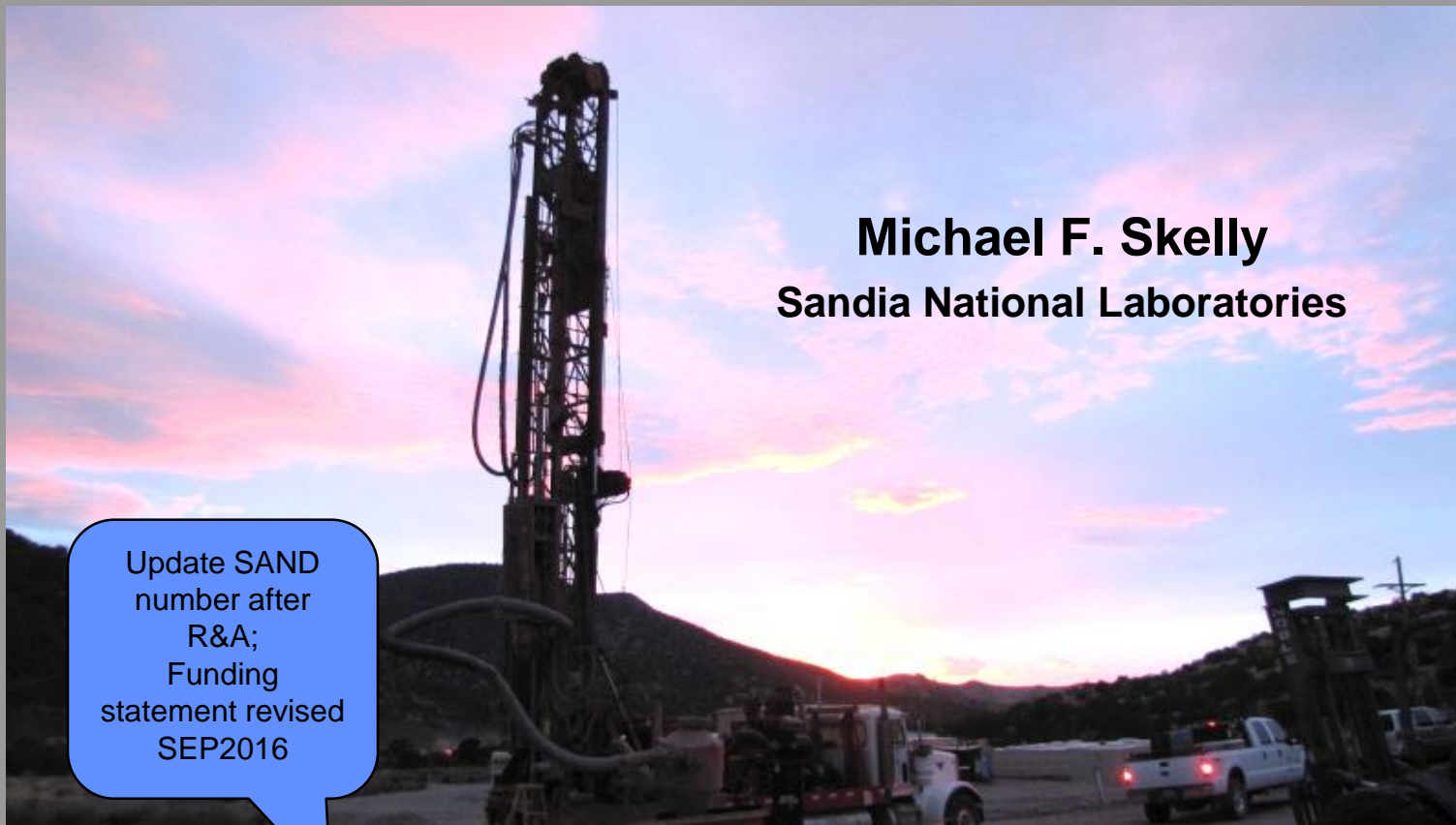


Burn Site Groundwater Area of Concern Characterization Activities Update, October 2016



Michael F. Skelly
Sandia National Laboratories

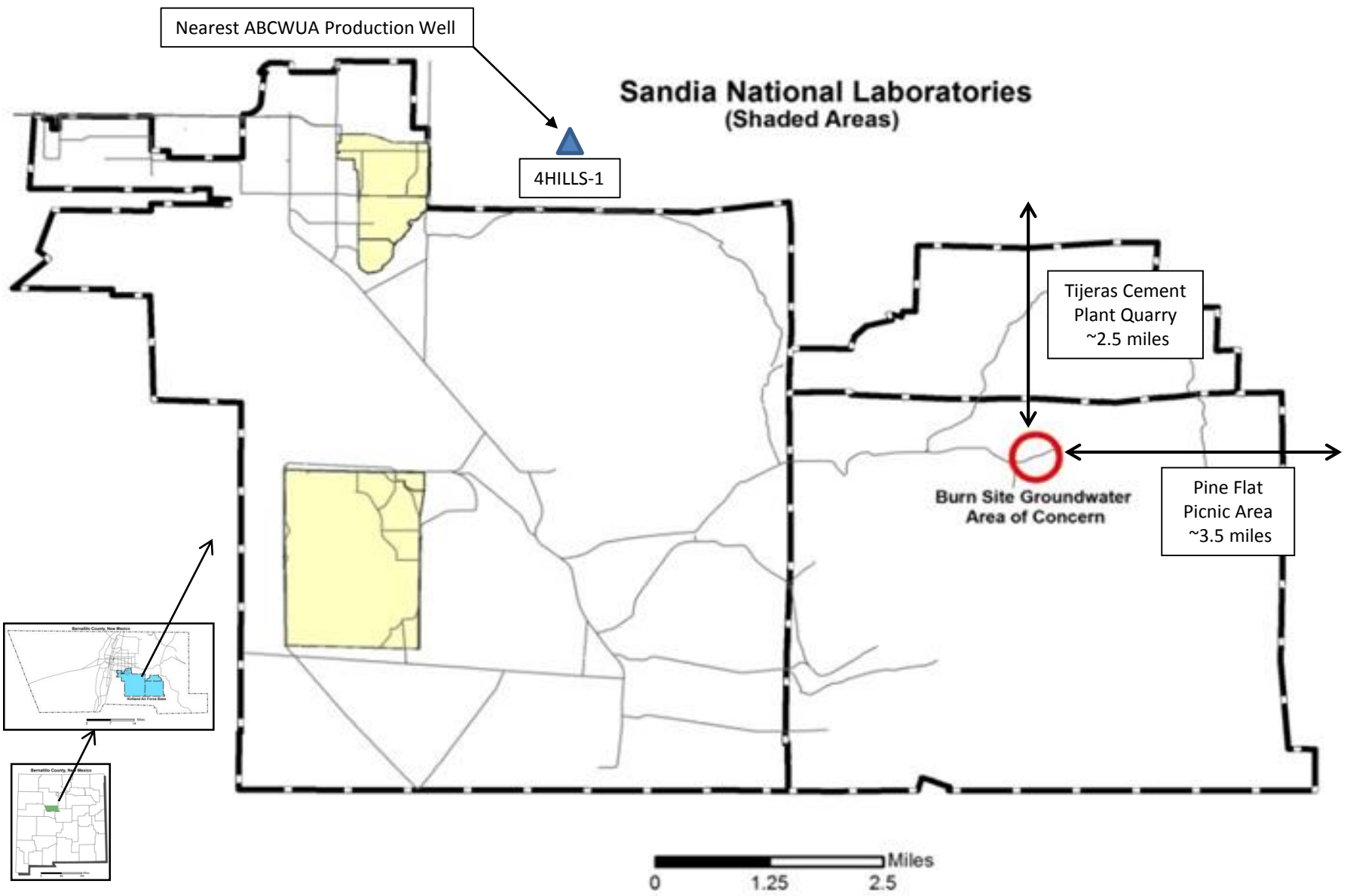
Update SAND
number after
R&A;
Funding
statement revised
SEP2016



Outline of Discussion

- Hydrogeologic Setting (complex)
- Site History
- Contaminant Distribution and Trends
- Recent Investigation Activities
- Future Work

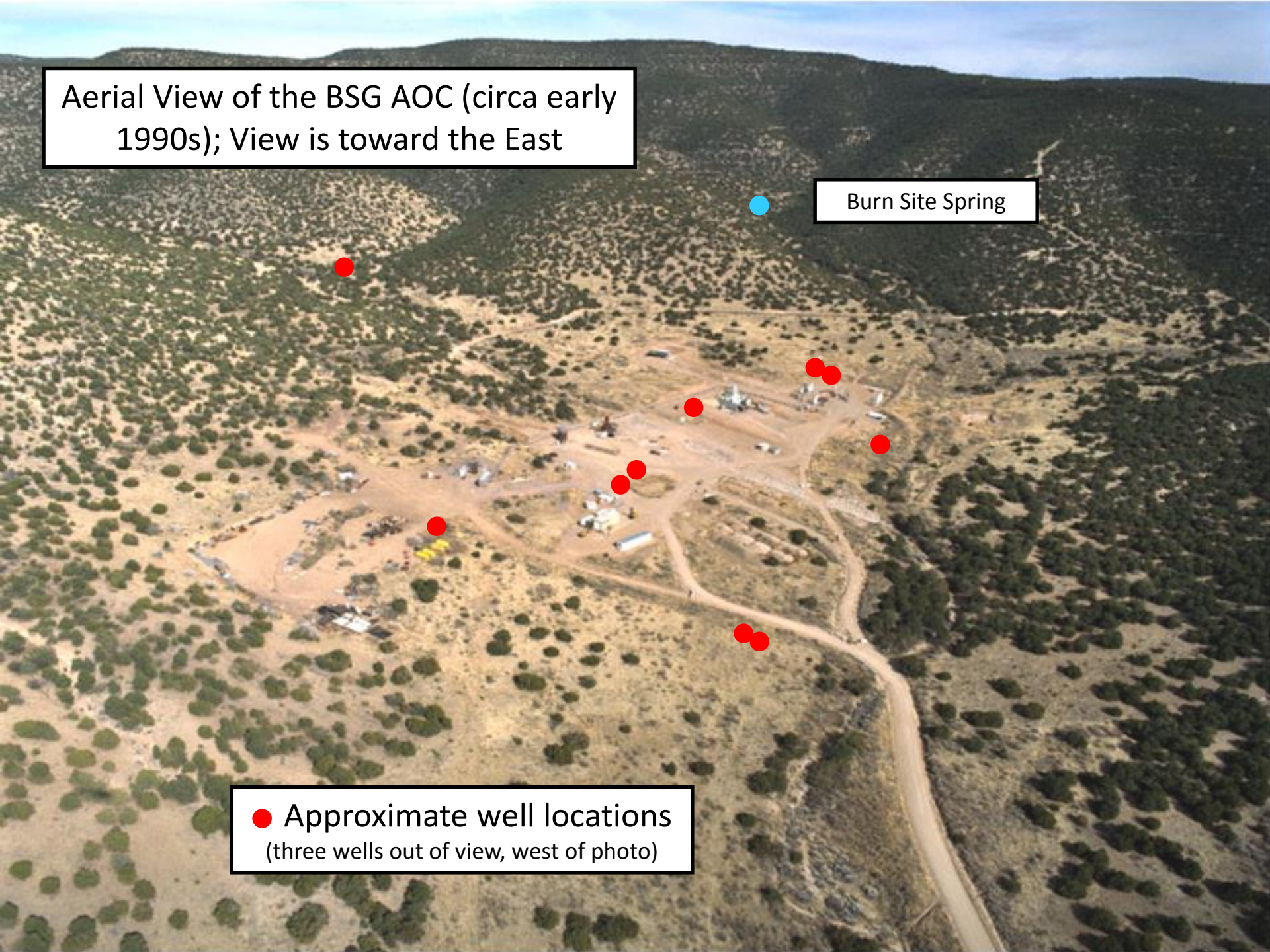
Location of Burn Site Groundwater Area of Concern



Aerial View of the BSG AOC (circa early 1990s); View is toward the East

Burn Site Spring

● Approximate well locations
(three wells out of view, west of photo)

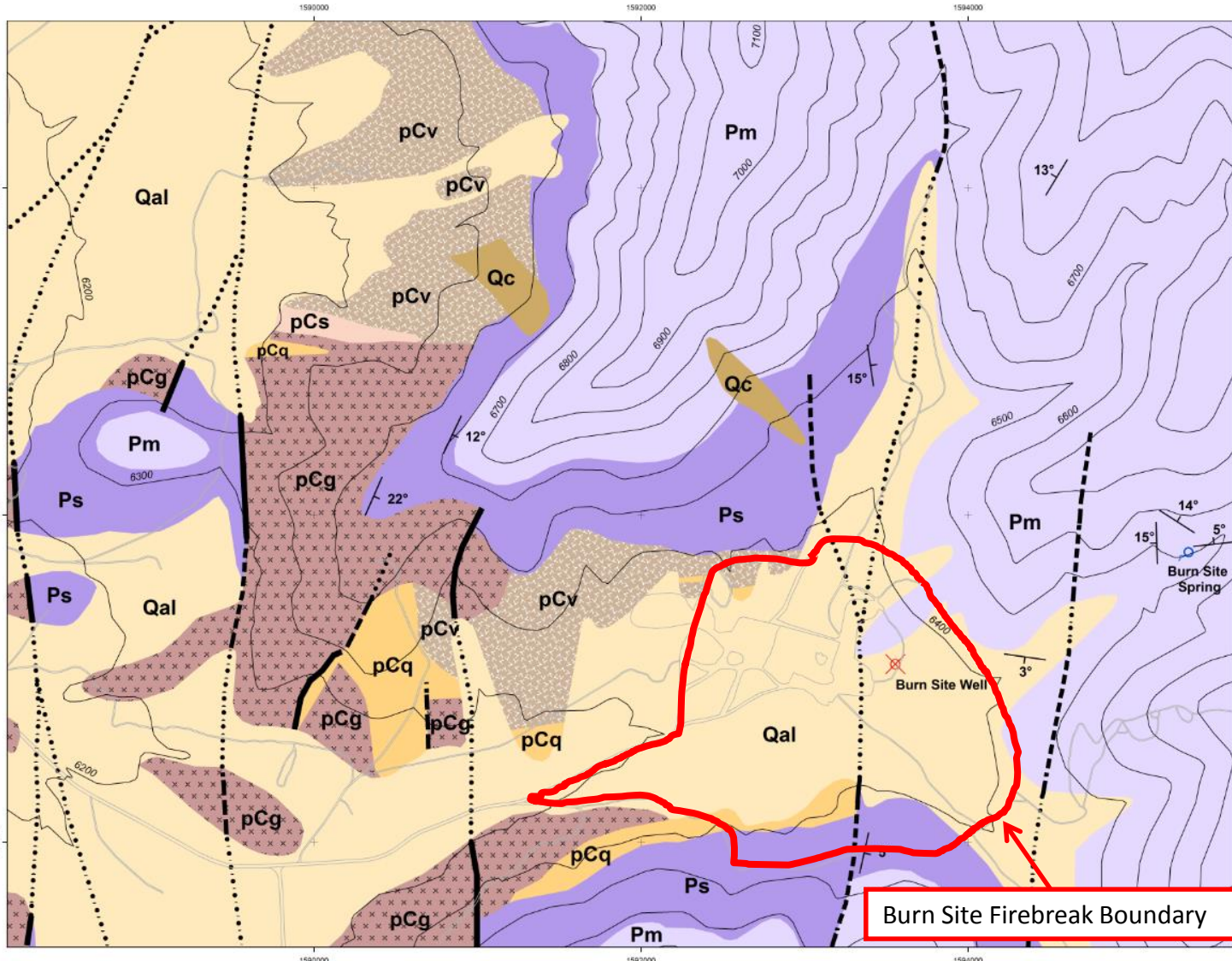




General Conditions at BSG AOC

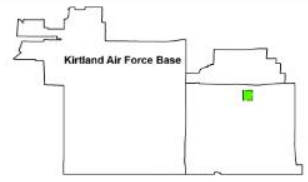
- GW monitored since 1996.
- Potentiometric surface at ~90 to 326 ft deep (average of ~200 ft) in a very complex fractured-bedrock aquifer (schist/phyllite/granite).
- Semiconfined to confined conditions. Narrow fracture zones, poorly interconnected--only produce a few gpm.
- Currently sampling 10 wells and collecting water levels in 12 wells.
- Nitrate currently exceeds standard in 7 wells with historical maximum of 41.9 ppm (MCL = 10 ppm).
- Nitrate plume is ~8 mi. east of nearest downgradient drinking-water well.
- Coyote Springs (perennial) are ~3 miles downgradient, and has ~0.5 ppm nitrate.

BSG AOC Geologic Map



Legend

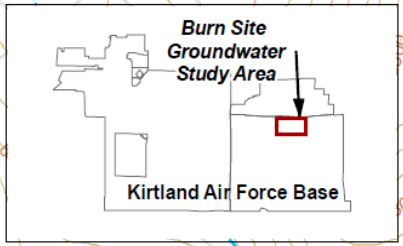
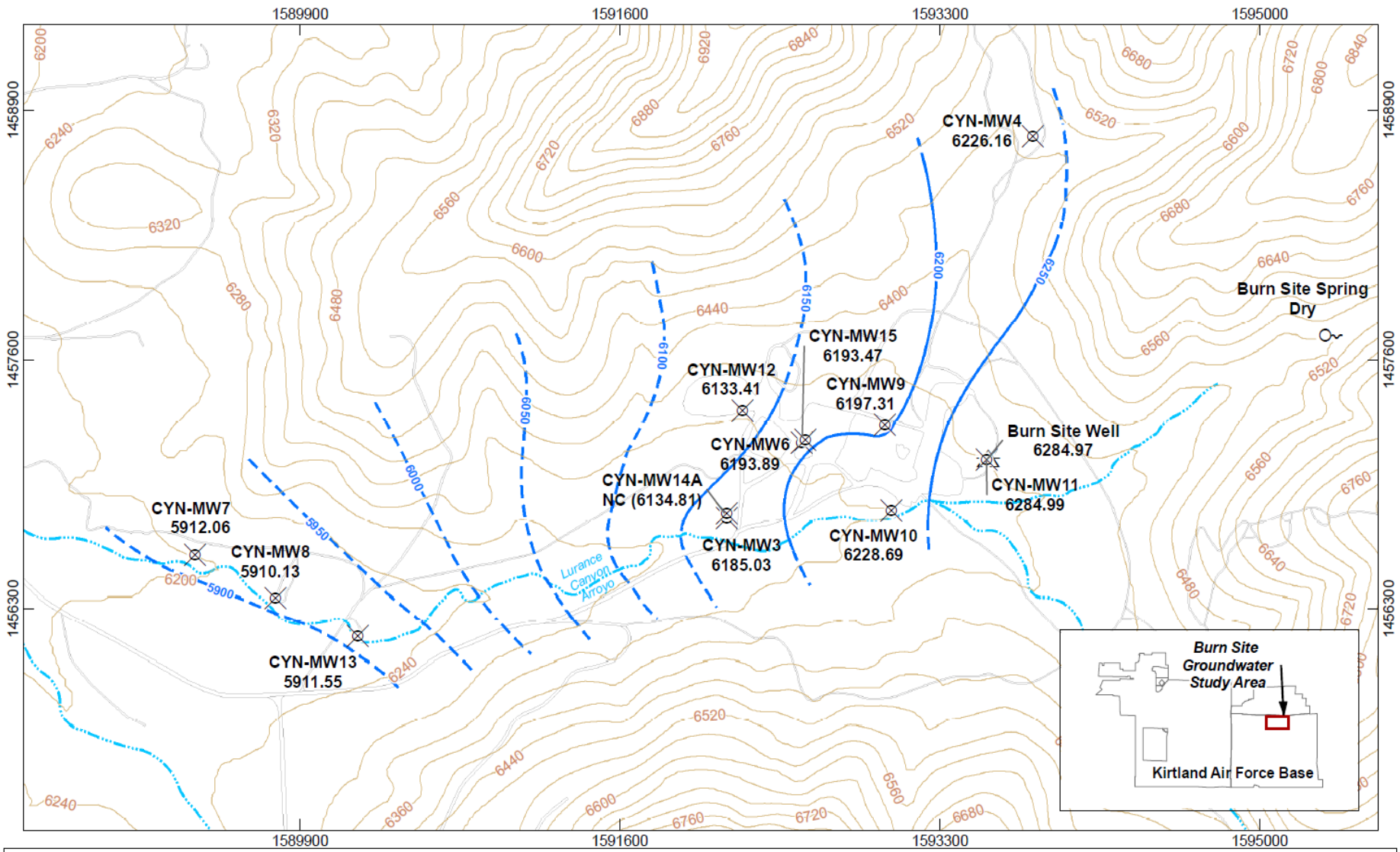
- Quaternary Units**
- Alluvium = Qal
 - Colluvium = Qc
- Pennsylvanian Units**
- Sandia Formation = Ps
 - Madera Group = Pm
- Precambrian Units**
- Granite = pCg
 - Quartzite = pCq
 - Metavolcanic = pCv
 - Schist and Phyllite = pCs
- Symbols**
- fault, concealed
 - - - fault, normal, approximate
 - fault, normal, certain
 - fault, normal, concealed
 - Topographic contour, 100-ft interval
 - Road, unpaved
 - ⊗ Burn Site Well
 - Burn Site Spring
 - ↘ Strike and dip (in degrees)
- 0 700 1,400
Feet
0 220 440
Meters



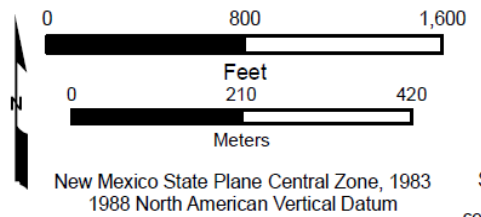
Geologic Map of The Burn Site Area
(Modified from Connell, 2008)



Burn Site Firebreak Boundary



- Legend**
- ⊗ Monitoring well, groundwater
Groundwater elevation (ft amsl)
October 2015, datum NAVD 88
 - △ Production well (non-potable)
 - Spring
 - NC Not contoured
 - Potentiometric surface contour
(ft amsl), dashed where inferred
 - Surface drainage, arroyo
 - Road, unpaved
 - Ground surface contour (40 ft)



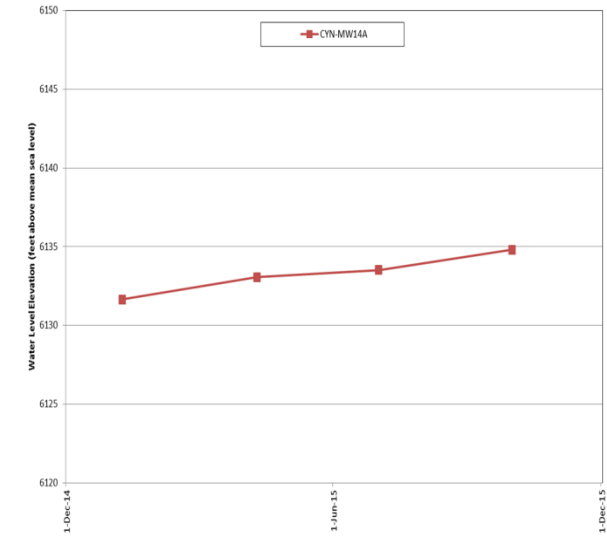
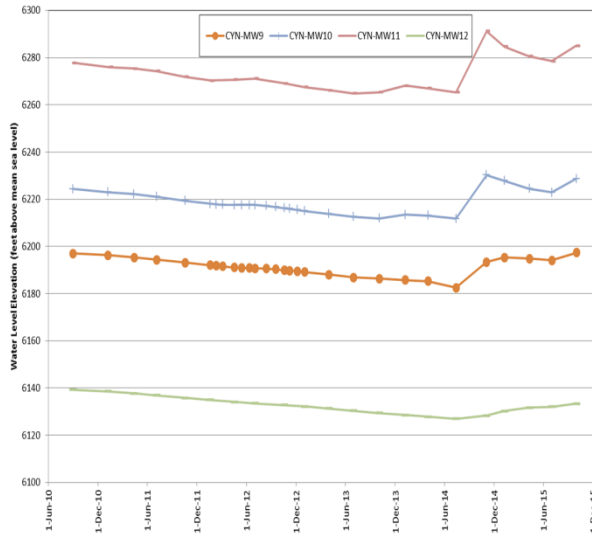
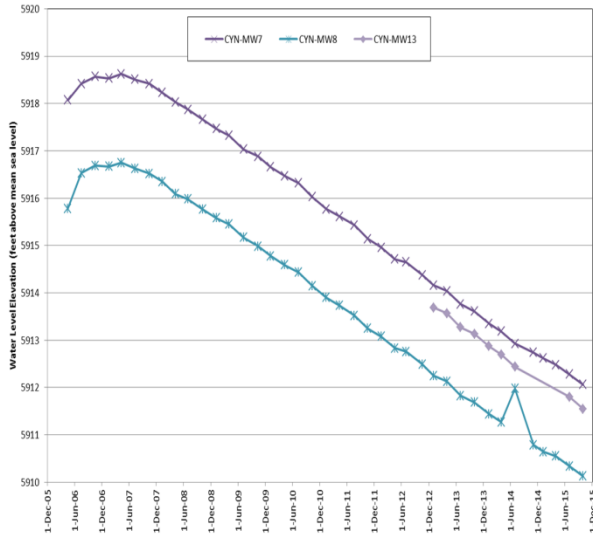
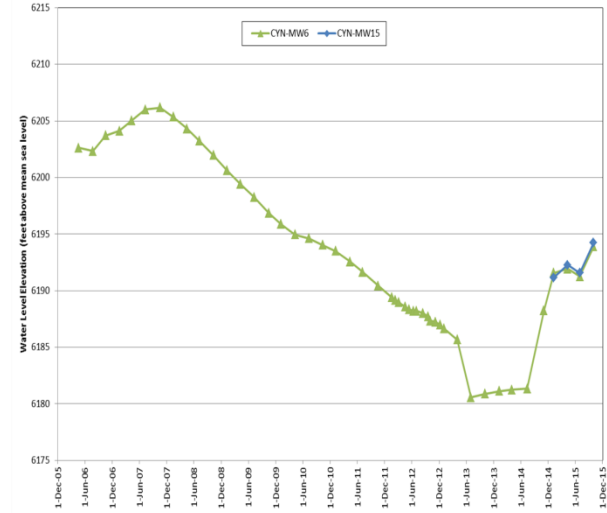
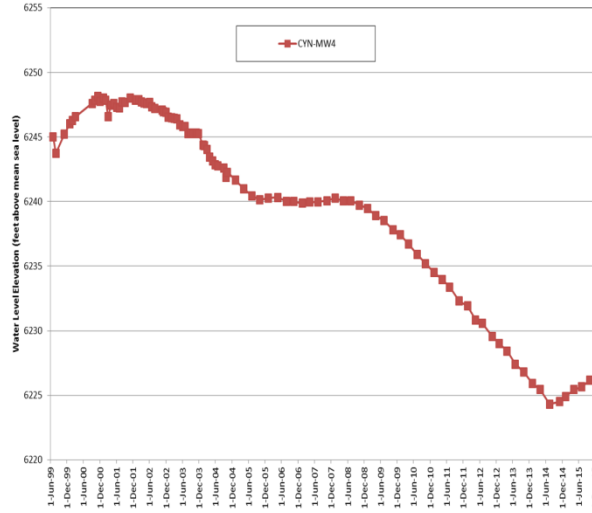
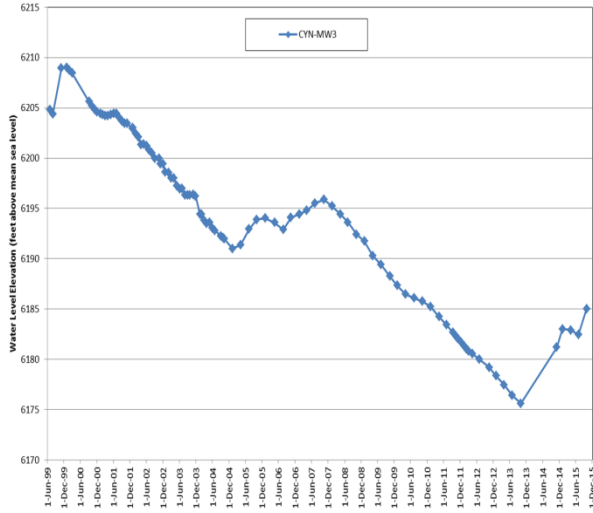
EGIS

Sandia National Laboratories

SNL EGIS.ORG.4142
ce16503 3-16-16 / mb115002

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BSG Water Levels Over Time





History of the Burn Site

- Groundwater characterization activities are regulated by NMED Hazardous Waste Bureau.
- The Lurance Canyon Burn Site and Lurance Canyon Explosive Test Site have been used since 1967.
- Historical operations included open detonation of HE compounds and open burning of HE compounds, liquid propellants, and solid propellants.
- Ammonium nitrate slurry tests conducted in 1969-1970.
- Burn testing using petroleum fuels began in early 1970s and has continued to the present.
- Early burn testing was conducted in unlined pits excavated in native alluvium and bedrock.



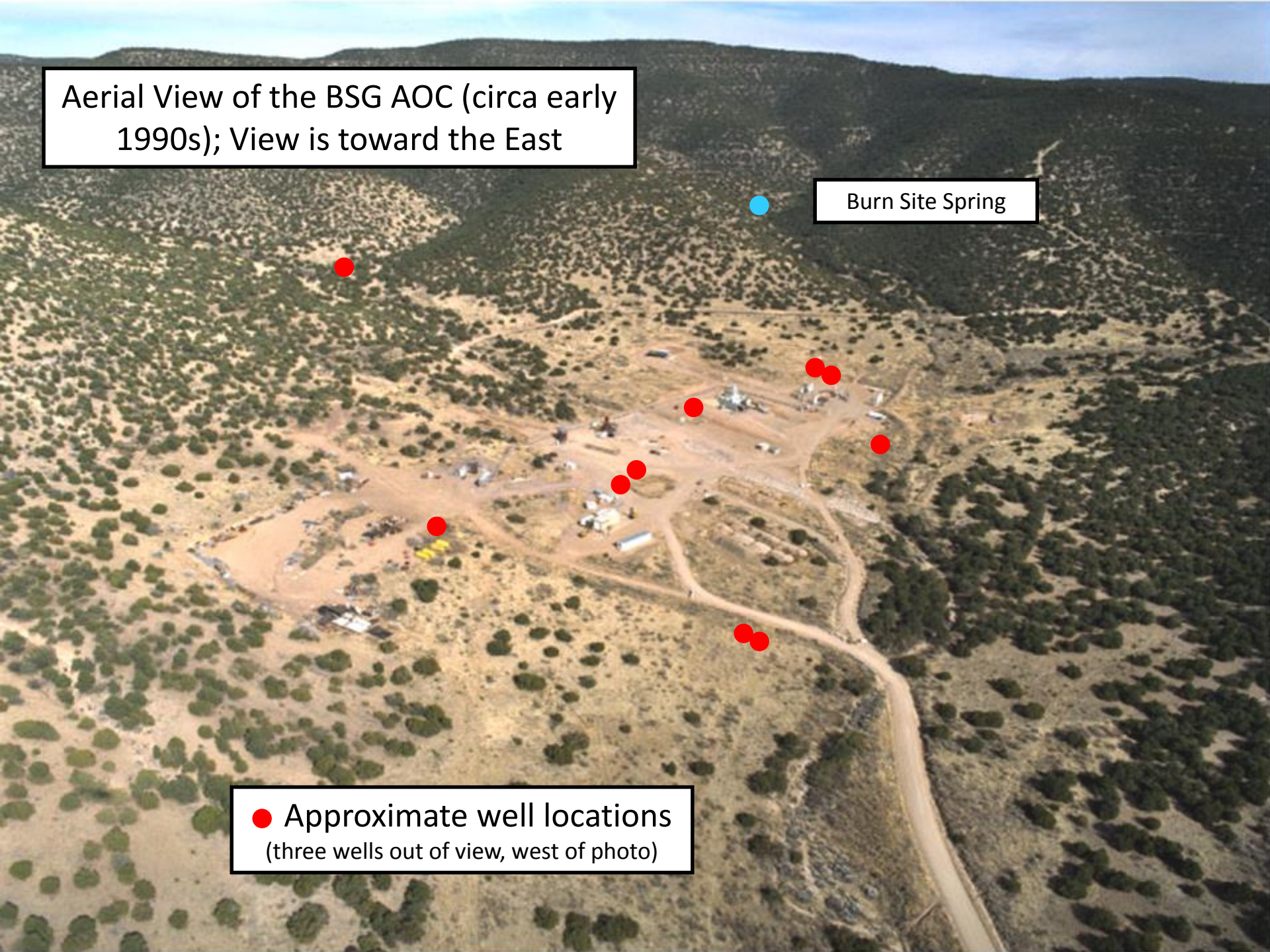
History of the Burn Site (continued)

- By 1975, portable, steel, burn pans were used for open burning with excess materials collected for reuse.
- Engineered burn units constructed in 1980 through 1983.
- Burn units used jet fuel.
- Research involves testing fire survivability of transportation containers, weapon components, simulated weapons, and satellite components.
- 16 SWMU subunits investigated for potential soil contamination; all approved for Corrective Action Complete.

Aerial View of the BSG AOC (circa early 1990s); View is toward the East

Burn Site Spring

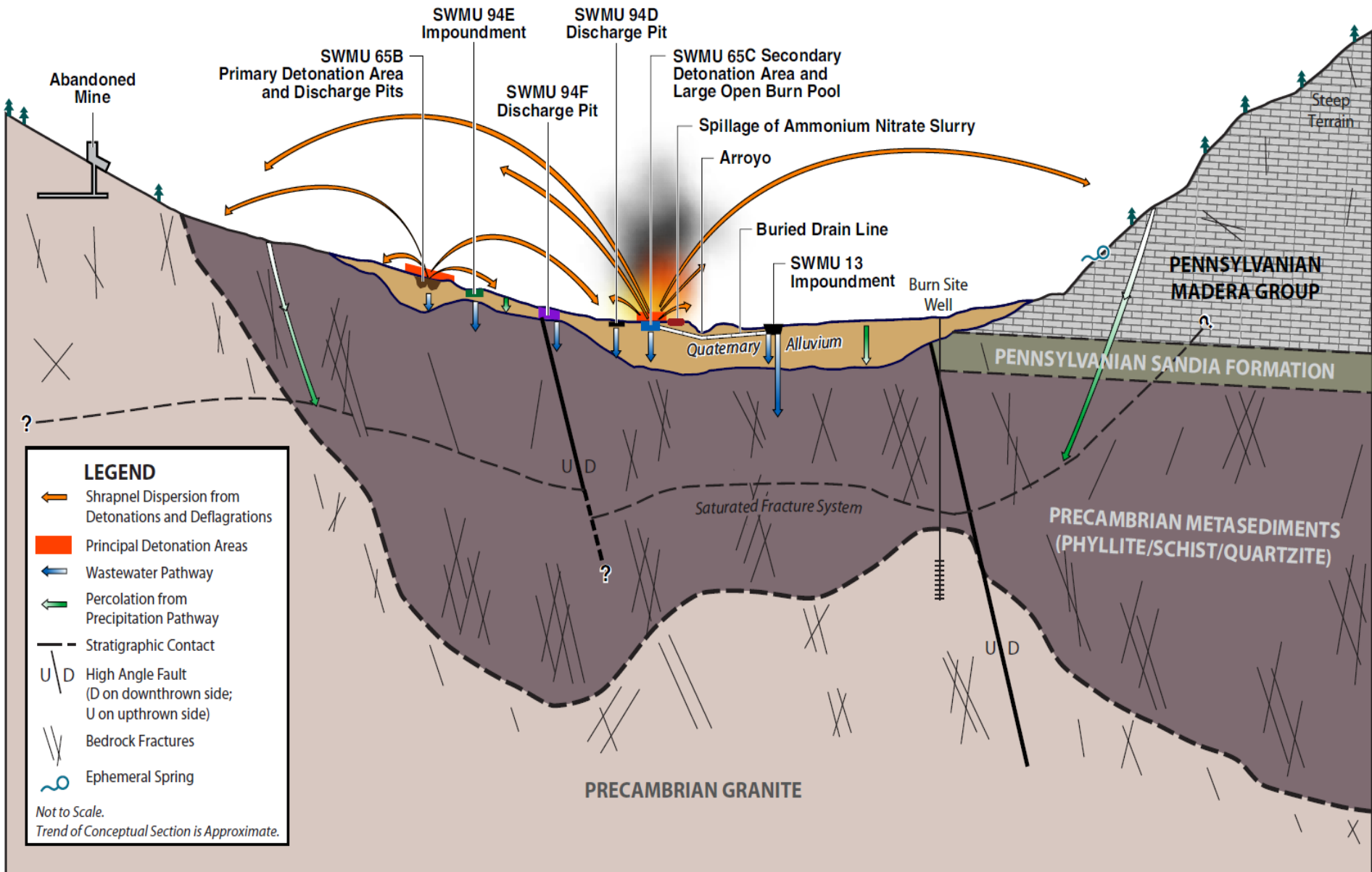
● Approximate well locations
(three wells out of view, west of photo)



Lurance Canyon

WEST

EAST

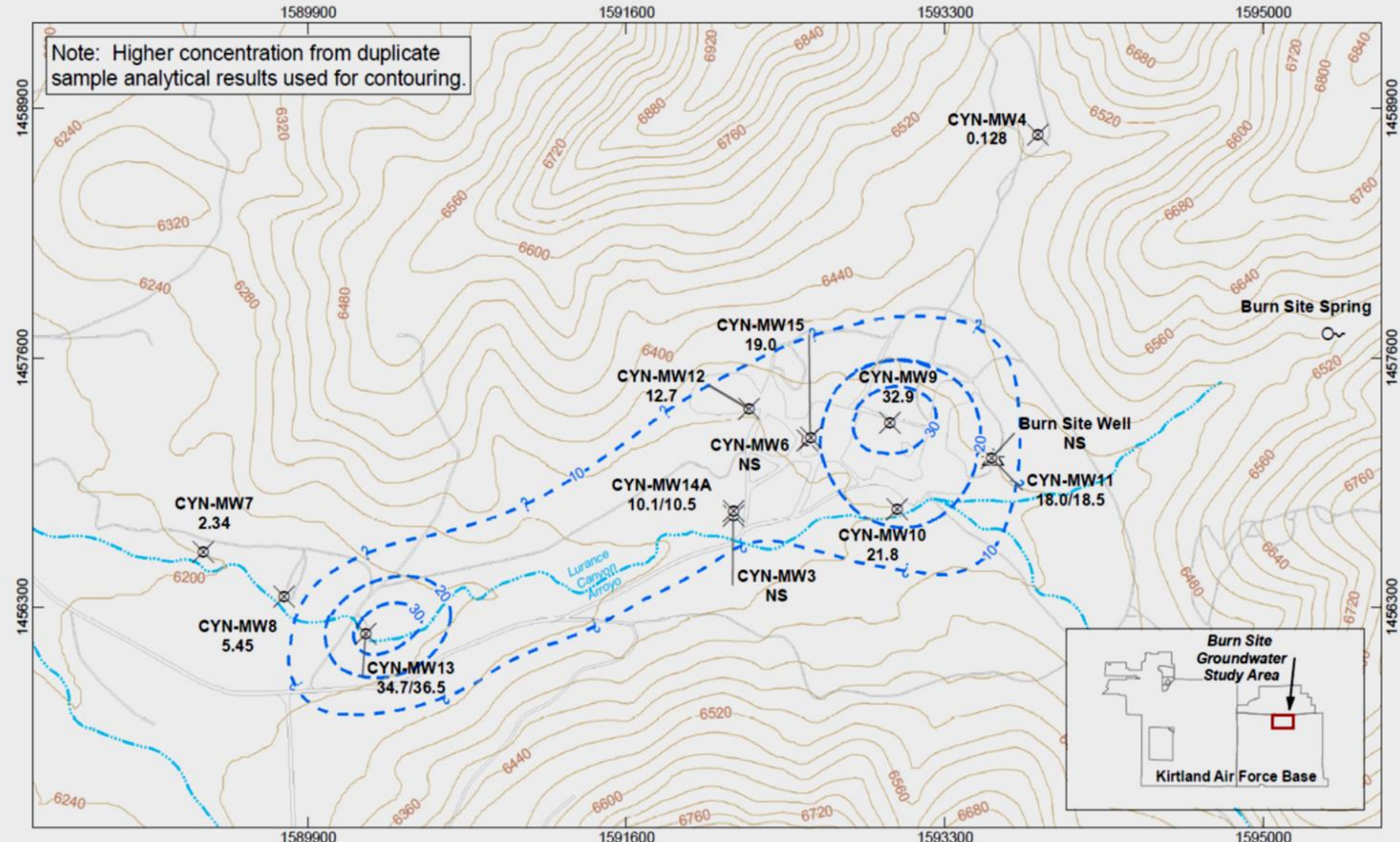


LEGEND

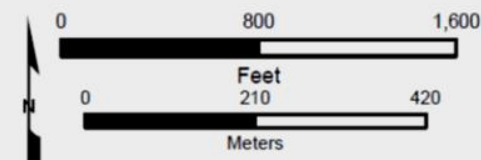
- Shrapnel Dispersion from Detonations and Deflagrations
- Principal Detonation Areas
- Wastewater Pathway
- Percolation from Precipitation Pathway
- Stratigraphic Contact
- High Angle Fault (D on downthrown side; U on upthrown side)
- Bedrock Fractures
- Ephemeral Spring

*Not to Scale.
Trend of Conceptual Section is Approximate.*

Potential Contaminant Release Mechanisms at the Burn Site Groundwater Area of Concern



- Legend**
- ⊗ Monitoring well, groundwater
 - 12.7 October/November 2015 Nitrate plus Nitrite concentration, mg/L
 - △ Production well (non-potable)
 - Spring
 - NS Not sampled
 - Concentration contour (mg/L) dashed where inferred, queried where uncertain
 - Surface drainage, arroyo
 - Road, unpaved
 - Ground surface contour (40 ft)



New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

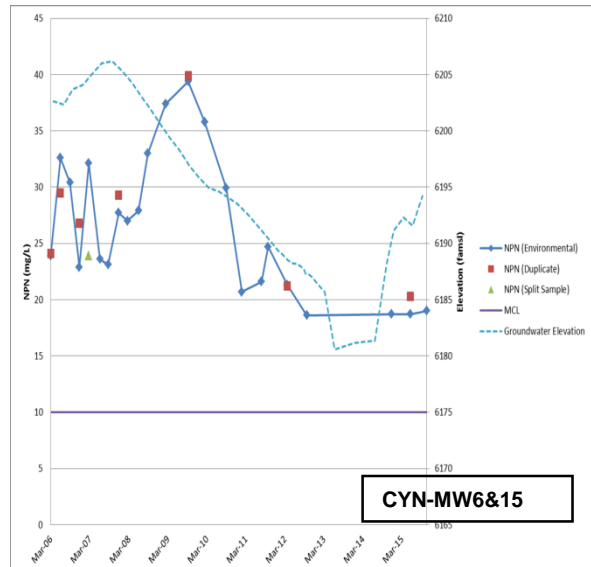
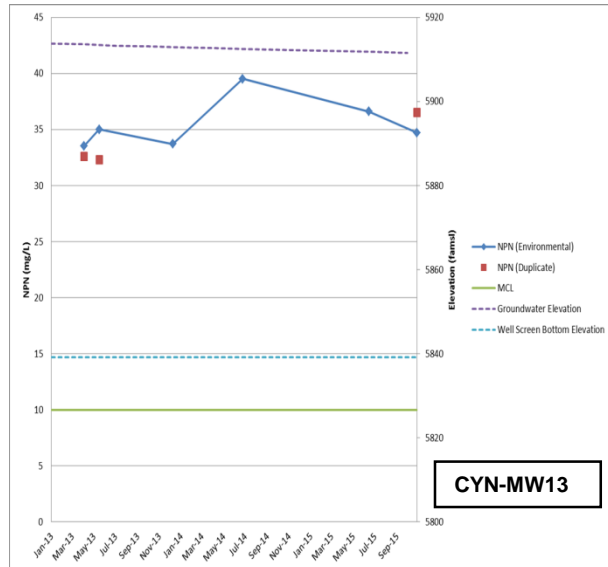
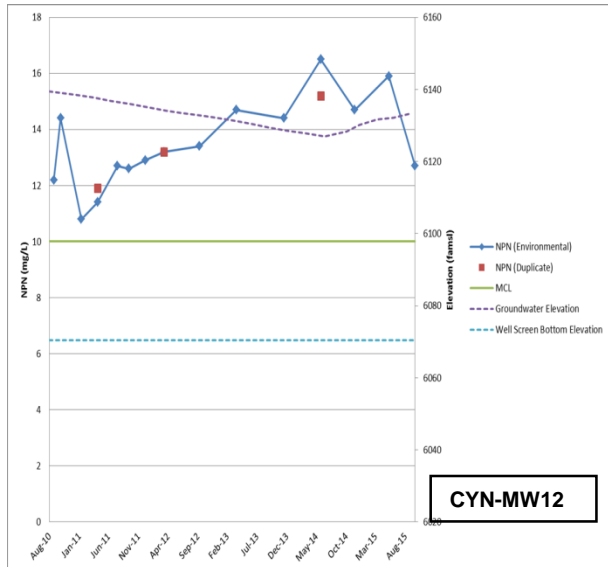
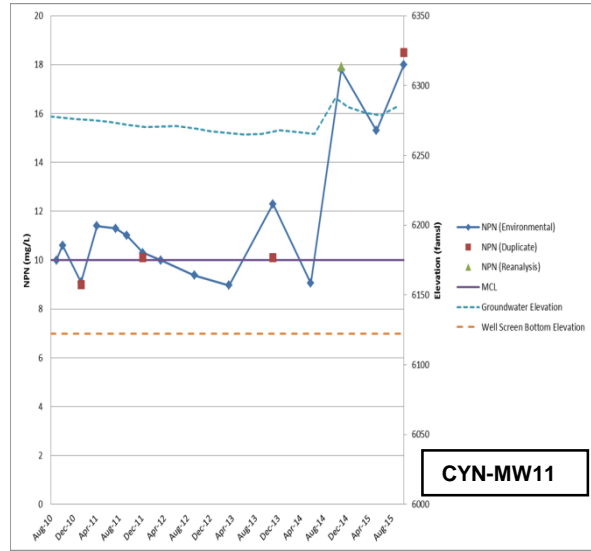
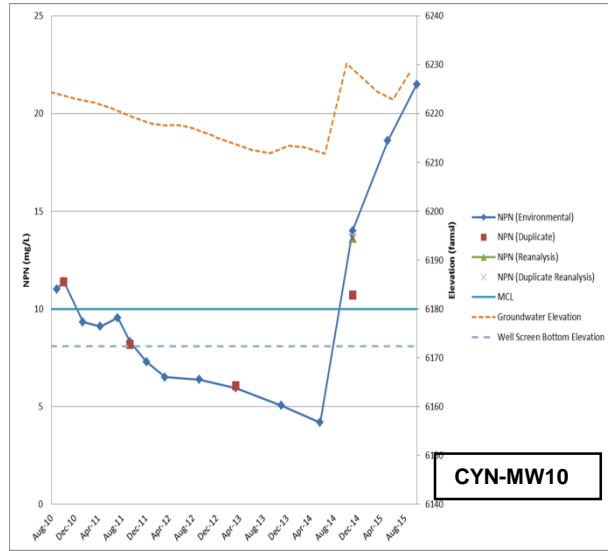
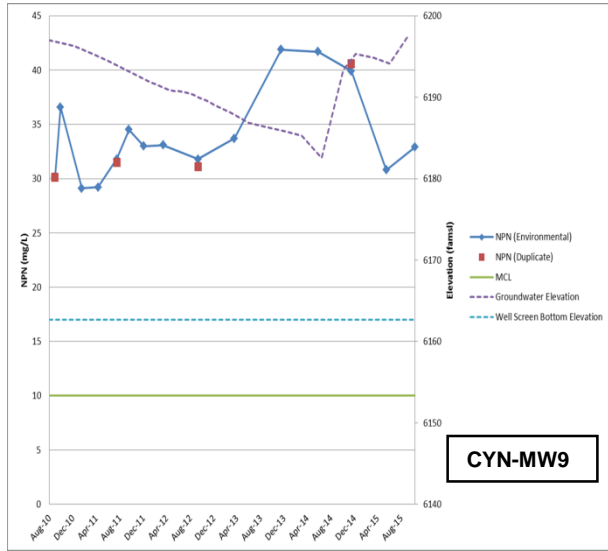


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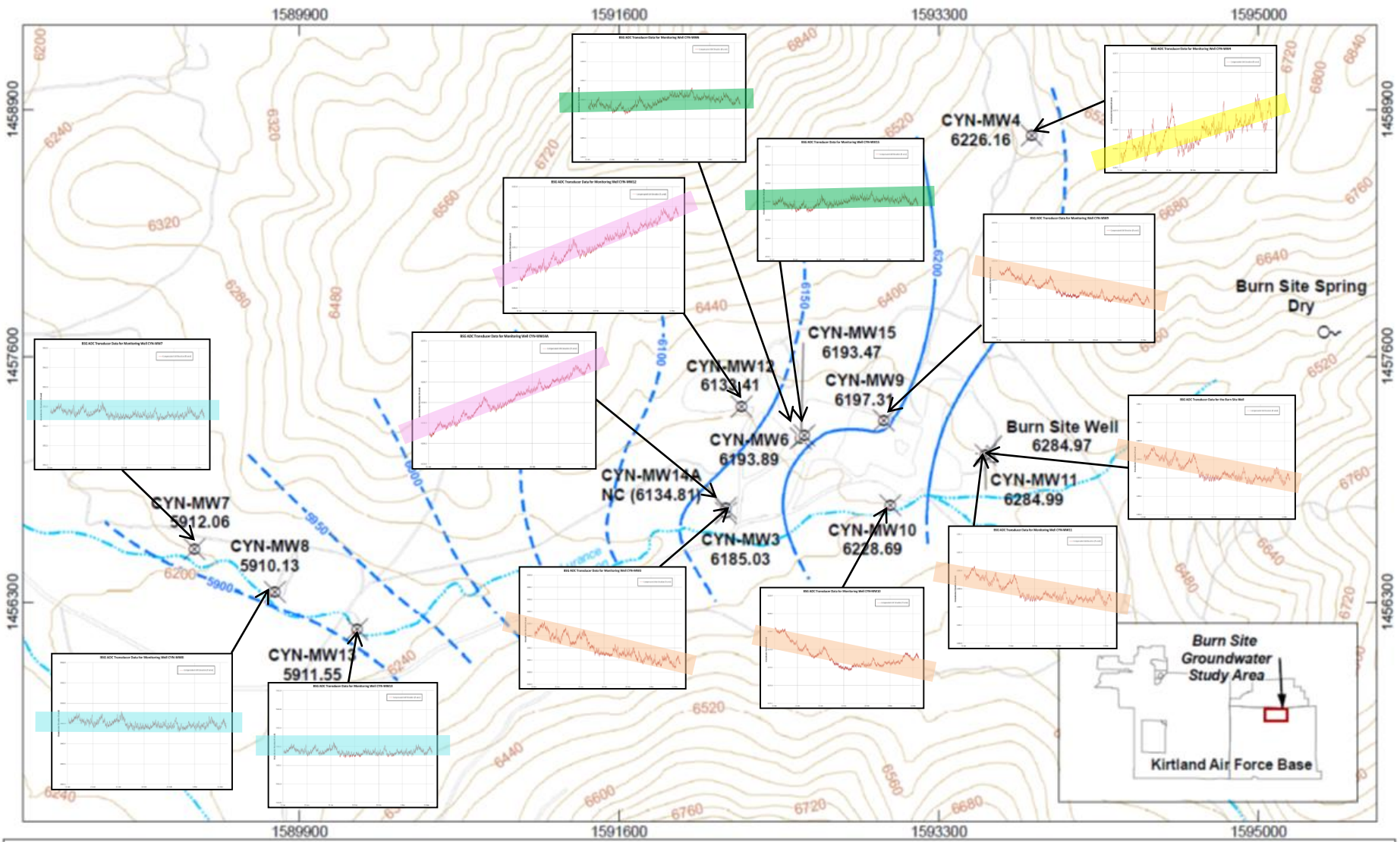
BSG Nitrate Concentrations Over Time





Long-Term Transducer Study (Preliminary)

- Placed transducers in 13 wells (including Burn Site well).
- Collected water level and barometric data January 11 through March 13, every 10 min.
- Transducers set at 1 ft above the bottom of the well screen.
- Constructed plots of barometric data, uncompensated water levels, and compensated water levels over time.
- Currently calculating barometric efficiencies and preparing field summary report.
- Another round of data will be collected for several months before Aquifer Pumping Test.
- Preliminary Results (next slide):



Legend

- Monitoring well, groundwater
Groundwater elevation (ft amsl)
October 2015, datum NAVD 88
- Production well (non-potable)
- Spring
- NC Not contoured
- Potentiometric surface contour
(ft amsl), dashed where inferred
- Surface drainage, arroyo
- Road, unpaved
- Ground surface contour (40 ft)

0 800 1,600
Feet
0 210 420
Meters

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

EGIS

Sandia National Laboratories

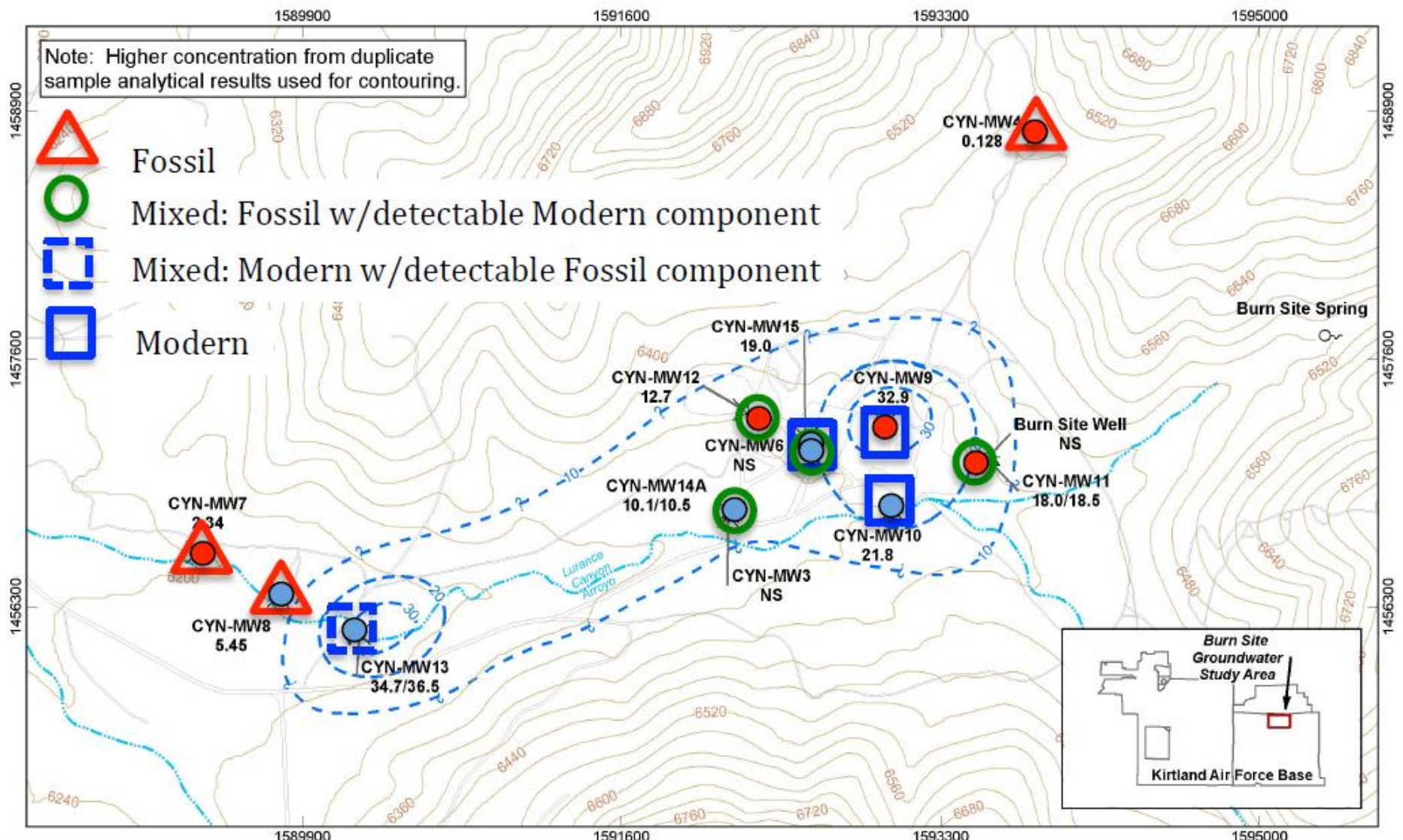
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Stable Isotope Study

- Samples collected for analyses of stable isotopes, denitrification and groundwater age data.
- Analysis and interpretation performed by LLNL Environmental Radiochemistry Laboratory.
- Recent samples collected in September 2015, and compared to similar sample suite collected in October 2012.
- Sample suite: Tritium ; $^3\text{He}/^4\text{He}$; noble gases (He, Ne, Ar, Kr, Xe); stable isotopes of water ($^{18}\text{O}/^{16}\text{O}$, $^2\text{H}/^1\text{H}$); stable isotopes of nitrate ($^{15}\text{N}/^{14}\text{N}$, $^{18}\text{O}/^{16}\text{O}$); dissolved N; dissolved Ar; and TOC.
- Preliminary Results (next slide):



Legend

⊗	Monitoring well, groundwater	---	Concentration contour (mg/L)
12.7	October/November 2015	---	dashed where inferred, queried where uncertain
△	Nitrate plus Nitrite concentration, mg/L	---	Surface drainage, arroyo
△	Production well (non-potable)	---	Road, unpaved
○	Spring	---	Ground surface contour (40 ft)
NS	Not sampled		

0 800 1,600
0 210 420
Feet
Meters

Sandia National Laboratories

New Mexico State Plane Central Zone, 1983
1988 North American Vertical Datum

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ce16508 3-16-16 / mb115002



Aquifer Pumping Test (In Preparation)

- Aquifer Pumping Test Work Plan submitted to NMED on June 6, 2016; approved by NMED on June 21, 2016.
- All wells instrumented, pumping at Burn Site Well.
 - Long-Term Transducer Study (round two).
 - Step-Drawdown Test.
 - Constant-Rate Test.
 - Interval sampling for nitrate in discharge water.
- Field work in the Spring 2017.
- Briefing with NMED Summer 2017.
- Report to NMED Spring 2018.



Future Work

(Contingent on Funding from Congress)

- Share final results of Long-Term Transducer Study with NMED (Fall 2016).
- Share vertical profile groundwater sampling nitrate results with NMED (Fall 2016).
- Share final results/meet with NMED on the Stable Isotope Study (Fall 2016).
- Perform Aquifer Pumping Test (Spring 2017).
- Discuss future work activities with NMED (Summer 2017).
- Submit CCM to NMED (Fall 2020).
- Submit CME Report to NMED (Fall 2020).



Corrective Measures Evaluation Process for BSG

Possible remedial alternatives identified in original (2004) CME Work Plan:

- Groundwater Monitoring
- Monitored Natural Attenuation (MNA)
- *In Situ* Bioremediation (ISB) followed by Groundwater Monitoring
- ISB followed by MNA
- Pump and Treat followed by Groundwater Monitoring
- Pump and Treat followed by MNA



Corrective Measures Evaluation

Current Thinking (not vetted)

- MNA may be a hard sell
 - Regulator has not approved MNA in New Mexico
 - Regulator not comfortable with remedy taking >25 years
 - No proof of denitrification
 - Can't prove decreasing concentrations
- Pumping and Beneficial Use
 - Landscaping or dust suppression
 - Land application permit required
- Land-Use Controls and Long-Term Monitoring
 - Prohibit drinking water wells in/near plume
 - 5-year evaluations



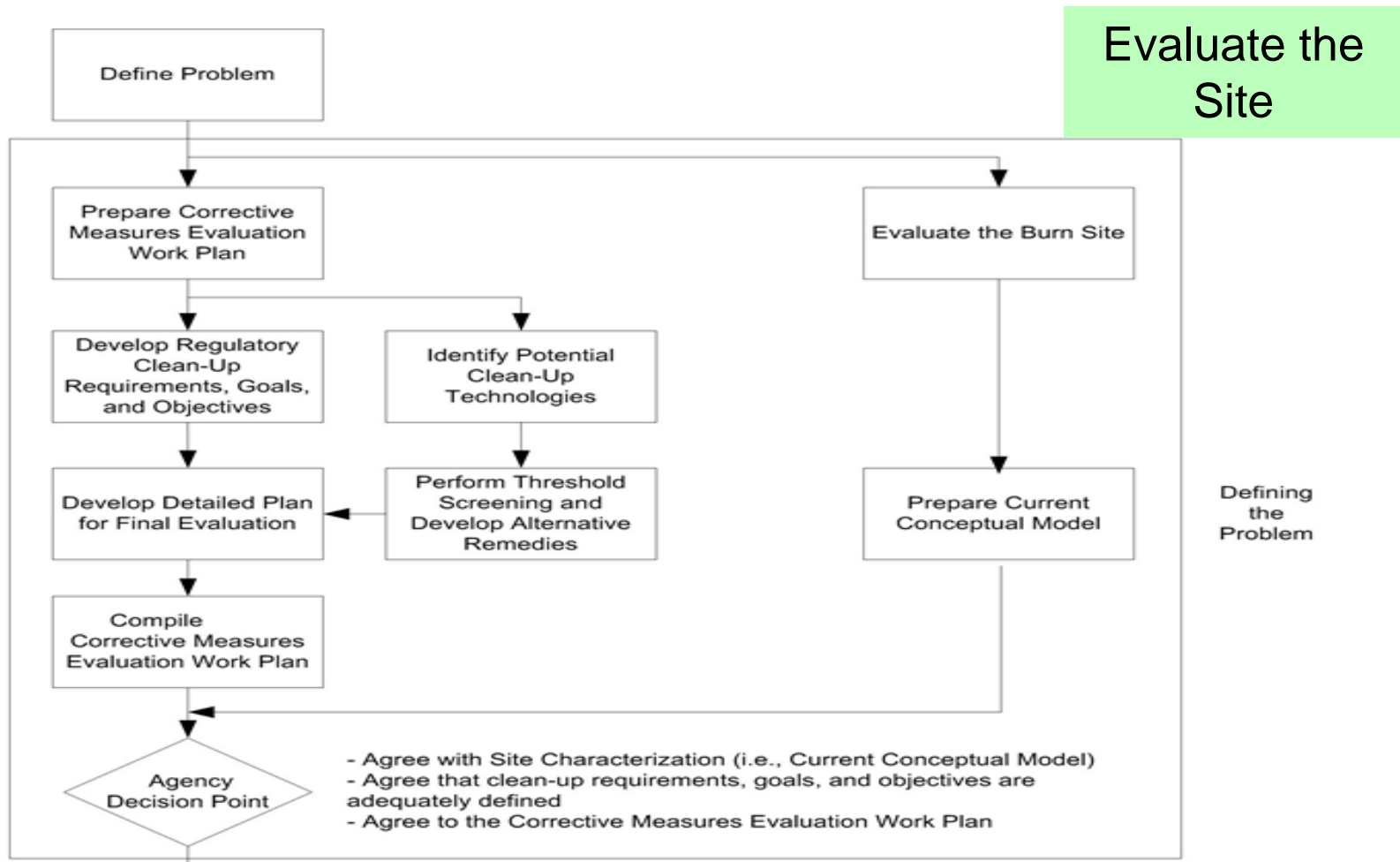
Summary

- The BSG AOC is in an isolated location--nearest downgradient ABCWUA production well is ~8 miles away.
- Very complex hydrogeology.
- Considerable groundwater characterization work has been completed.
- SNL characterization activities are regulated by the NMED Hazardous Water Bureau.
- Nitrate is the only contaminant of concern and is only found at relatively minor concentrations.
- Nitrate from the BSG AOC will never reach production well at concentrations exceeding MCL.

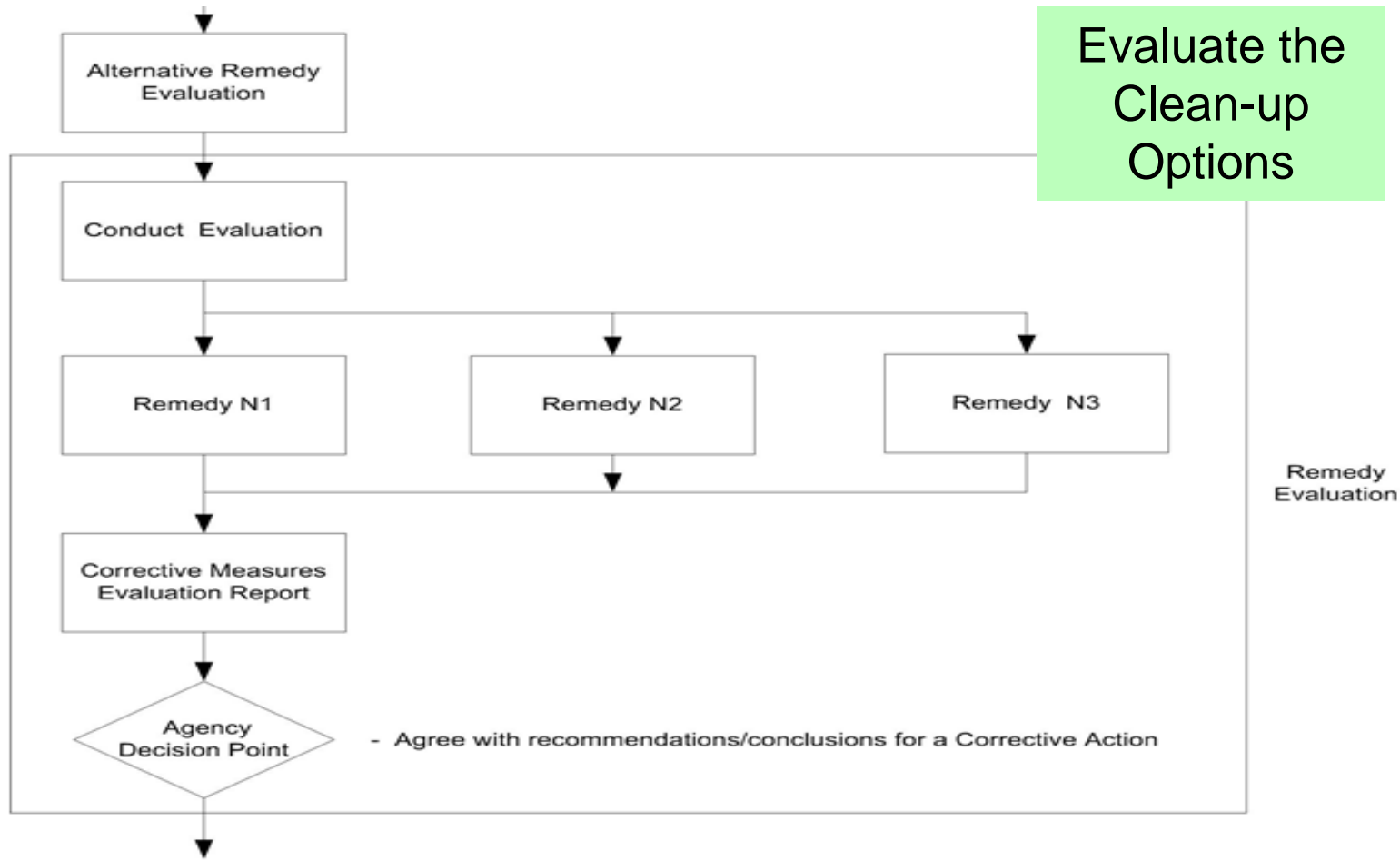


BACKUP SLIDES

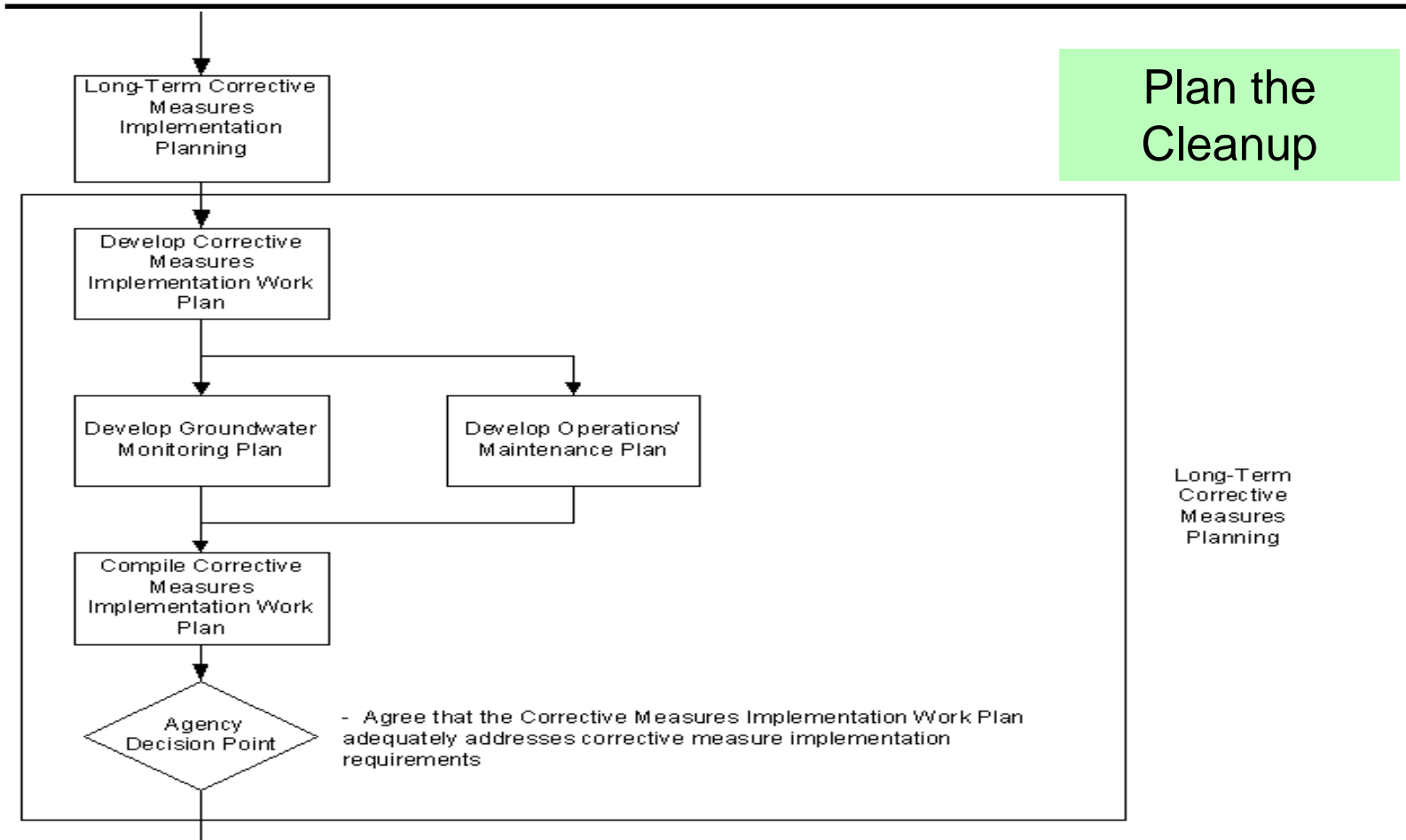
Corrective Measures Evaluation Process



Corrective Measures Evaluation Process



Corrective Measures Evaluation Process



Corrective Measures Evaluation Process

