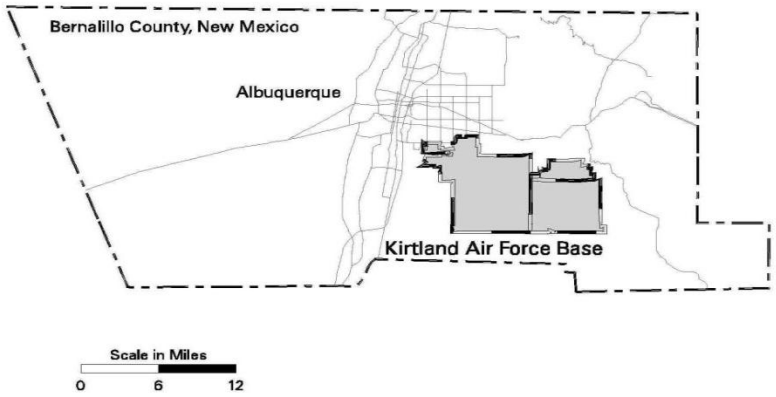
SAND2012-7489P

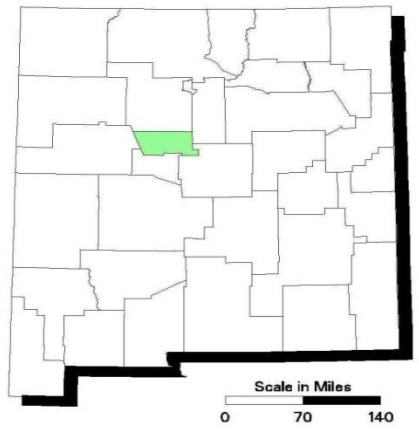
Overview of Groundwater Monitoring at Sandia National Laboratories

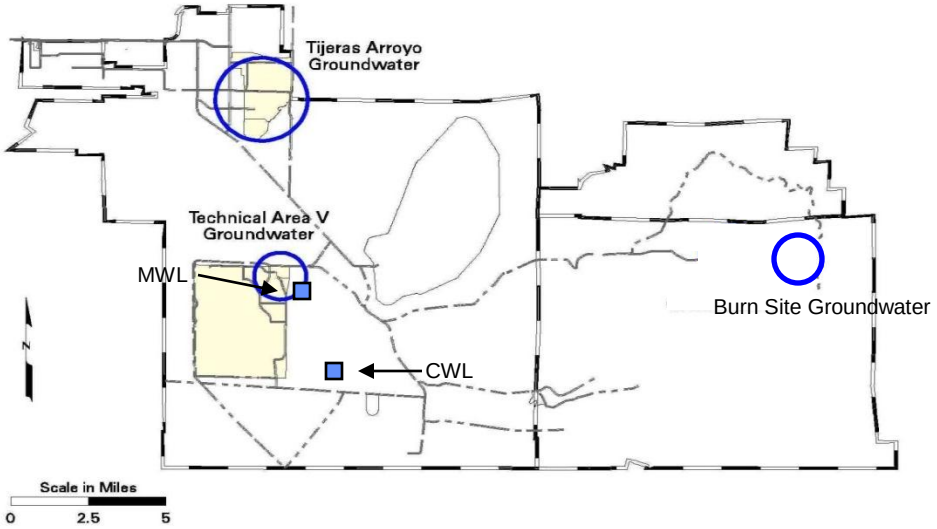
Michael Skelly
SNL/NM
Department 6234
mfskell@sandia.gov

Location of Sandia Groundwater Projects



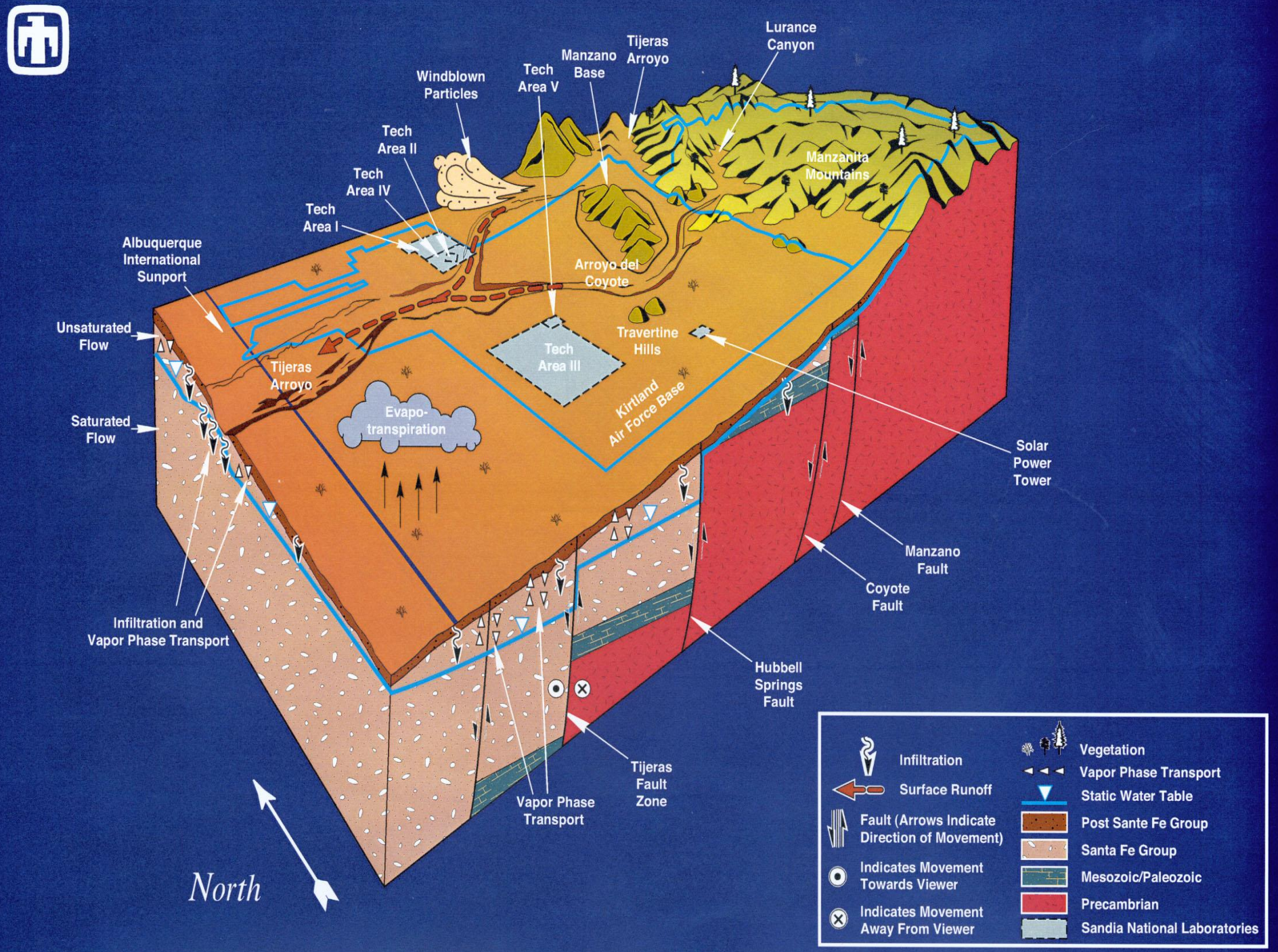
Sandia National Laboratories
New Mexico
Groundwater Investigations

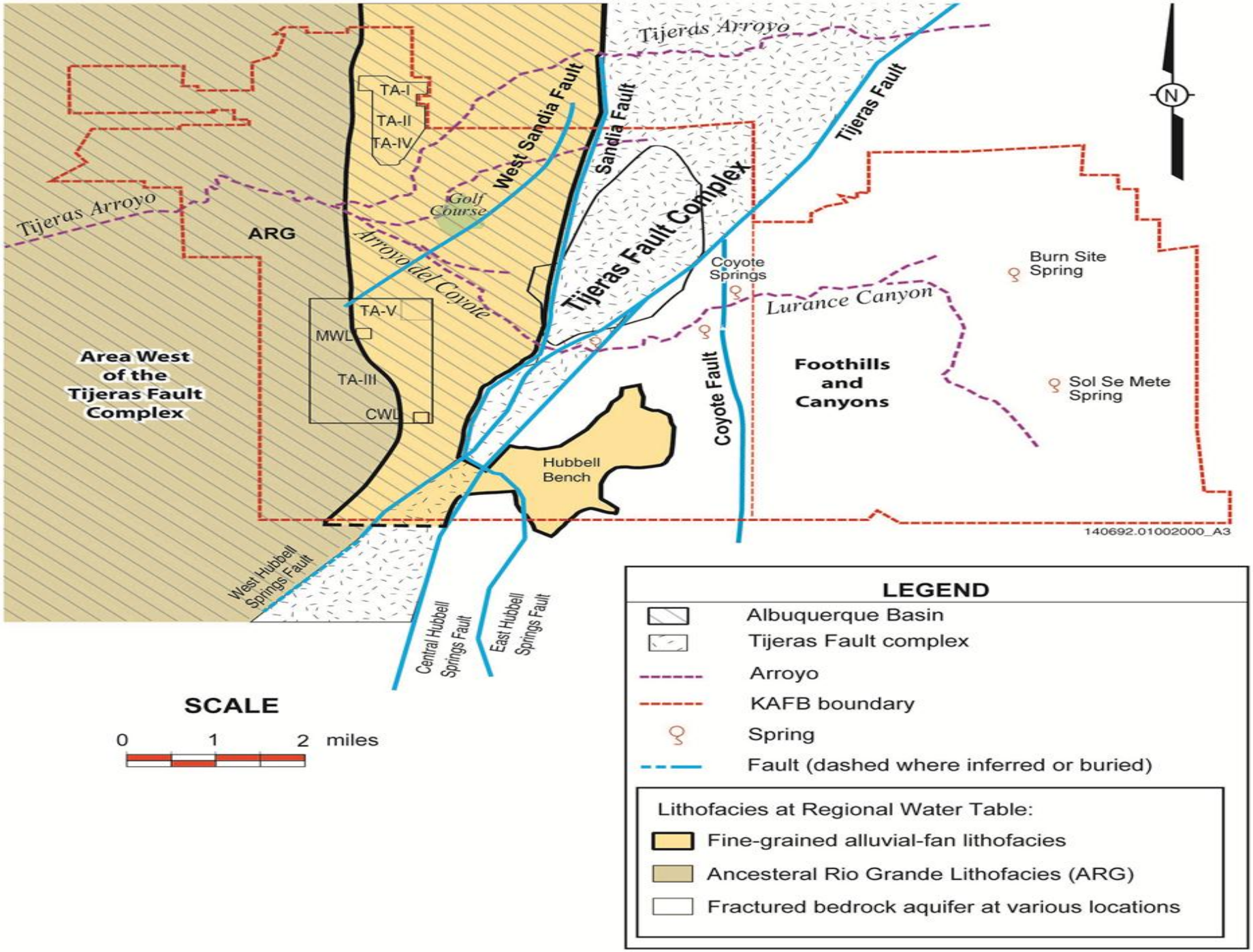


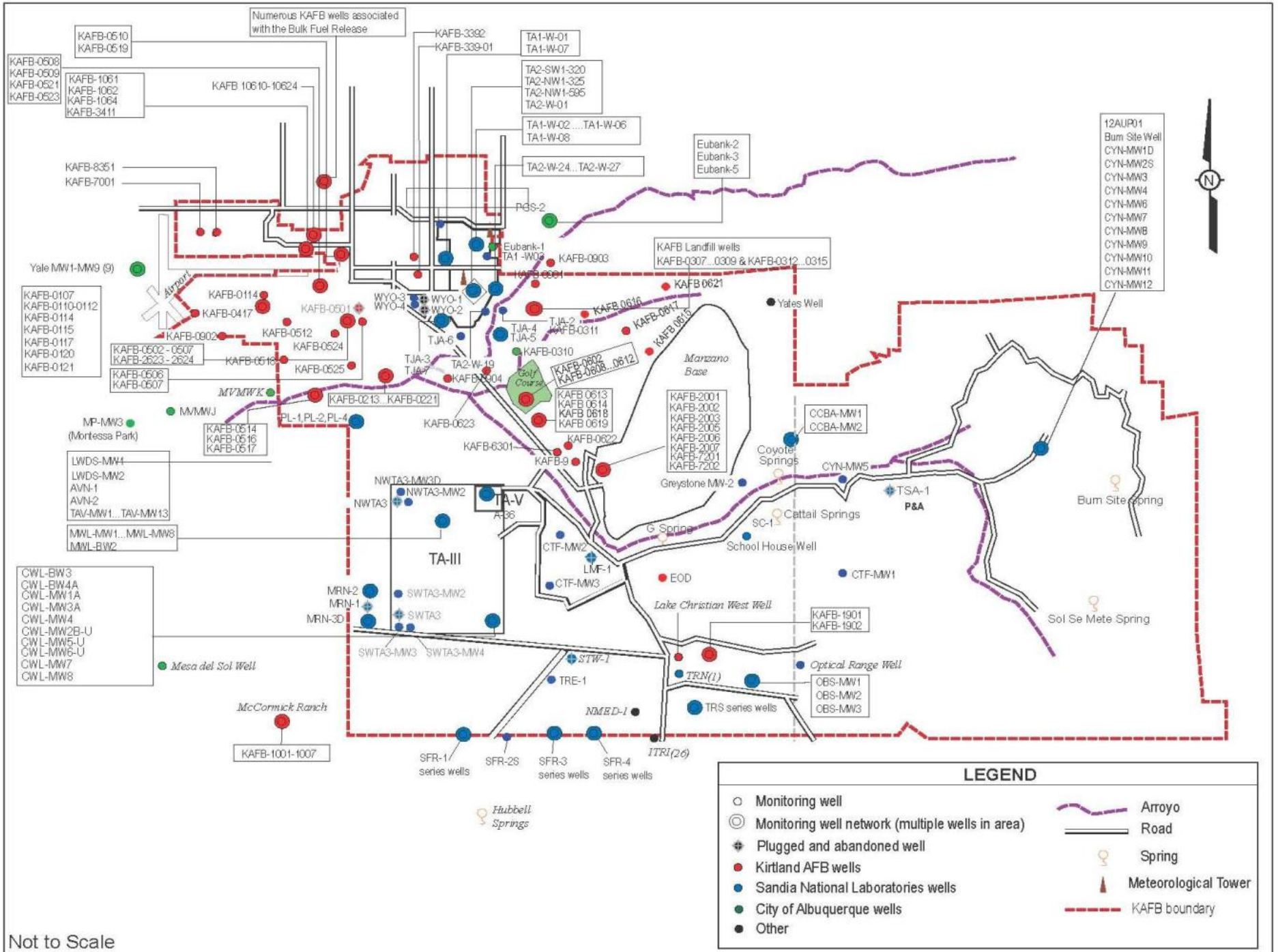


General Groundwater Conditions at Sandia

- Groundwater occurs in two regimes, a basin-fill aquifer and a bedrock aquifer
- Depths to groundwater is typically 100 ft (bedrock) to 550 ft (basin fill)
- Naturally flows from the mountains to the Rio Grande
- Drinking water-supply wells are located in the northern part of KAFB
- Currently flowing northwest toward KAFB and ABCWUA water-supply wells
- Water table is falling 1 to 2 ft per year due to pumping, except for wells in the far north
- Minimal recharge from rain--except in mountains and along channels
- Slow flow rates (few ft per year to 10's of ft per year), except on the west side of the base (100's ft per year)


Lurance Canyon
Tijeras Arroyo
Manzano Base
Tech Area V
Windblown Particles
Tech Area II
Tech Area IV
Tech Area I
Manzanita Mountains
Albuquerque International Sunport
Arroyo del Coyote
Unsaturated Flow
Travertine Hills
Tech Area III
Tijeras Arroyo
Kirtland Air Force Base
Saturated Flow
Evapo-transpiration
Solar Power Tower
Manzano Fault
Coyote Fault
Infiltration and Vapor Phase Transport
Hubbell Springs Fault
Tijeras Fault Zone
Vapor Phase Transport
North
Infiltration
Surface Runoff
Fault (Arrows Indicate Direction of Movement)
Indicates Movement Towards Viewer
Indicates Movement Away From Viewer
Vegetation
Vapor Phase Transport
Static Water Table
Post Sante Fe Group
Santa Fe Group
Mesozoic/Paleozoic
Precambrian
Sandia National Laboratories


Tijeras Arroyo
TA-I
TA-II
TA-IV
West Sandia Fault
Sandia Fault
Tijeras Fault
N
Tijeras Arroyo
ARG
Golf Course
Arroyo del Coyote
Tijeras Fault Complex
Coyote Springs
Burn Site Spring
Lurance Canyon
TA-V
MWL
TA-III
CWL
Area West of the Tijeras Fault Complex
Coyote Fault
Foothills and Canyons
Sol Se Mete Spring
Hubbell Bench
140692.01002000_A3
West Hubbell Springs Fault
Central Hubbell Springs Fault
East Hubbell Springs Fault
SCALE
0
1
2
miles
LEGEND
Albuquerque Basin
Tijeras Fault complex
Arroyo
KAFB boundary
Spring
Fault (dashed where inferred or buried)
Lithofacies at Regional Water Table:
Fine-grained alluvial-fan lithofacies
Ancesteral Rio Grande Lithofacies (ARG)
Fractured bedrock aquifer at various locations


Numerous KAFB wells associated with the Bulk Fuel Release
KAFB-0510
KAFB-0519
KAFB-0508
KAFB-0509
KAFB-0521
KAFB-0523
KAFB-1061
KAFB-1062
KAFB-1064
KAFB-3411
KAFB 10610-10624
KAFB-3392
KAFB-339-01
TA1-W-01
TA1-W-07
TA2-SW1-320
TA2-NW1-325
TA2-NW1-585
TA2-W-01
TA1-W-02....TA1-W-06
TA1-W-08
TA2-W-24...TA2-W-27
KAFB-8351
KAFB-7001
Eubank-2
Eubank-3
Eubank-5
PGS-2
Eubank-1
TA1 -W-03
KAFB-0903
KAFB-0901
KAFB Landfill wells
KAFB-0307...0309 & KAFB-0312...0315
12AUP01
Burn Site Well
CYN-MW1D
CYN-MW2S
CYN-MW3
CYN-MW4
CYN-MW6
CYN-MW7
CYN-MW8
CYN-MW9
CYN-MW10
CYN-MW11
CYN-MW12
Yale MW1-MW9 (9)
Airport
KAFB-0107
KAFB-0110-0112
KAFB-0114
KAFB-0115
KAFB-0117
KAFB-0120
KAFB-0121
KAFB-0114
KAFB-0417
KAFB-0501
WYO-3
WYO-4
WYO-1
WYO-2
KAFB 0621
KAFB 0616
KAFB 0617
KAFB 0615
Yates Well
KAFB-0902
KAFB-0512
KAFB-0524
KAFB-0311
TJA-2
TJA-4
TJA-5
TJA-6
KAFB-0502 - 0507
KAFB-2623 - 2624
KAFB-0518
KAFB-0525
KAFB-0310
TJA-3
TJA-7
TA2-W-19
KAFB-0604
Golf Course
KAFB-0602
KAFB-0608...0612
Manzano Base
KAFB-0506
KAFB-0507
MVMWK
KAFB-0213...KAFB-0221
KAFB 0613
KAFB 0614
KAFB 0618
KAFB 0619
KAFB-2001
KAFB-2002
KAFB-2003
KAFB-2005
KAFB-2006
KAFB-2007
KAFB-7201
KAFB-7202
MVMWJ
MP-MW3
(Montessa Park)
PL-1,PL-2,PL-4
KAFB-0623
KAFB-0622
KAFB-6301
KAFB-9
KAFB-0514
KAFB-0516
KAFB-0517
CCBA-MW1
CCBA-MW2
Coyote Springs
CYN-MW5
Greystone MW-2
TSA-1
P&A
Burn Site Spring
LWDS-MW1
LWDS-MW2
AVN-1
AVN-2
TAV-MW1...TAV-MW13
NWTA3-MW3D
NWTA3-MW2
NWTA3
TA-V
A-36
G Spring
SC-1
Cattail Springs
School House Well
MWL-MW1...MWL-MW8
MWL-BW2
TA-III
CTF-MW2
LMF-1
CTF-MW3
EOD
CTF-MW1
CWL-BW3
CWL-BW4A
CWL-MW1A
CWL-MW3A
CWL-MW4
CWL-MW2B-U
CWL-MW5-U
CWL-MW6-U
CWL-MW7
CWL-MW8
MRN-2
MRN-1
MRN-3D
SWTA3-MW2
SWTA3
SWTA3-MW3
SWTA3-MW4
Lake Christian West Well
KAFB-1901
KAFB-1902
Sol Se Mete Spring
Mesa del Sol Well
STW-1
TRE-1
TRN(1)
Optical Range Well
OBS-MW1
OBS-MW2
OBS-MW3
TRS series wells
NMED-1
McCormick Ranch
KAFB-1001-1007
SFR-1
series wells
SFR-2S
SFR-3
series wells
SFR-4
series wells
ITRI(26)
Hubbell Springs
N
LEGEND
Monitoring well
Monitoring well network (multiple wells in area)
Plugged and abandoned well
Kirtland AFB wells
Sandia National Laboratories wells
City of Albuquerque wells
Other
Arroyo
Road
Spring
Meteorological Tower
KAFB boundary
Not to Scale

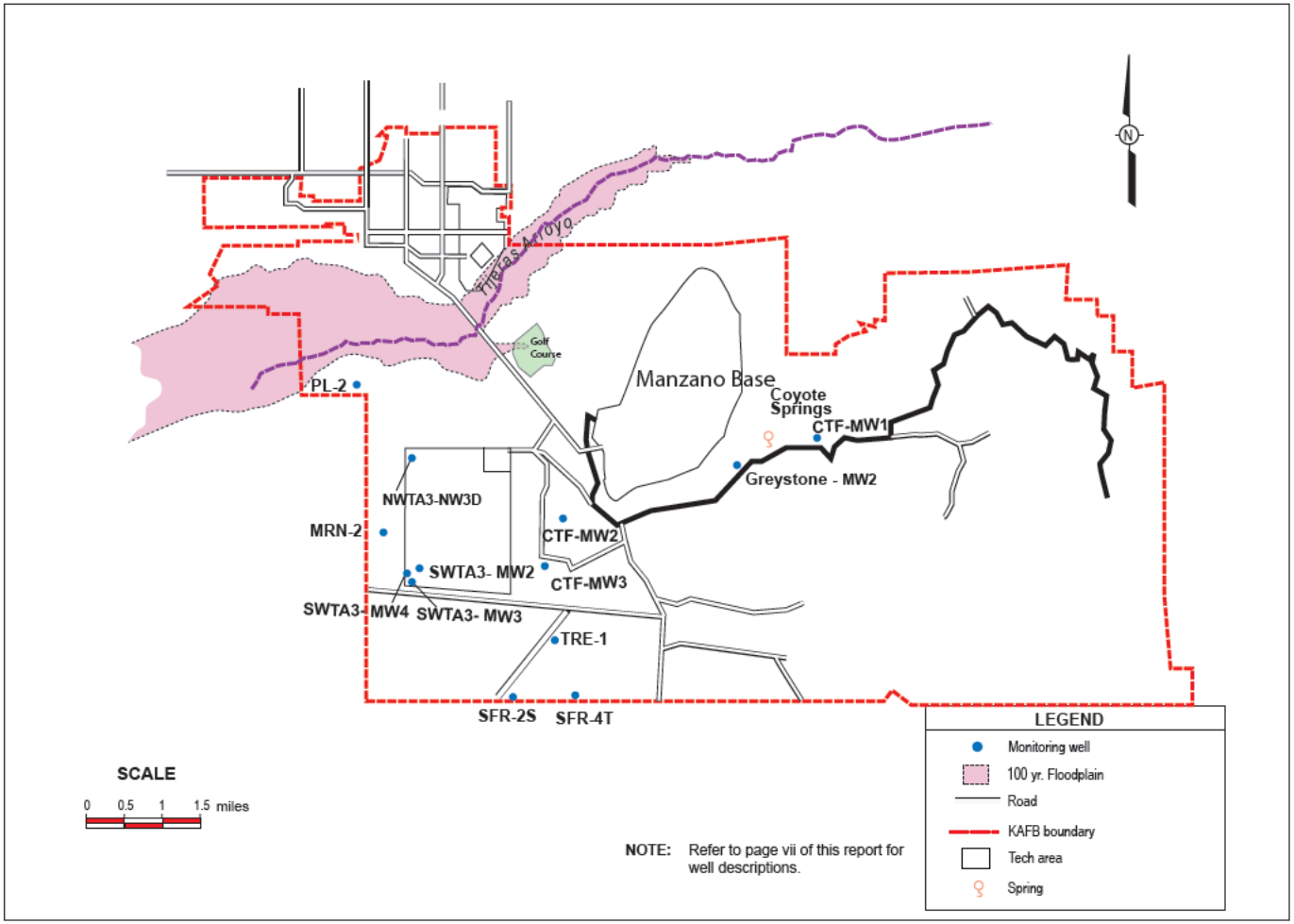
Seven Groundwater Projects at Sandia

1. **Groundwater Protection Program**--detection monitoring around perimeter to ensure that current operations are not degrading groundwater
2. **Chemical Waste Landfill**—detection monitoring of a remediated landfill
3. **Mixed Waste Landfill**—detection monitoring of a closed, covered landfill
4. **Burn Site Groundwater**--contamination regulated as Solid Waste Management Unit (SWMU) with nitrate above regulatory standard and perchlorate above NMED screening level
5. **Tijeras Arroyo Groundwater**--contamination regulated as SWMU with nitrate and trichloroethene (TCE) contamination above regulatory standards
6. **Technical Area V**--contamination regulated as SWMU with nitrate and TCE above regulatory standards
7. **Miscellaneous SWMUs-**-Five small sites, each with one to three wells, with routine characterization monitoring

Groundwater Protection Program

- Protects groundwater resources at Sandia and the surrounding area.
- Determining the impact, if any, of operations at Sandia on the quality and quantity of groundwater.
- Establishing baseline water quality and groundwater flow information.
- Provides stakeholders an update of groundwater data for SNL/NM through the publication of an *Annual Groundwater Monitoring Report* (available on the internet at http://www.sandia.gov/news/publications/environmental_reports/index.html)

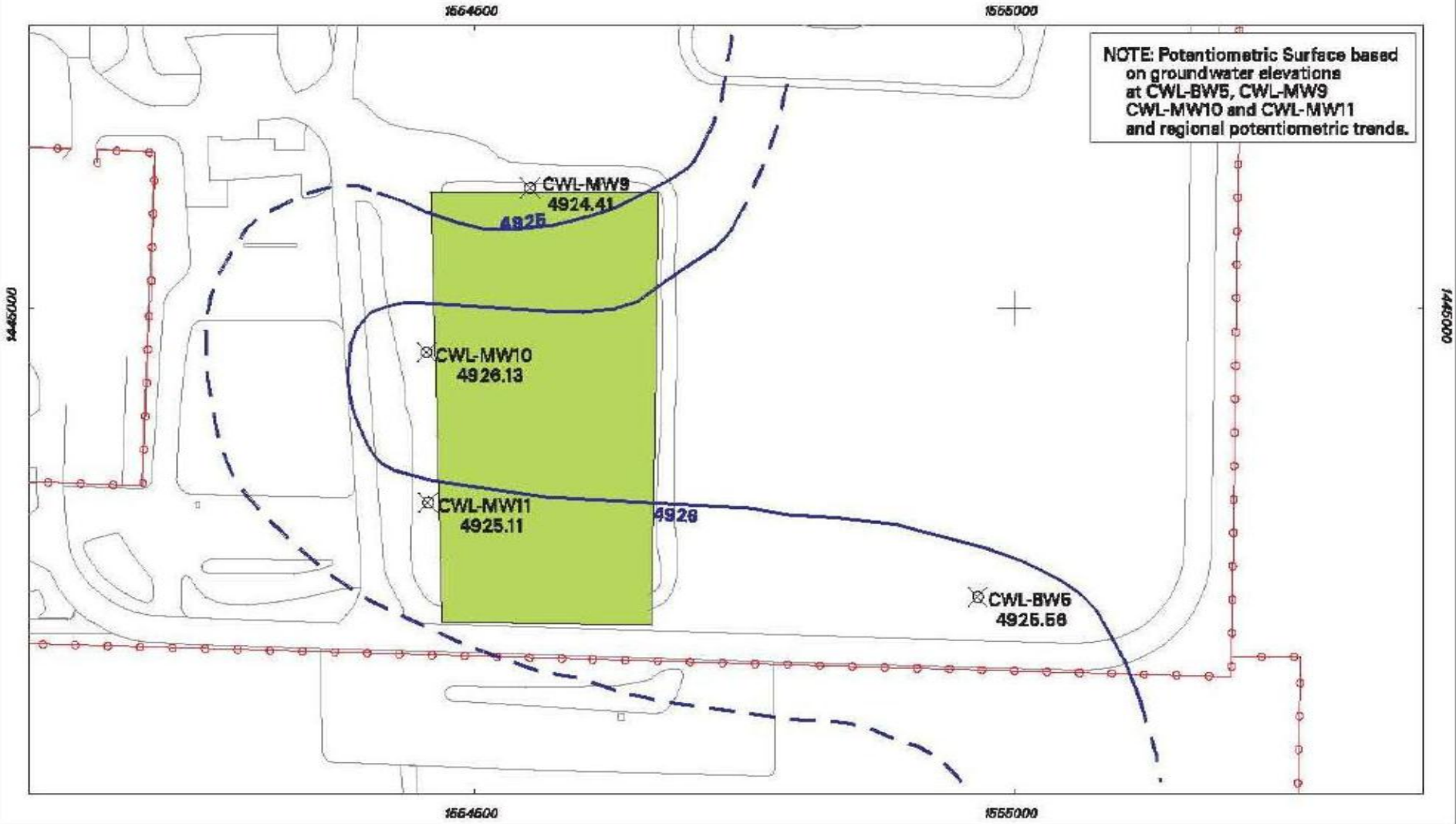
Groundwater Protection Program



Chemical Waste Landfill

- 1.9 acre landfill, operational from 1962 to 1981
- TCE discovered in 1990 in groundwater prompted remediation via soil-vapor extraction and excavation of contaminated soils and debris.
- Currently regulated under a Post-Closure Care Permit
- 4 groundwater monitoring wells sampled semiannually, no analytes above regulatory standards
- 5 soil-vapor monitoring wells sampled annually
- Data reported annually to the NMED in the Annual Groundwater Monitoring Report

MAPID=120056 02/08/12 SNL EGIS ORG. 4142 DHelfrich dh120056.aml



Legend

- Groundwater Monitoring Well
- Road, paved and unpaved
- Fence
- Potentiometric surface contour, feet above Mean Sea Level, dashed where inferred
- Chemical Waste Landfill

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone, 1983 North American Horizontal Datum, 1988 North American Vertical Datum

0 75 150
Scale in Feet

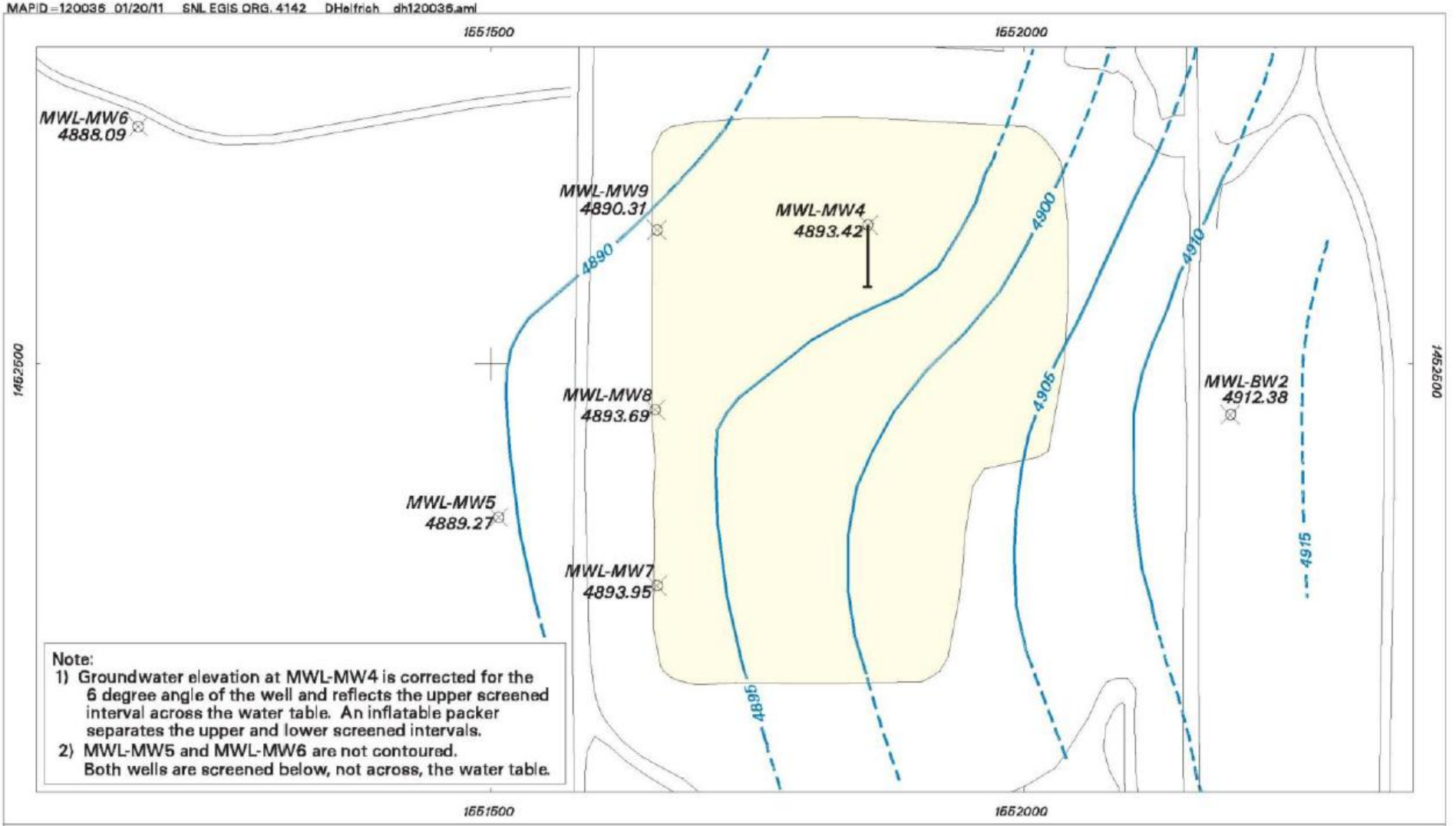
0 18 36
Scale in Meters

Mixed Waste Landfill

- 2.6 acre landfill, operational 1959 to 1988
- Groundwater monitoring & other field investigations began 1990
- Public Hearing on remedy in 2004
- NMED issued Final Order in 2005; selecting evapotranspirative cover w/ bio-intrusion barrier as remedy (constructed in 2009)
- 7 groundwater monitoring wells sampled annually, no analytes above regulatory standards
- Data reported annually to the NMED in the Annual Groundwater Monitoring Report

Mixed Waste Landfill

MAPID=120036 01/20/11 SNL EGIS ORG. 4142 DHelfrich dh120036.aml



Legend

- Monitoring well, groundwater
- Monitoring well, angled extent shown for MWL-MW4 with water table elevation
- Potentiometric Surface contour, feet amsl, dashed where inferred
- Road, unpaved
- Mixed Waste Landfill

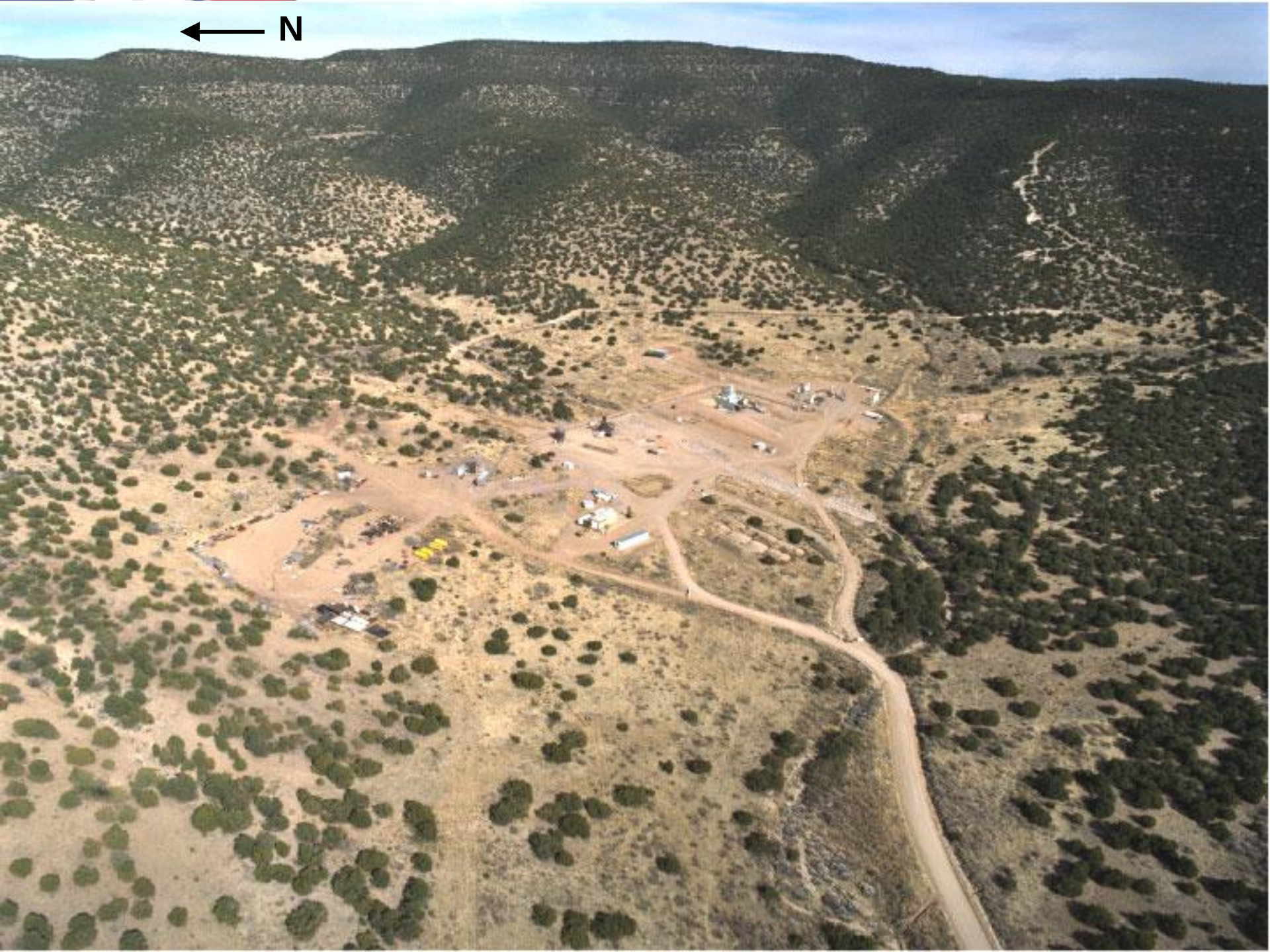
0 75 150
Scale in Feet

0 18 36
Scale in Meters

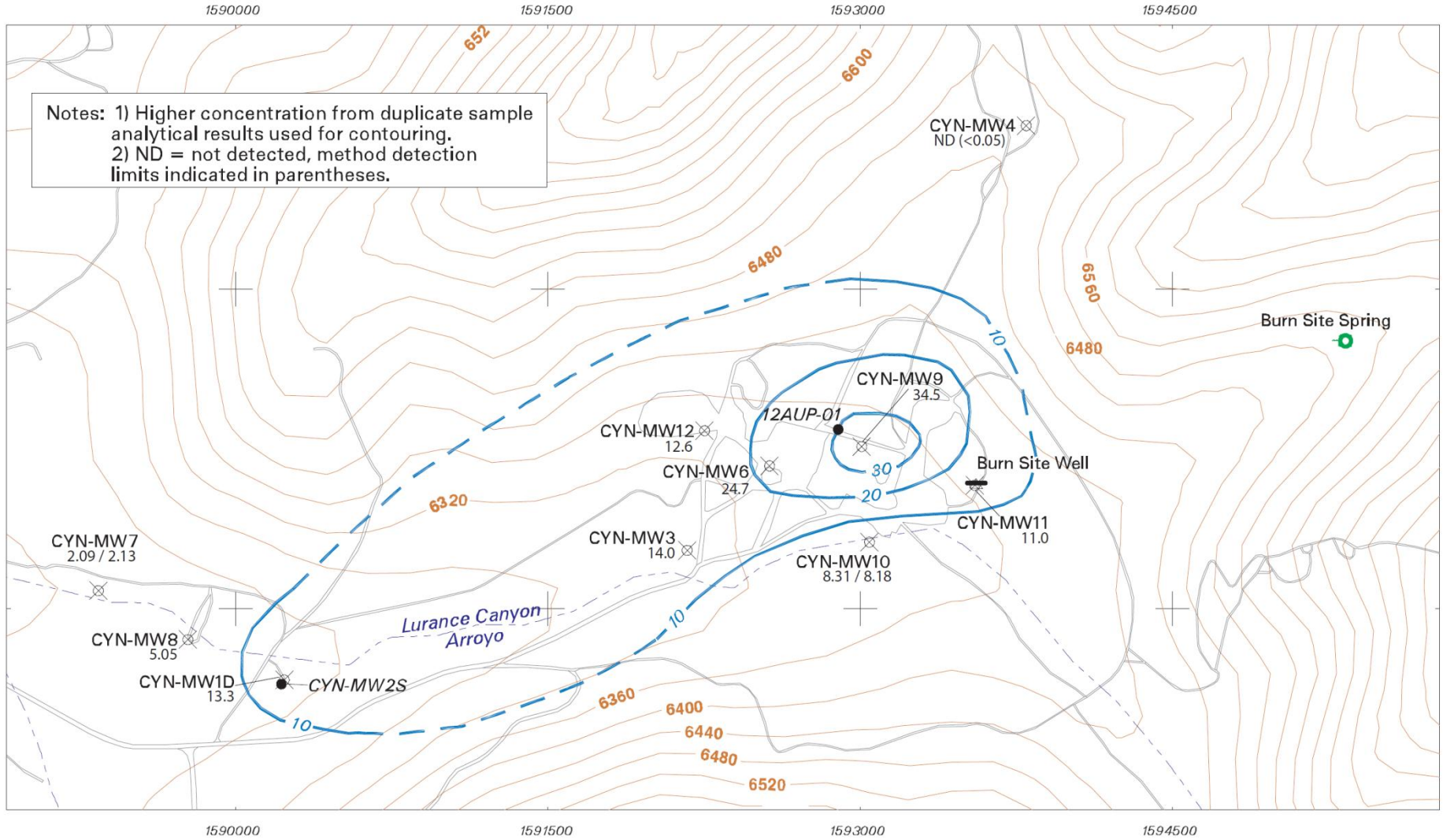
Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone, 1983 North American Horizontal Datum, 1988 North American Vertical Datum

Burn Site Groundwater

- Groundwater monitored since 1996
- Groundwater occurs at ~100 to 200 ft deep in fractured bedrock
- Currently monitoring 10 wells
- Contaminated with nitrate (5 to 6 wells) and perchlorate (1 well)
  - Nitrate: 0 to 37 parts per million (ppm) (regulatory standard is 10 ppm)
  - Perchlorate: 0 to 9 parts per billion (ppb) (no drinking water standard established)
- Small plume very far away from drinking-water supplies
- Tentative source—suspected wide-spread non-point source from use of high explosives
- Data reported annually to the NMED in the Annual Groundwater Monitoring Report


N

MAPID=120070 02/07/12 SNL EGIS ORG. 4142 DHelfrich dh120070.aml



Legend

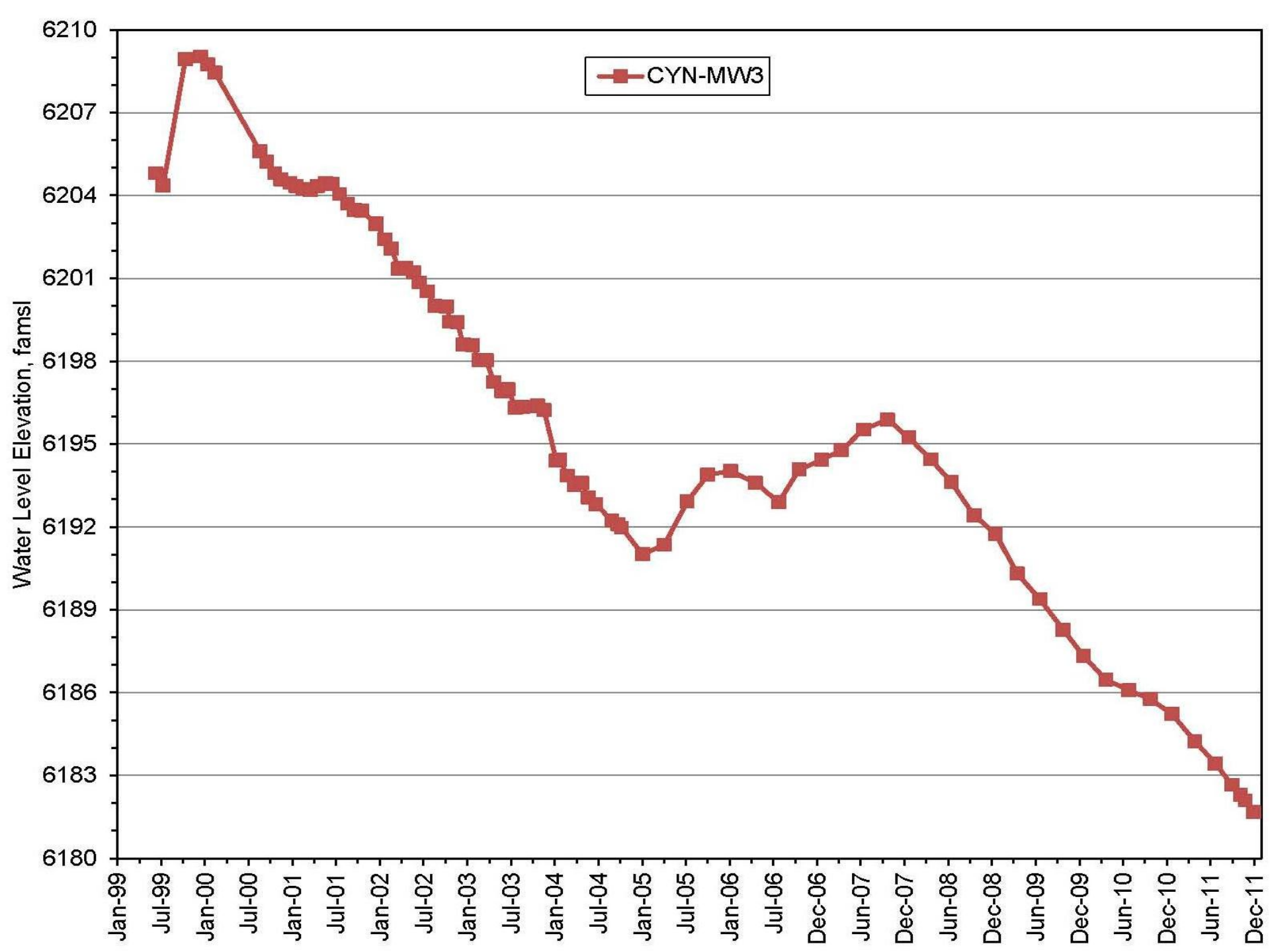
- Groundwater Monitoring Well, with October 2011 Nitrate plus Nitrite Contentrations (mg/L)
- Production Well (non-potable)
- Spring
- Peizometer
- Unpaved Road
- 40-ft. Contour
- Major Surface Drainage
- Concentration Contour (mg/L)

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

0 400 800
Scale in Feet

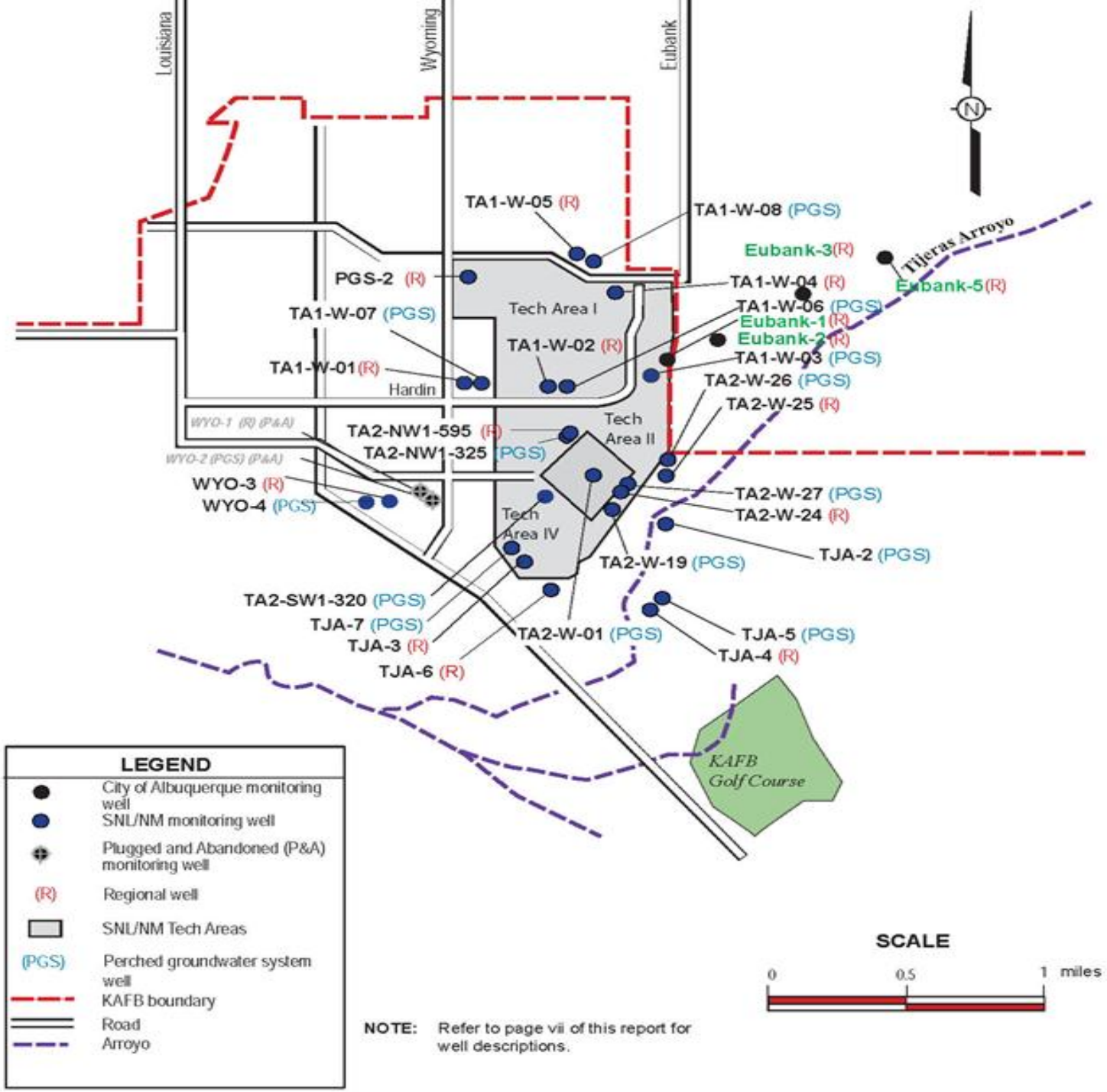
0 96 192
Scale in Meters

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone 1983 North American Horizontal Datum, 1988 North American Vertical Datum

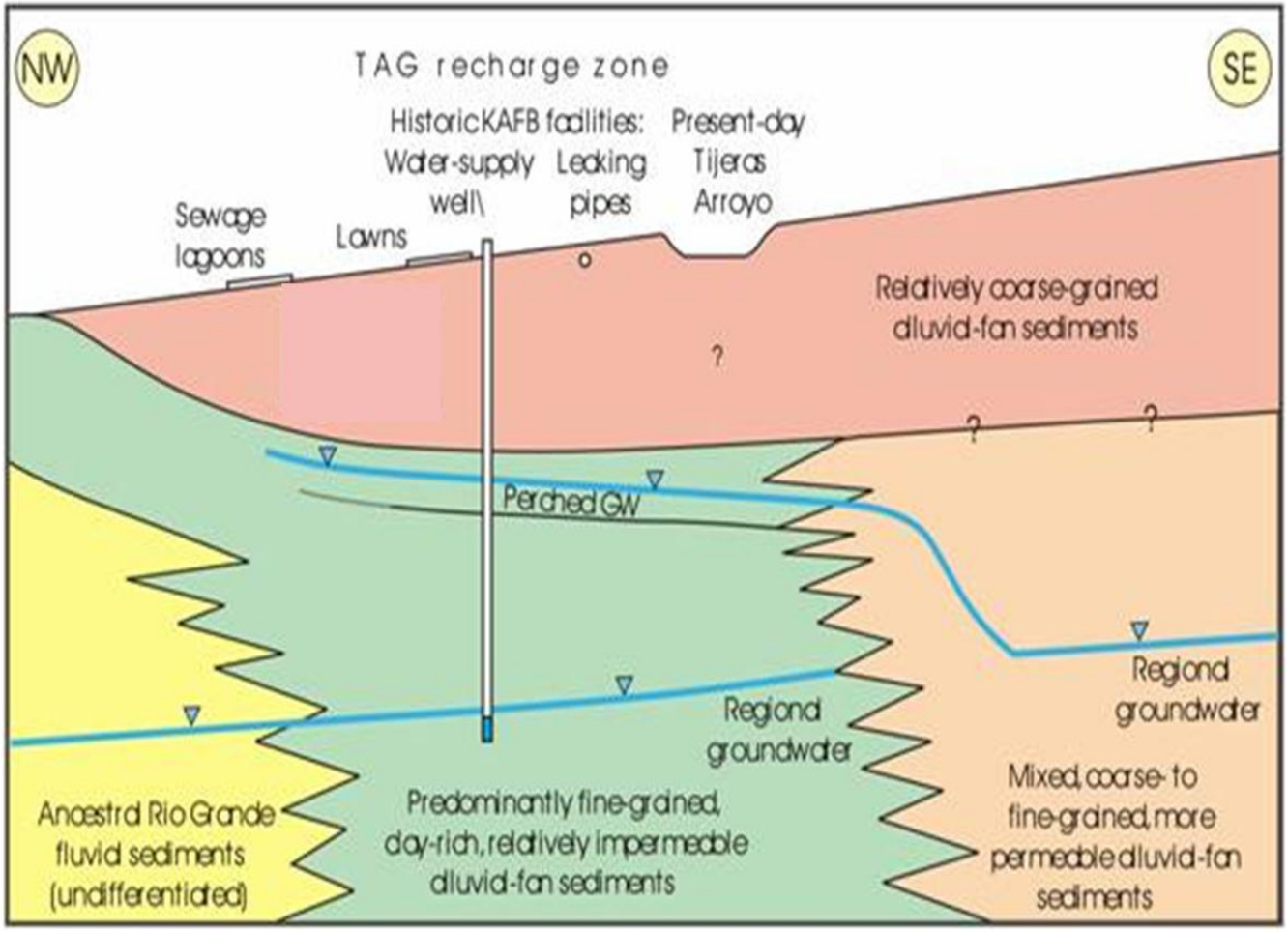

CYN-MW3
Water Level Elevation, famsl
6210
6207
6204
6201
6198
6195
6192
6189
6186
6183
6180
Jan-99
Jul-99
Jan-00
Jul-00
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
Jul-06
Dec-06
Jun-07
Dec-07
Jun-08
Dec-08
Jun-09
Dec-09
Jun-10
Dec-10
Jun-11
Dec-11

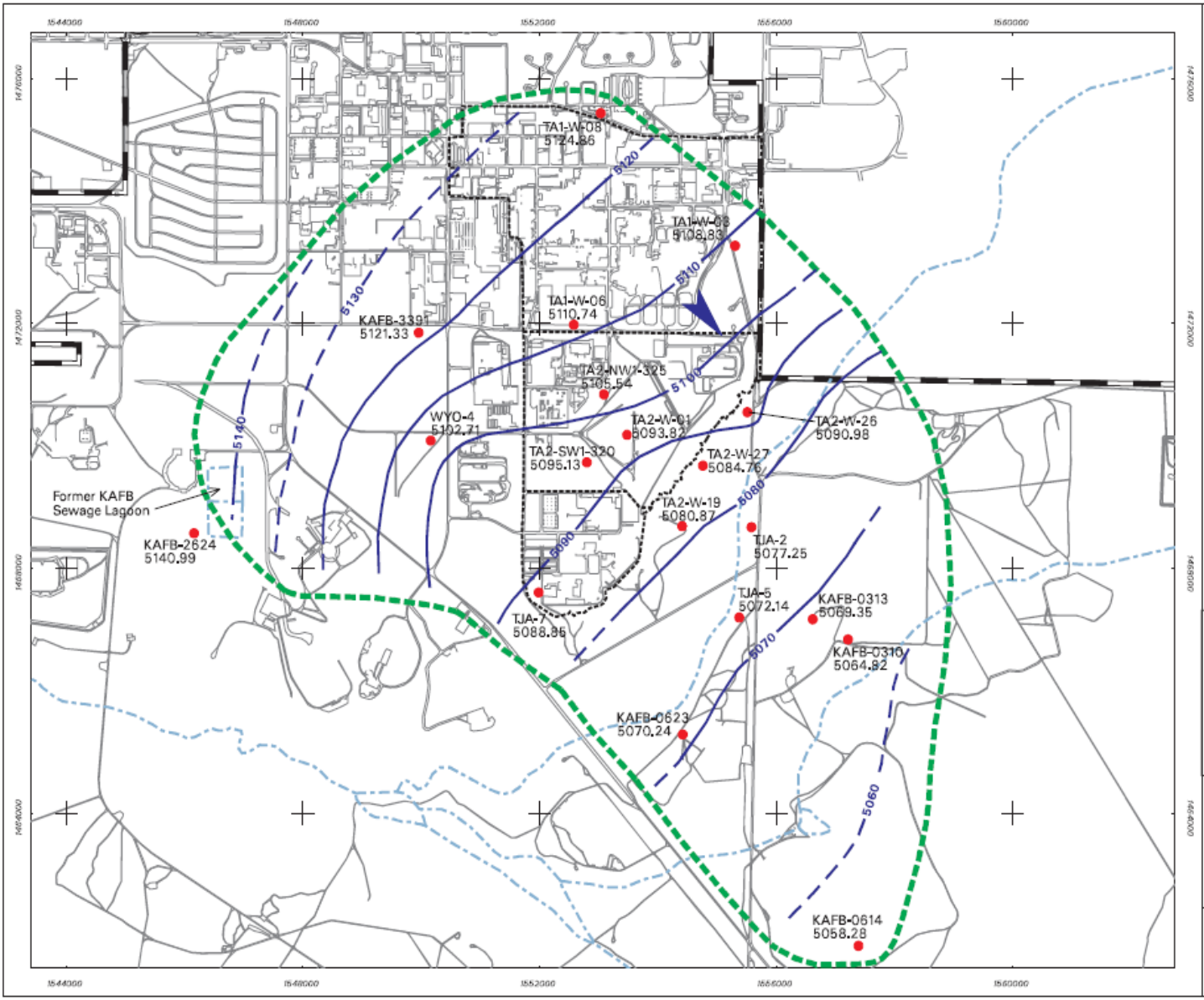
Tijeras Arroyo Groundwater

- Groundwater monitored since 1992
- Groundwater occurs at ~300 ft in a perched aquifer and 500 ft in the regional aquifer in unconsolidated sediments
- Large area--covers forty square miles, Sandia responsible for less than 2 square miles of the total and limited to contaminants found in the perched aquifer
- Contaminated with nitrate (5 wells) and TCE (1 well)
  - Nitrate: 0 to 33 ppm (regulatory standard is 10 ppm)
  - TCE: 0 to 9 ppb (regulatory standard is 5 ppb)
- Suspected sources include septic systems owned and operated by DOE/Sandia, Kirtland AFB and ABCWUA
- Data reported annually to the NMED in the Annual Groundwater Monitoring Report


Louisiana
Wyoming
Eubank
N
TA1-W-05 (R)
TA1-W-08 (PGS)
Eubank-3(R)
Tijeras Arroyo
Eubank-5(R)
PGS-2 (R)
TA1-W-04 (R)
TA1-W-07 (PGS)
Tech Area I
TA1-W-06 (PGS)
Eubank-1(R)
Eubank-2(R)
TA1-W-02 (R)
TA1-W-03 (PGS)
TA1-W-01(R)
Hardin
TA2-W-26 (PGS)
TA2-W-25 (R)
WYO-1 (R) (P&A)
Tech Area II
TA2-NW1-595 (R)
TA2-NW1-325 (PGS)
WYO-2 (PGS) (P&A)
WYO-3 (R)
WYO-4 (PGS)
TA2-W-27 (PGS)
TA2-W-24 (R)
Tech Area IV
TJA-2 (PGS)
TA2-W-19 (PGS)
TA2-SW1-320 (PGS)
TJA-7 (PGS)
TJA-3 (R)
TA2-W-01 (PGS)
TJA-5 (PGS)
TJA-4 (R)
TJA-6 (R)
KAFB Golf Course
LEGEND
City of Albuquerque monitoring well
SNL/NM monitoring well
Plugged and Abandoned (P&A) monitoring well
(R) Regional well
SNL/NM Tech Areas
(PGS) Perched groundwater system well
KAFB boundary
Road
Arroyo
SCALE
0
0.5
1 miles
NOTE: Refer to page vii of this report for well descriptions.

Tijeras Arroyo Groundwater





Legend

- Monitoring well, groundwater Groundwater elevation, feet amsl, October 2011
- Groundwater flow direction, inferred
- Potentiometric surface contour, feet amsl, dashed where inferred
- Extent of Perched system
- KAFB boundary
- Surface drainage, arroyo
- Tech Area boundary
- Road, paved and unpaved

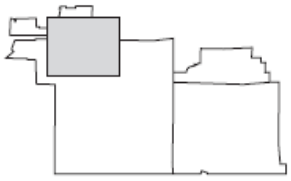
Note: Groundwater elevations from KAFB-0310, KAFB-0313, KAFB-0614, KAFB-0623, KAFB-2624, and KAFB-3391 are from November 2011.

0 1800 3600

Scale In Feet

0 432 864

Scale In Meters

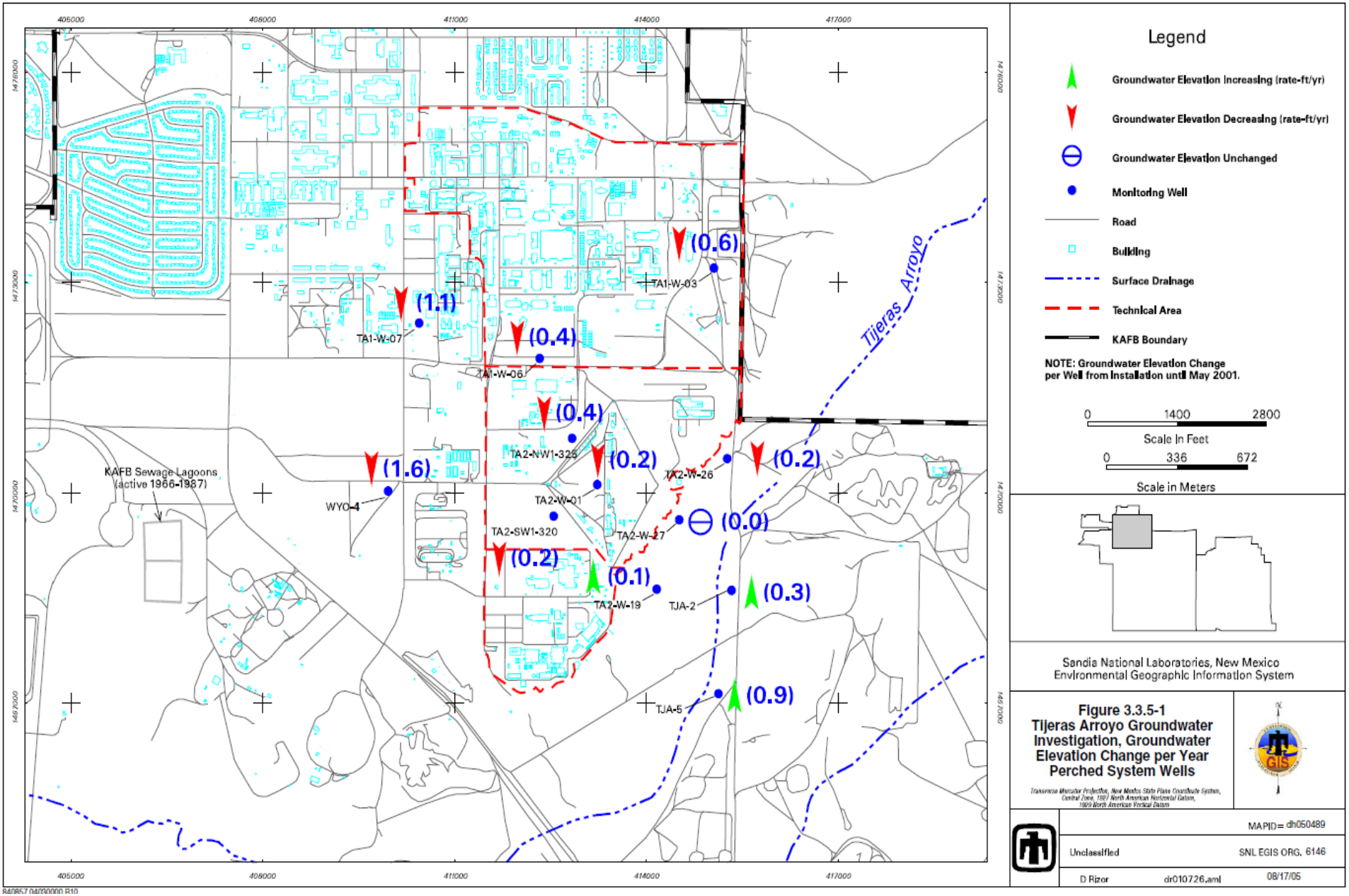


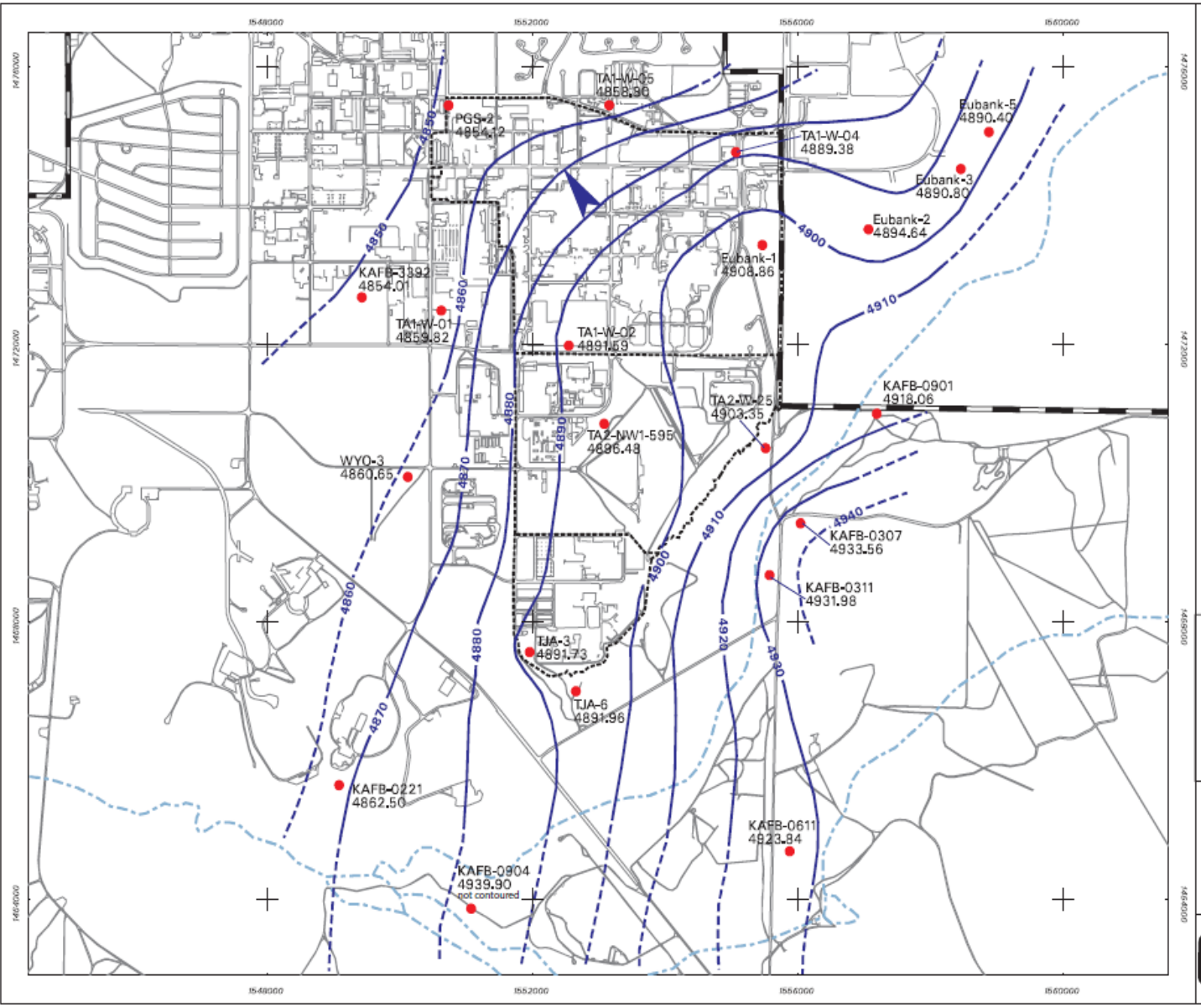
Tijeras Arroyo Groundwater Investigation Potentiometric Surface Map for the Perched System (October 2011)

SNL EGIS ORG. 4142 MAPID=120060

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone, 1983 North American Horizontal Datum, 1988 North American Vertical Datum

DHelfrich dh120060.aml 02/01/12


405000
408000
411000
414000
417000
1476000
1473000
1470000
1467000
(0.6)
TA1-W-03
(1.1)
TA1-W-07
(0.4)
TA1-W-06
(0.4)
TA2-NW1-325
(0.2)
TA2-W-01
(0.2)
TA2-W-26
(1.6)
WYO-4
KAFB Sewage Lagoons
(active 1966-1987)
TA2-SW1-320
(0.2)
TA2-W-27
(0.0)
(0.1)
TA2-W-19
TJA-2
(0.3)
TJA-5
(0.9)
Tijeras Arroyo
Legend
Groundwater Elevation Increasing (rate-ft/yr)
Groundwater Elevation Decreasing (rate-ft/yr)
Groundwater Elevation Unchanged
Monitoring Well
Road
Building
Surface Drainage
Technical Area
KAFB Boundary
NOTE: Groundwater Elevation Change per Well from Installation until May 2001.
0
1400
2800
Scale In Feet
0
336
672
Scale in Meters
Sandia National Laboratories, New Mexico
Environmental Geographic Information System
Figure 3.3.5-1
Tijeras Arroyo Groundwater Investigation, Groundwater Elevation Change per Year Perched System Wells
MAPID= dh050489
Unclassified
SNL EGIS ORG. 6146
D Rizor
dr010726.aml
08/17/05



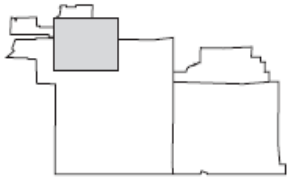
Legend

- Monitoring well, groundwater elevation, feet amsl, November 2011
- Groundwater flow direction, inferred
- Potentiometric surface contour feet amsl, dashed where inferred
- KAFB boundary
- Surface drainage, arroyo
- Tech Area boundary
- Road, paved and unpaved

Note: Groundwater elevations for Eubank-2, Eubank-3, Eubank-5, and all seven KAFB wells are from November 2011.

0 1600 3200
Scale In Feet

0 384 768
Scale In Meters

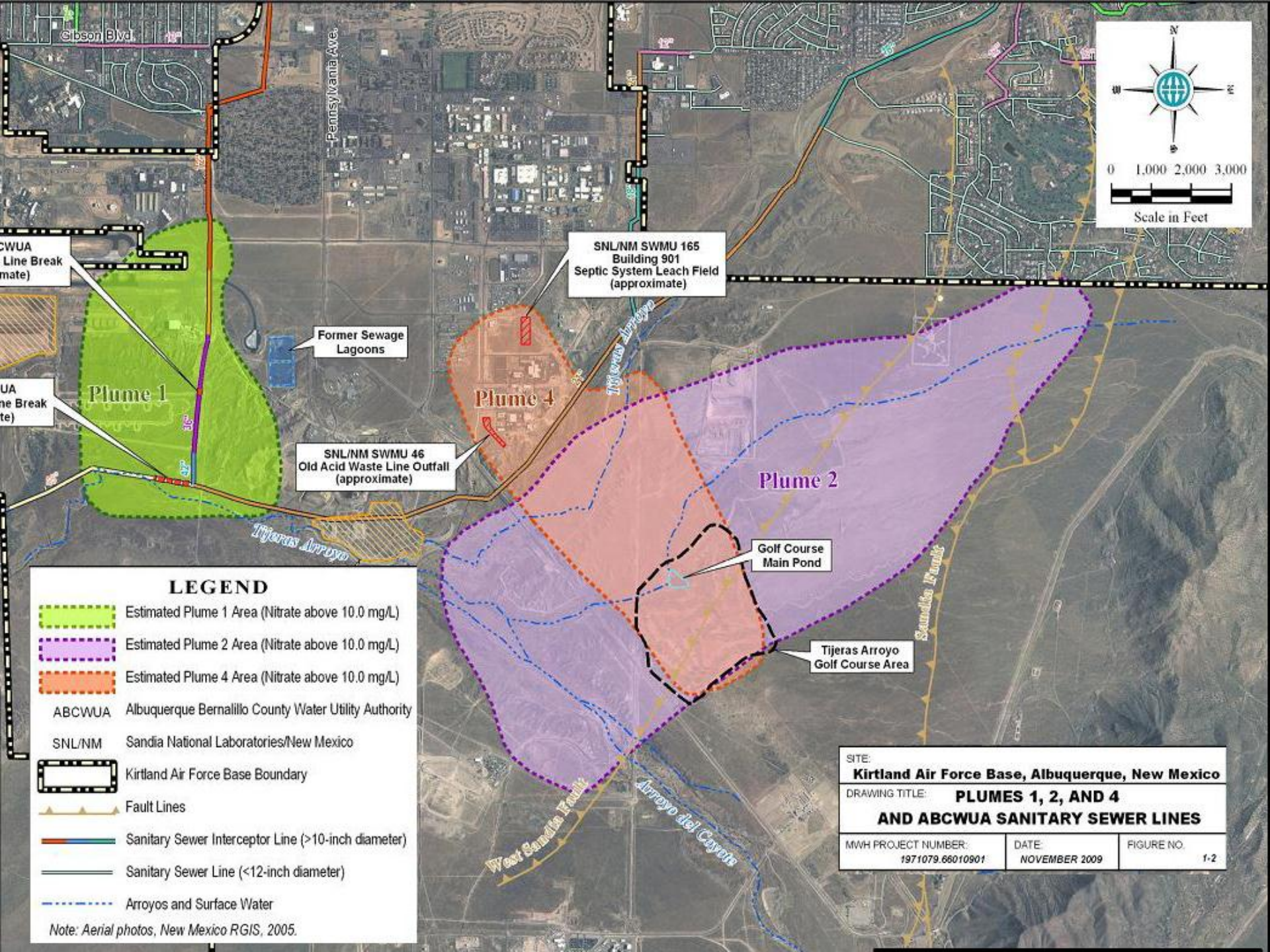


Tijeras Arroyo Groundwater Investigation Potentiometric Surface Map for the Regional Aquifer (October 2011)

SNL EGIS ORG. 4142 MAPID=120059

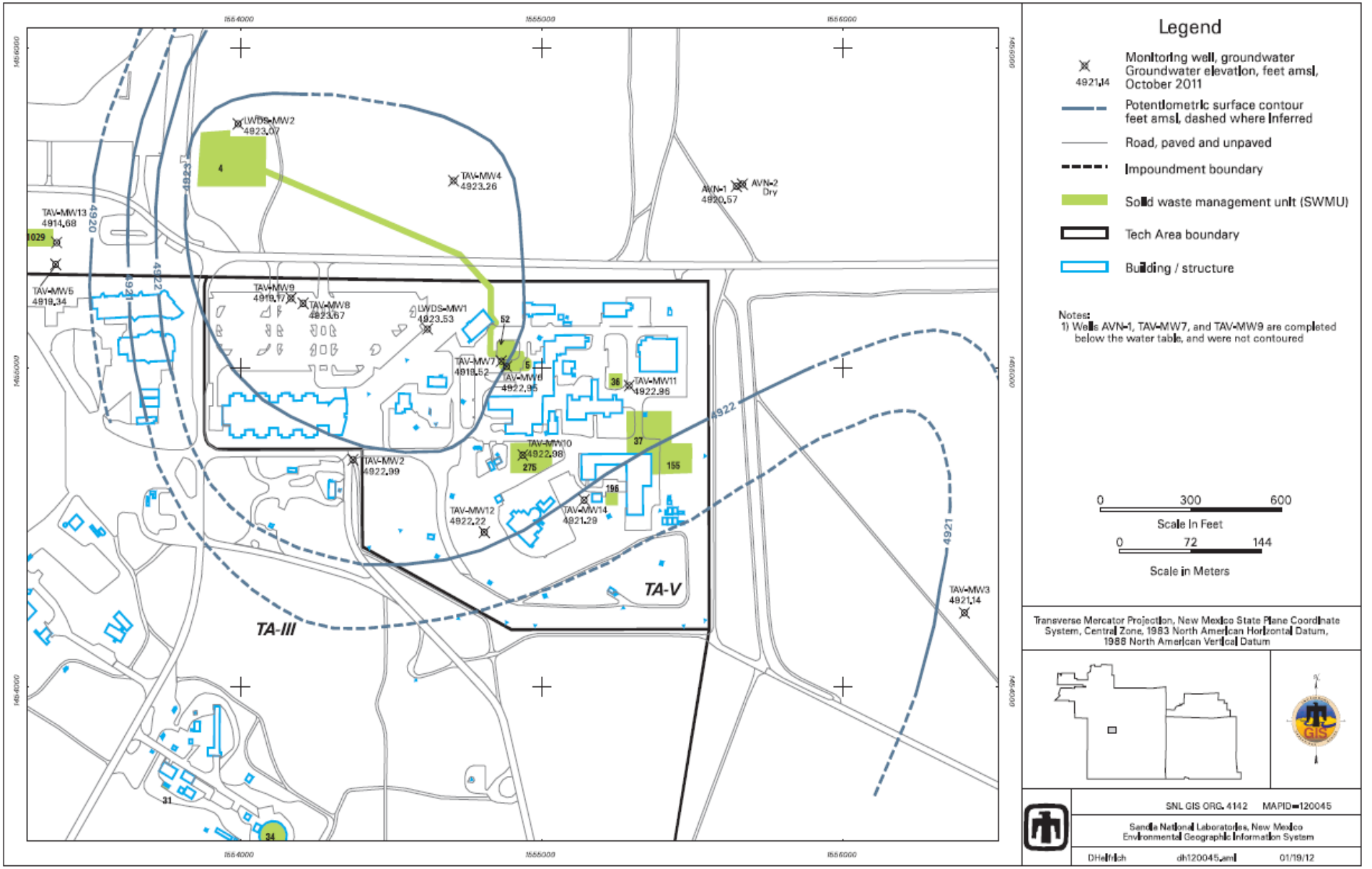
Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone, 1983 North American Horizontal Datum, 1999 North American Vertical Datum

DHelfrich dh120059.eml 02/02/12


Gibson Blvd.
Pennsylvania Ave.
N
W
E
S
0 1,000 2,000 3,000
Scale in Feet
SNL/NM SWMU 165
Building 901
Septic System Leach Field
(approximate)
Former Sewage Lagoons
Plume 1
Plume 4
Plume 2
Tijeras Arroyo
SNL/NM SWMU 46
Old Acid Waste Line Outfall
(approximate)
Golf Course Main Pond
Tijeras Arroyo Golf Course Area
Sandia Fault
West Sandia Fault
Arroyo del Coyote
LEGEND
Estimated Plume 1 Area (Nitrate above 10.0 mg/L)
Estimated Plume 2 Area (Nitrate above 10.0 mg/L)
Estimated Plume 4 Area (Nitrate above 10.0 mg/L)
ABCWUA Albuquerque Bernalillo County Water Utility Authority
SNL/NM Sandia National Laboratories/New Mexico
Kirtland Air Force Base Boundary
Fault Lines
Sanitary Sewer Interceptor Line (>10-inch diameter)
Sanitary Sewer Line (<12-inch diameter)
Arroyos and Surface Water
Note: Aerial photos, New Mexico RGIS, 2005.
SITE:
Kirtland Air Force Base, Albuquerque, New Mexico
DRAWING TITLE:
PLUMES 1, 2, AND 4
AND ABCWUA SANITARY SEWER LINES
MWH PROJECT NUMBER: 1971079.66010901
DATE: NOVEMBER 2009
FIGURE NO. 1-2

Technical Area V Groundwater

- Groundwater monitored since 1992
- Groundwater occurs ~500 ft deep in unconsolidated sediments
- Contaminated with nitrate and TCE
  - Nitrate: 0 to 14 ppm (regulatory standard is 10 ppm)
  - TCE: 0 to 19 ppb (regulatory standard is 5 ppb)
- Suspected sources include high-volume waste-water disposal systems
- Small plume very far away from drinking-water supplies
- 16 groundwater monitoring wells sampled four times per year
- 3 soil-vapor monitoring wells sampled four times per year—low-level detections of TCE in vapor phase
- Data reported annually to the NMED in the Annual Groundwater Monitoring Report



Legend

- Monitoring well, groundwater Groundwater elevation, feet amsl, October 2011 (4921.14)
- Potentiometric surface contour feet amsl, dashed where inferred
- Road, paved and unpaved
- Impoundment boundary
- Solid waste management unit (SWMU)
- Tech Area boundary
- Building / structure

Notes:
1) Wells AVN-1, TAV-MW7, and TAV-MW9 are completed below the water table, and were not contoured

0 300 600
Scale In Feet

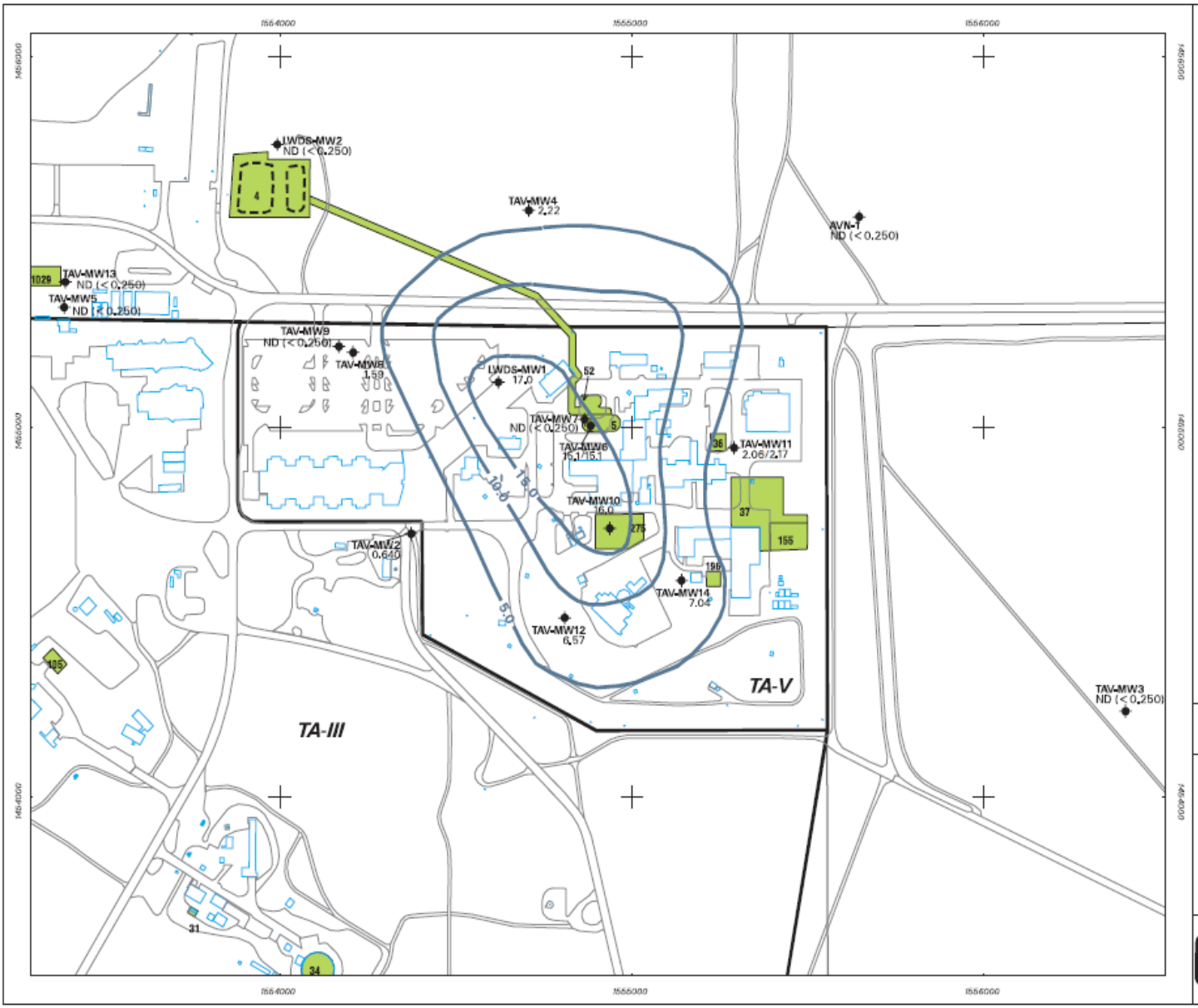
0 72 144
Scale in Meters

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone, 1983 North American Horizontal Datum, 1988 North American Vertical Datum

SNL GIS ORG. 4142 MAPID=120045

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

DHelfrich dh120045.aml 01/19/12



Legend

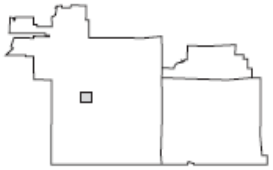
- Monitoring well, with November 2011 Trichloroethene concentrations (µg/L)
- Concentration contour (µg/L)
- Road, paved and unpaved
- Impoundment boundary
- Solid waste management unit (SWMU)
- Tech Area boundary
- Building

Notes:
1) Wells TAV-MW7, TAV-MW9 and TAV-MW13 are completed below the water table, and were not used for contouring.
2) Higher concentration from duplicate sample analytical results used for contouring.
3) ND = not detected; method detection limit indicated in parentheses.

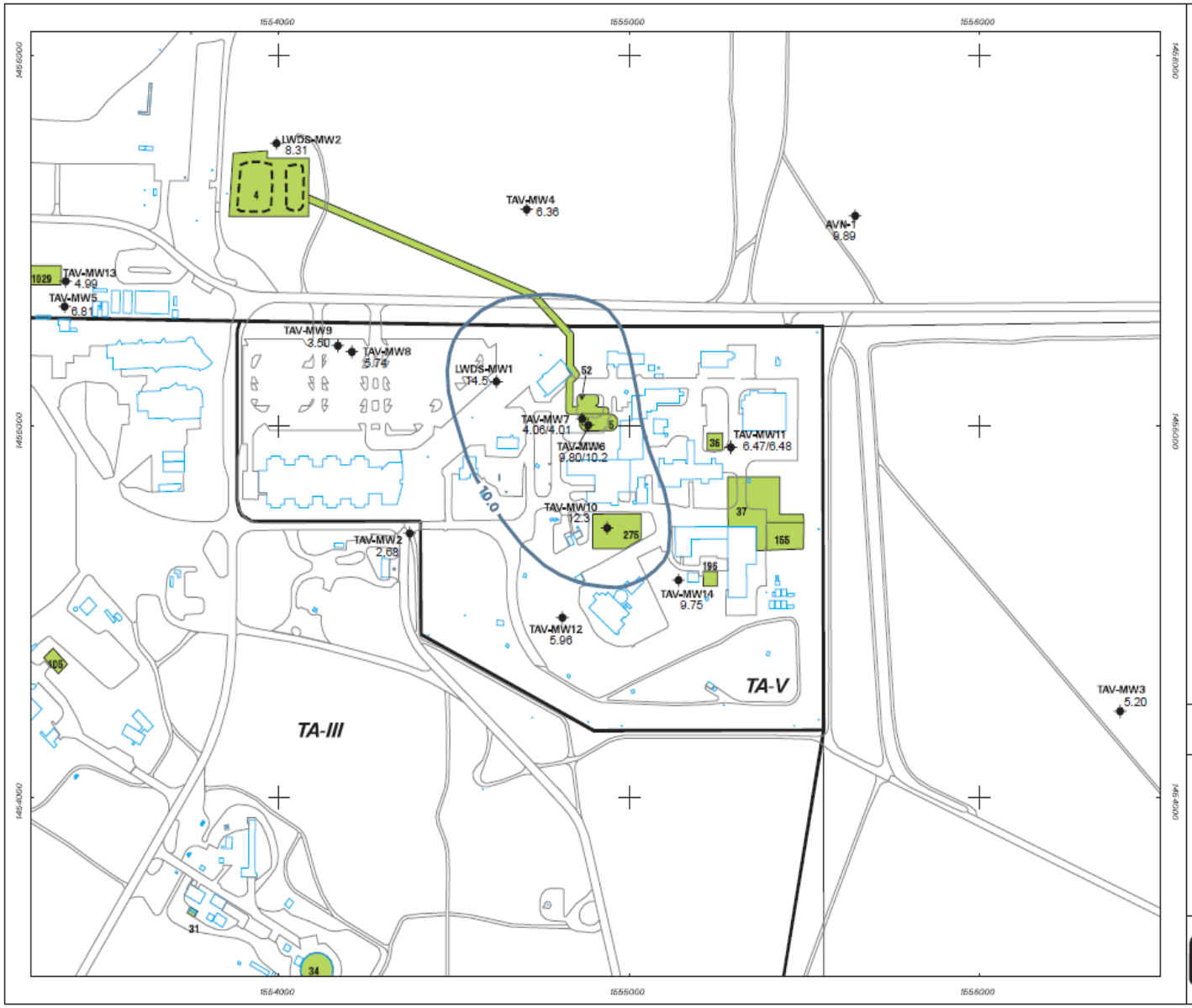
0 300 600
Scale In Feet

0 72 144
Scale in Meters

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone, 1983 North American Horizontal Datum, 1988 North American Vertical Datum



SNL GIS ORG. 4142	1:3600	MAPID=120049
Sandia National Laboratories, New Mexico Environmental Geographic Information System		
DHelfrich	dh120049.aml	01/20/12



Legend

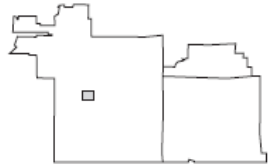
- Monitoring well, with November 2011 Nitrate plus Nitrite concentrations (mg/L)
- Concentration contour (mg/L)
- Road, paved and unpaved
- Impoundment boundary
- Solid waste management unit (SWMU)
- Tech Area boundary
- Building

Notes:
1) Wells TAV-MW7, TAV-MW9 and TAV-MW13 are completed below the water table, and were not used for contouring.
2) Higher concentration from duplicate sample analytical results used for contouring.

0 300 600
Scale in Feet

0 72 144
Scale in Meters

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone, 1983 North American Horizontal Datum, 1988 North American Vertical Datum



SNL GIS ORG. 4142 1:3600 MAPID=120115

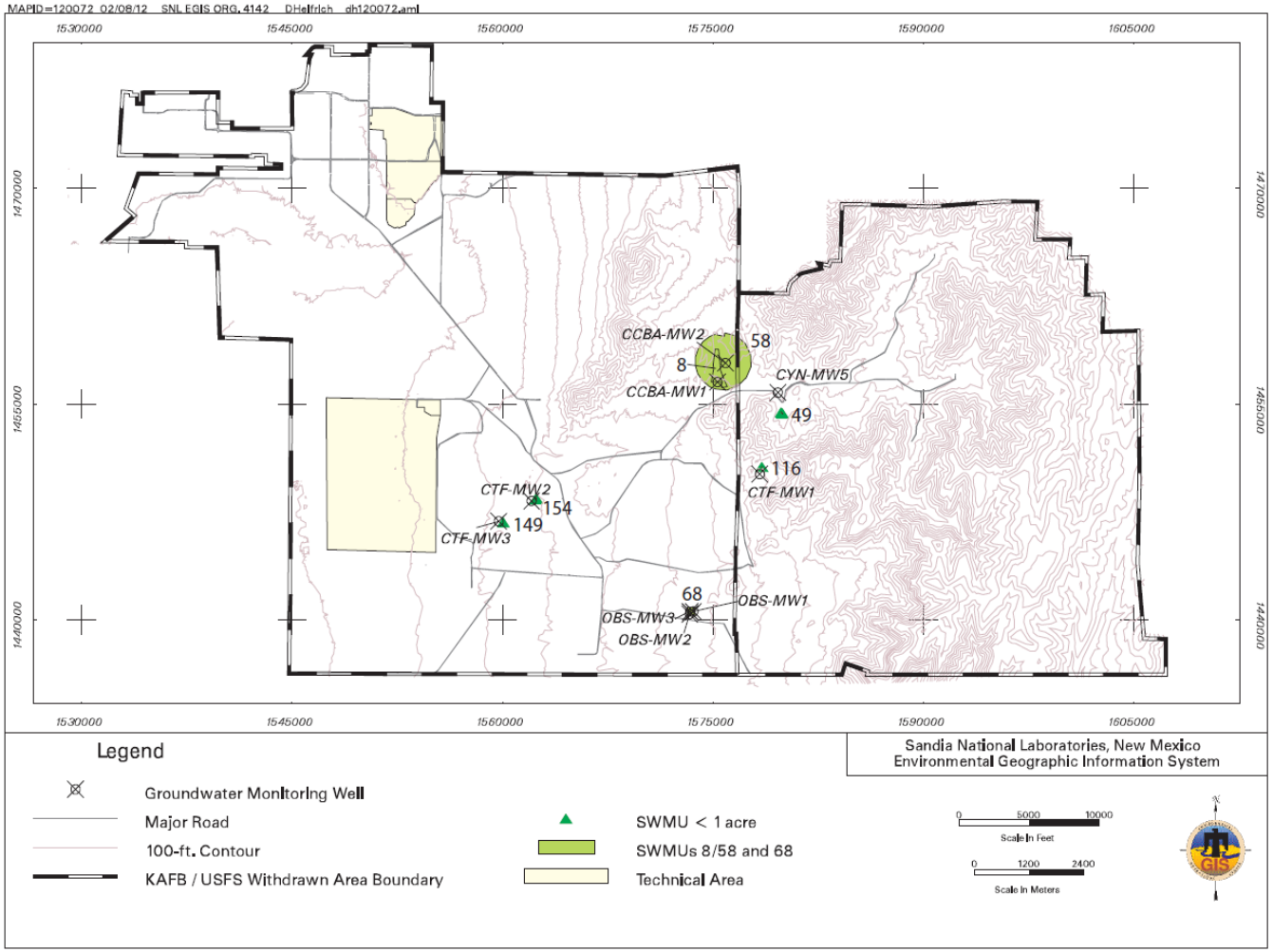
Sandia National Laboratories, New Mexico
Environmental Geographic Information System

DHelfrich dh120115.aml 04/26/12

Miscellaneous Solid Waste Management Units

- No groundwater contamination detected above regulatory standards, except as noted
- **SWMU 8&58**—Explosives test area, two wells. Fluoride above drinking water standard in one well is naturally occurring
- **SWMU 49**—Septic system drain field, one well
- **SWMU 68**—Former burn site, three wells
- **SWMU 116**—Septic system drain field, one well
- **SWMU 149**—Septic system drain field, one well
- **SWMU 154**—Septic system drain field, one well. Trace concentration (less than one part per billion) of an explosive, RDX (no regulatory standard); and arsenic up 0.0774 ppm (regulatory standard is 0.01 ppm)
- Data reported annually to the NMED in the Annual Groundwater Monitoring Report

Miscellaneous Solid Waste Management Units



Key Points

- Groundwater contaminated at four locations, most commonly nitrate and TCE
- Contamination levels are typically low (just above regulatory standards)
- Sites are well characterized and are not a threat to the Albuquerque water supply aquifer
- Groundwater Protection Program and Environmental Restoration Operations will continue to characterize and monitor groundwater by following NMED requirements

Overview of Groundwater Monitoring at Sandia National Laboratories

For questions about Environmental Management, contact Sandia National Laboratories Community Involvement (505) 284-5200

Electronic Versions of the
Annual Groundwater Monitoring Reports and
Annual Site Environmental Reports

http://www.sandia.gov/news/publications/environmental_reports/index.html