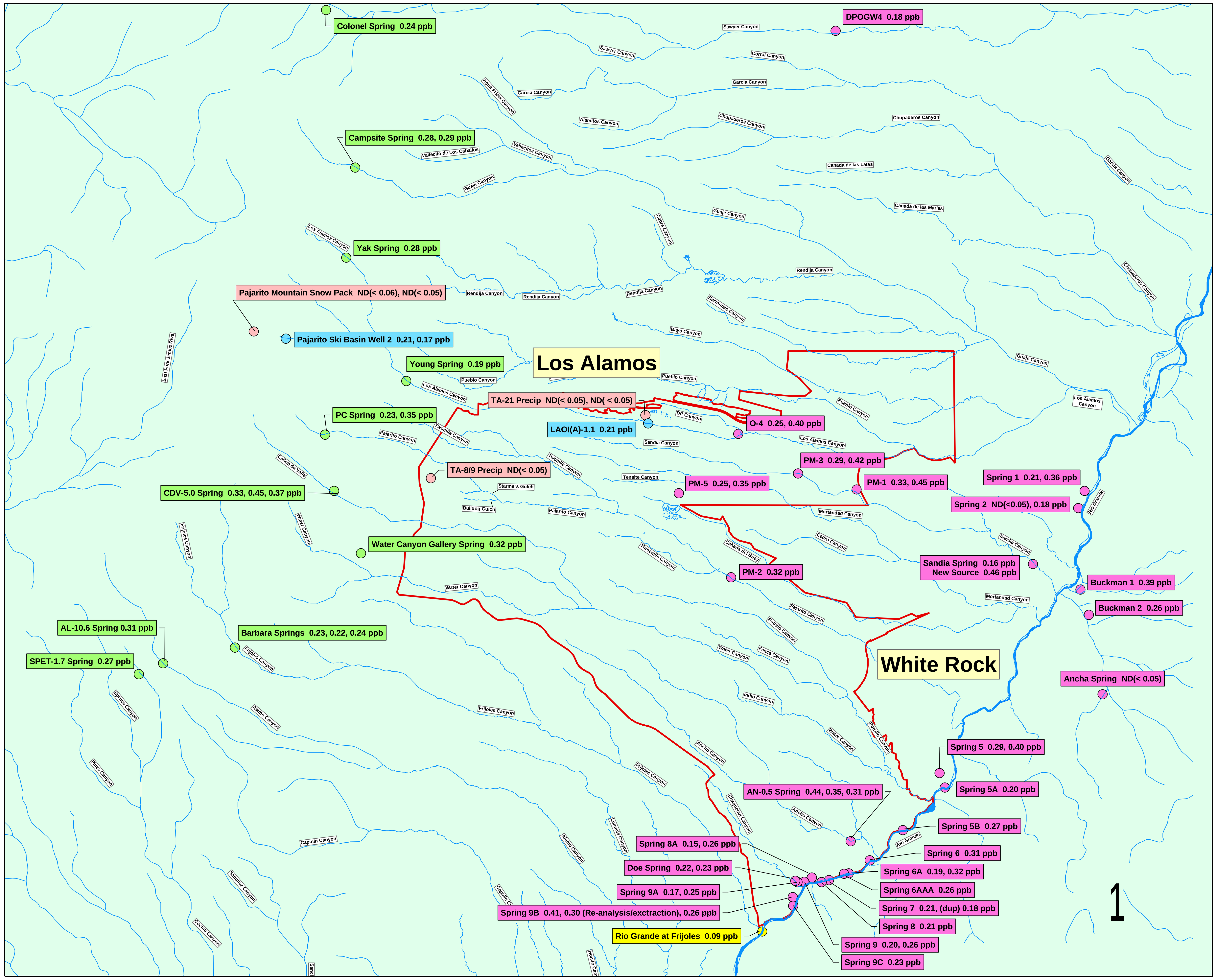

Plate 2 - Selected Stations and Results for the Determination of Background Perchlorate in Ground Water, Surface Water, and Precipitation, Pajarito Plateau

Intermediate Aquifer	LANL Boundary
Precipitation/Snow Pack	Drainage
Surface Water	
Shallow Aquifer	
Deep Aquifer	

1:45,000

0 0.5 1 2 3 4 5 6 7 8 9 10 Miles

DATA SOURCES:
RRES Remediation Services Project
Los Alamos National Laboratory
NMED DOE Oversight Bureau

PROJECTION:
New Mexico State Plane Coordinate System
Central Zone
North American Datum, 1983

Map Produced by K. Granzow, October, 2004
NMED DOE Oversight Bureau
134 State Road 4, Suite A
White Rock, NM 87544

State of New Mexico
Environment Department

DOE Oversight Bureau

Trace Perchlorate in Ground Waters of the Pajarito Plateau, Española Basin and the Rio Grande north of Taos, New Mexico

Michael R. Dale[1], Kim P. Granzow[1], Steve M. Yanicak[1], and David Englert[1],
Patrick Longmire[2], Dale Counce[2]

SUMMARY

The ubiquitous nature of trace levels of perchlorate (see sidebar) in local ground waters of northern New Mexico has recently been determined by researchers from the New Mexico Environment Department (NMED) and Los Alamos National Laboratory (LANL). Widespread and consistent low-level detections of the contaminant in non-human impacted ground-water samples collected from local springs and wells are the basis for this interpretation. The concentration and persistence of perchlorate in a spatial (location) and temporal (ground-water age) sense, however, are not yet fully understood. The NMED and LANL undertook a preliminary investigation to determine the concentration of perchlorate in selected waters within the northern Rio Grande Basin. With an established background concentration value or range, other perchlorate-containing waters within the study region may be more precisely evaluated to assess whether a non-natural source, such as an industrial release, is influencing water quality. If a regionally similar ground-water sample contains perchlorate at a concentration greater than NMED's statistically defensible background value, the elevated perchlorate is most likely due to a man-made source.

New Mexico Environment Department has compiled 76 low-level perchlorate results from 47 ground-water wells and springs within the northern Rio Grande Basin (Plate 1). These results represent locations from the Pajarito Plateau (LANL area), the Española Basin (Plate 2), and several deep-aquifer springs located along the west and east sides of the Rio Grande north of Taos (Plate 1). All water samples were selected based on technical considerations such as aquifer location, age, and water quality (i.e., lack of human-derived contaminants such as nitrate). Six different ground-water zones were sampled, with about half the sample results representing the regional aquifer beneath the Laboratory.

The selected waters were verified as "true background" candidates through the analysis of major ions including chloride and nitrate. These supplemental "water quality" parameters showed sample results indicative of natural levels of nitrate at less than 1 mg/L. Additionally, tritium was measured because it is a naturally occurring radioactive isotope of hydrogen that is commonly used for ground-water dating, and to provide estimates on residence times and flow paths. Tritium results, coupled with local hydrogeologic relationships, show that springs located on the east-facing slope of Sierra de Los Valles represent young water (<50 years) in the early stage of the local hydrologic cycle. Most springs within White Rock Canyon illustrate very old water discharging at the end of the hydrologic cycle. Water collected from monitoring and drinking-water production wells located west and east of the Rio Grande show ages in excess of 1000 years. Based on concentrations of tritium, ground-water age(s) for springs collected north of Taos along the Rio Grande range from very old water (>1000 years) on the west side to more youthful (<500 years) on the east. Stable-isotope (dD and d^{18}O) data were collected from historical and current analyses to estimate the elevation of precipitation for which the ground water was derived (see Plate 3). These measurements provide an indication of recharge elevation that can be used to assess residence times and flow paths.

This study exclusively used a more sensitive Liquid Chromatography/Mass Spectrometry/Mass Spectrometry (LC/MS/MS) method (EPA SW846 8321M) that is able to detect perchlorate at 0.033 micrograms per liter (mg/L) or parts per billion (ppb). The conventional EPA method (SW846 314.0) is less sensitive that can only detect perchlorate at 4 ppb.

Analytical results for perchlorate exhibit spatial variability in concentration between samples collected in the Los Alamos area versus those of Taos. The variability may be due to natural and/or geologic, biologic or atmospheric (evaporation) controls. Additional sampling will be needed so as to determine if temporal variations occur within these aquifers. Seven precipitation samples were collected and analyzed using the LC/MS/MS method to rule out the presence of trace levels in precipitation as a source for the perchlorate in ground water. Perchlorate was not detected in these samples above the method detection limit (MDL) of 0.033 ppb. In late August of this year, we collected and analyzed two additional rain samples using a method similar to LC/MS/MS but with an MDL of 0.0012 ppb or about 30 times lower than that of the LC/MS/MS method. Results, though preliminary and not yet validated, show that perchlorate **may** be present in these precipitation samples at 0.006 ppb and 0.017 ppb.

NMED's first iteration of establishing a background perchlorate concentration was determined by calculating an upper tolerance limit (UTL) based on the available data pool. The 76 analytical results show an average background perchlorate concentration of 0.24 ± 0.10 (1 s) ppb. An upper tolerance limit (UTL) of 0.44 ppb was calculated by adding two standard deviations to the mean. The significance of the UTL is that it can be used by NMED, DOE, municipalities, and local Native American tribal agencies as a background comparison tool for perchlorate. Any water sample showing perchlorate above 0.44 ppb would then be statistically above background. This "first cut" UTL of 0.44 ppb value is approximately ten times below any perchlorate health standard as proposed or recommended by EPA or neighboring states.

These initial findings will be useful in determining if ground waters beneath the Pajarito Plateau have been impacted by Laboratory operations or other human activities, and may aid in the process of setting a state drinking-water standard for perchlorate.

[1] New Mexico Environment Department, DOE Oversight Bureau, 134 State Road 4, Suite A, White Rock, NM 87544

[2] Los Alamos National Laboratory, EES-6, MS D469, Los Alamos, NM 87544

Perchlorate is a man-made chemical used in explosives, rocket fuel, fixers for fabrics, airbags, nuclear reactors, plutonium processing, and many other industrial applications. It is also naturally occurring. The chemical is very soluble in water and persistent in the environment, and is a known thyroid inhibitor - it competes with iodide in the production of thyroid hormones. It is also suspected of causing brain-development problems in infants and small children. Several states have adopted drinking-water standards for perchlorate at levels ranging from 1.5 to 31 ppb. The Environmental Protection Agency has yet to set a Federal drinking-water standard, however, they do have guidance levels at 4 to 18 ppb. California just recently set a state standard at 6 ppb. Moreover, New Mexico does not currently regulate perchlorate in groundwater.

Perchlorate Sources and Presence in Ground Water - Historically, the contaminant was released via Laboratory effluent discharges to several canyons that dissect the Pajarito Plateau. The releases occurred from the mid-1940s through 2002, and were associated with plutonium processing using perchloric acid. Additional sources in the area may include spent household chemicals released to the local wastewater (sewage) treatment systems. Some very preliminary work by NMED indicates that perchlorate may be concentrated in cooling-tower outfall waters via the evaporation processes. Perchlorate has been found in the local drinking-water aquifer beneath the plateau at levels (2 - 5 ppb) suspected of being greater than that of a natural source or background. The highest levels of perchlorate contamination (100 - 400 ppb) are found in the shallow canyon-bottom aquifers. Perchlorate concentrations in the intermediate (130 – 650 feet) aquifers range from less than 1 ppb to as high as 180 ppb.

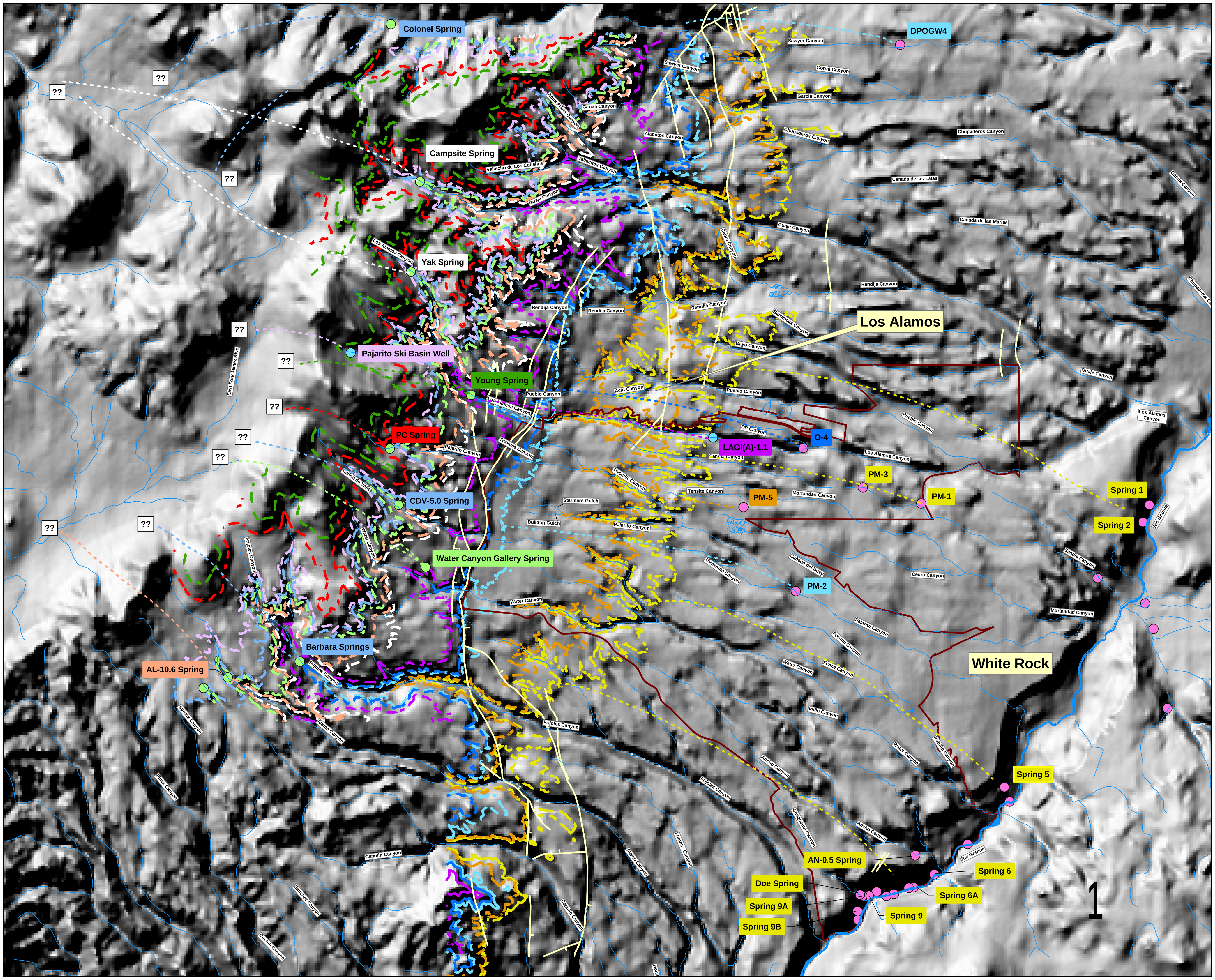

Plate 3 - Estimated Recharge Elevation Based on Stable Isotope Analyses

Estimated Recharge Elevation Based on Stable Isotope Analyses

7200 ft	8300 ft	8800 ft
7300 ft	8400 ft	9100 ft
7600 ft	8600 ft	9400 ft
7700 ft	8700 ft	
8000 ft		

Recharge elevations based on stable isotope data from:
1) Longmire, et al, 2004
2) Meeker, et al, 1990
3) Blake, et al, 1995
4) RACER database, in progress
5) NMED database, 1998-2004

Recharge calculation from delta 18O data using Vuataz and Goff, 1986, following the equation E(m) = 314(delta 18O) - 1161 (r = -0.97)
Estimated recharge elevation uncertainty is unknown (± 500 ft?)
Stable isotope analytical uncertainty: ± 0.1 per mil or about 100 ft elevation

Intermediate Aquifer	LANL Boundary
Shallow Aquifer	Drainage
Deep Aquifer	Fault Zones

1:45,000

0 0.5 1 2 3 4 5 6 7 Miles

SPATIAL DATA SOURCES:
RRES Remediation Services Project
Los Alamos National Laboratory
NMED DOE Oversight Bureau

PROJECTION:
New Mexico State Plane Coordinate System
Central Zone
North American Datum, 1983

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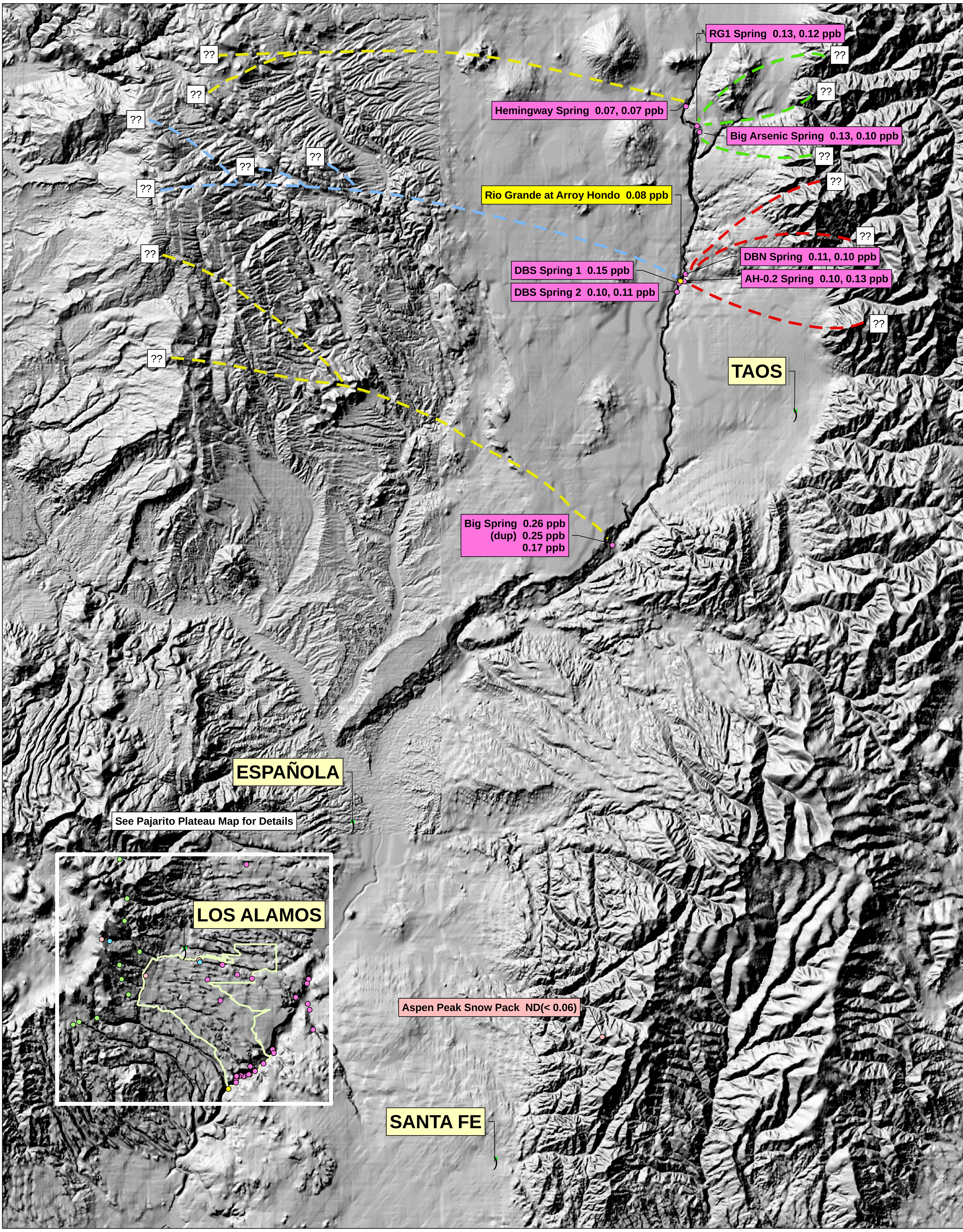

Plate 1 - Selected Stations and Results for the Determination of Background Perchlorate and Estimated Recharge Elevations in Ground Water, Surface Water, Pajarito Plateau, Española Basin, and the Rio Grande North of Taos, New Mexico

1:200,000

0 5 10 20 30 40 50 Miles

Estimated Recharge Elevation Based on Stable Isotope Analyses

- 10,300 ft
- 10,500 ft
- 10,900 ft
- 11,200 ft

- Town Sites
- Intermediate Aquifer
- Precipitation/Snow Pack
- Surface Water
- Shallow Aquifer
- Deep Aquifer
- LANL Boundary

Recharge elevations based on stable isotope data from:
1) NMED database, 1998-2004
Recharge calculation from delta 18O data using Vuataz and Goff, 1986,
following the equation E(m) = 314(delta 18O) - 1161 (r = -0.97)
Estimated recharge elevation uncertainty is unknown (± 500 ft?)
Stable isotope analytical uncertainty: ± 0.1 per mil or about 100 ft elevation

DATA SOURCES:
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