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February 13, 2002

Mr. Alec Naugle
Regional Water Quality Control Board
San Francisco Bay Region
1515 Clay Street, Suite 1400
Oakland, CA 94612

Subject: Recommendation to modify San Mateo Plain Groundwater Basin boundary in *"A Comprehensive Groundwater Protection Evaluation for South San Francisco Bay Basins" {draft for Stakeholder Review}, December 2001*

Dear Mr. Naugle,

As members of the Environmental Protection and Restoration (EP&R) Group at Stanford Linear Accelerator Center (SLAC), we have reviewed your draft document and would like to extend our appreciation and thanks for your committee's effort. The document covers a large, complicated area, and we feel you have done a very good job integrating a wide variety of data sets to identify the key problems and issues regarding the groundwater of the South Bay area.

SLAC is located in an incorporated area of southeast San Mateo County on bedrock uplands east of the Santa Cruz Mountains and 6.5 miles southwest of San Francisco Bay (Figure 1). The facility is located in an area dominated by Eocene to Miocene consolidated marine sedimentary rocks estimated to be in excess of 2,000 feet thick (Figure 2) (Page and Tabor, 1967). In this letter we would like to present results of our geologic and hydrologic investigations conducted over the last 40 years at this facility and to provide you with our supporting data, conclusions, and recommendations to be considered when finalizing your document.

You have recommended modifying the San Mateo Plain Boundaries (*Table ES-3. Recommendations Requiring Coordination Between Agencies*), and we strongly agree. In addition to your recommendations, we would like to make some suggestions regarding the area around SLAC in Menlo Park in southern San Mateo County (Figure 1) that would affect your *Figure 3* (*Surficial Geology*), *Figure 9* (*Map of San Mateo Plain Groundwater Basin*), and *Figure 26* (*Interim Prioritization Approach for the South Bay Basins*). Our supporting documentation and recommendations are as follows.

Recommendations for South San Francisco Bay Document

Figure 3: Surficial Geology

We recommend changing your draft *Figure 3: Surficial Geology* to what is shown on the attached Figure 8. This recommendation is based on:

- the distribution of mapped bedrock units in the SLAC area (Figure 2),
- the low permeability of rock units at SLAC (Figures 3 and 4),
- the elevated TDS of the groundwater at SLAC (Figure 5), and
- the distribution of groundwater production wells in the SLAC area (Figures 6 and 7).

Figure 8 (a modified version of your *Figure 3*) more accurately represents the distribution of Santa Clara Formation in southern San Mateo County based on SLAC's available on-site data as shown on Figure 2.

Figure 9: San Mateo Plain Groundwater Basin

Based on the distribution of bedrock and the Santa Clara Formation shown on Figure 8 (the revised *Figure 3: Surficial Geology*), *Figure 9: San Mateo Plain Groundwater Basin* should be modified to exclude the eastern part of SLAC as shown on Figure 9. We also noticed an error on your map that shows I-280 offset at Alpine Road (see "freeway offset" on Figure 9).

Figure 26: Interim Prioritization Approach for Groundwater Protection

Finally, based on modifications shown on Figures 8 and 9, *Figure 26: Interim Prioritization Approach for Groundwater Protection* should be modified as shown on Figure 10. In San Mateo County, the definition of priority protection areas should reflect the geology and hydrogeology of the San Mateo Plain Groundwater Basin and surrounding bedrock regions. To define the appropriate priority protection areas, the boundaries of the groundwater basin need to accurately reflect the current understanding of the geology and hydrogeology of the area.

Defining the Boundaries of the San Mateo Plain Groundwater Basin

Our data suggest that the majority of the SLAC area, including the eastern end of SLAC, is outside the San Mateo Plain Groundwater Basin. The EP&R group has been working on the SLAC site for over ten years, and we have installed over 80 monitoring and extraction wells. Many of these wells have both geophysical logs and continuous cores that have been described in detail. We have integrated our hydrochemical and hydraulic data with the subsurface data and with the extensive geologic mapping of the SLAC site. With this wealth of information, we developed our own site-specific hydrogeologic model that could provide better information to define the basin boundary in the model portrayed in your document. Specifically, you show much of the eastern end of SLAC to be within the San Mateo Plain Groundwater Basin, and our data suggest that it is outside the basin boundary and is within the bedrock region.

You define groundwater basin boundaries in section *2.1 Groundwater Basin Boundaries*:

> *Groundwater basin boundaries, from a groundwater flow perspective, are generally drawn along barriers to groundwater flow. Most of the South Bay Basin boundaries are artificial and have been established for convenience rather than along "no-flow" boundaries. The only true boundaries that meet this definition in the South Bay are those between alluvium and bedrock.*

You have defined the San Mateo Plain Groundwater Basin boundary (as shown on your *Figure 9*) as the contact between the Santa Clara Formation and Tertiary bedrock, rather than the bedrock – alluvium contact in the area around SLAC (see your *Figure 3*). Your *Figure 3* generalizes and misrepresents the distribution of Santa Clara Formation in the SLAC area. Our hydrologic model includes data indicating that most of SLAC is underlain by bedrock with a few isolated, thin veneers of generally unsaturated Santa Clara Formation resting locally on the bedrock. In your description of the Santa Clara Formation in *Appendix B South Bay Geology,* you state:

> *The Santa Clara Formation is considered to be partly water bearing. The portion that outcrops{sic} above the edges of the valley is generally considered to be non-water-bearing.*

We agree and recommend changing the boundary of the San Mateo Plain Groundwater Basin to be consistent with this statement. This is supported by:

- the geology and hydrostratigraphy of SLAC (particularly the distribution of the Santa Clara Formation)
- groundwater flow and hydraulic conductivity at SLAC
- the hydrochemistry of groundwater at SLAC
- distribution of off-site groundwater production wells

Much of the data and reasoning for our recommendation are presented in SLAC (2001).

Introduction to SLAC

SLAC is a national research facility whose mission is the study of the basic properties of matter (Figure 1). It is owned and operated by Stanford University for the U.S. Department of Energy. The facility is located on 426 acres of low, rolling foothills between the alluvial plain to the east and the Santa Cruz Mountains to the west. SLAC is following a site-wide priority investigation and cleanup process developed in 1992 for the identification and restoration of potentially contaminated areas (SLAC, 1993). These areas are generally divided into "soil-only sites" that contain polychlorinated biphenyls (PCBs) and "groundwater sites" with chlorinated solvents.

The San Mateo County Environmental Health Services Division provides oversight of soil-only sites. The California Regional Water Quality Control Board provides oversight and approval of restoration activities for groundwater.

Geology of SLAC

The understanding of the geology and hydrogeology of SLAC is based on over forty years of geotechnical investigations related to constructing SLAC facilities and over ten years of environmental restoration investigations. Numerous geologic studies have been conducted at the SLAC property and surrounding region since the late 1950's. Pre-construction geological investigations for siting of the two-mile long accelerator began in 1959, and continued into the mid-1960's. These early investigations focused on how the subsurface environment would affect siting, construction, and operation of the linear accelerator. Geological and hydrological investigations of the eastern portion of the SLAC site were performed in 1975 and 1982 to gather data for the siting and construction of two additional underground experimental facilities, the Positron Electron Project (PEP) and the Stanford Linear Collider (SLC) (Figure 1).

Construction of the underground portions of the experimental facilities at SLAC required extensive information on the geology underlying the site. Numerous studies were performed with the goal of determining how the geologic environment would affect construction and the integrity of the underground tunnels. Information on the subsurface environment was obtained through the drilling of almost two hundred boreholes. A small percentage of the boreholes were converted into groundwater monitoring wells to determine the groundwater elevation and its impact on tunneling operations. These monitoring wells were all subsequently destroyed.

Since the early 1990s over 80 groundwater monitoring and extraction wells have been installed at SLAC as part of the environmental restoration program. In addition to the wells, hundreds of samples from soil borings have been collected and thousands of chemical analyses have been performed on soil, rock, and groundwater samples. All these data have been integrated into our understanding of the geology and hydrogeology of SLAC.

SLAC is located on bedrock uplands east of the Santa Cruz Mountains and west of San Francisco Bay. As shown on Figure 2, the facility is located east of the San Andreas Fault in an area dominated by two marine sedimentary units, the Eocene Whiskey Hill Formation (55 to 38 million years old) and the Miocene Ladera Sandstone (24 to 5 million years old) (ABA, 1965; Page and Tabor, 1967; Pampeyan, 1993; SLAC, 1994). The older Whiskey Hill Formation crops out in the western part of SLAC. The younger Ladera Sandstone crops out predominantly in the central and eastern part of SLAC. These units are interpreted to be greater than 2,000 feet thick at SLAC (ABA, 1965; Page and Tabor, 1967; Pampeyan, 1993). At SLAC, groundwater is primarily encountered within these two units.

Whiskey Hill Formation

The Whiskey Hill Formation is a turbiditic sandstone and mudstone with local chaotic zones that are interpreted to reflect submarine slumping. Exposures of the Whiskey Hill Formation are present in excavation outcrops along the linear accelerator at the SLAC facility (ABA, 1965; Page and Tabor, 1967; Pampeyan, 1993).

Ladera Sandstone

The Ladera Sandstone has been intensively studied at SLAC because of the placement of the linear accelerator and the Positron Electron Project (PEP) and Stanford Linear Collider (SLC) tunnels into this formation. Remedial investigations at SLAC have also focused on the Ladera Sandstone (SLAC, 1998; 1999).

The Ladera Sandstone consists of marine silty sandstone to sandy siltstone and rests unconformably on the Whiskey Hill Formation. It is generally massive, although fractures and bedding are observed locally. The unit is commonly cemented with calcite and/or gypsum and is weakly to well consolidated. The Ladera Sandstone was deposited in a nearshore to open shelf marine environment.

Santa Clara Formation

Locally at SLAC, the Ladera Sandstone is overlain by a thin veneer of the Santa Clara Formation (typically 10 feet or less), a terrestrial sedimentary unit, and by recent alluvium. Extensive occurrences of the Santa Clara Formation (approximately 5 million to 10,000 years old) and Quaternary alluvium (less than 10,000 years old) have been mapped to the south of SLAC (Figure 2).

Sediments of the Santa Clara Formation consist of gravel, sand, silt, and clay and can be distinguished from younger alluvium by the local occurrence of chert pebbles and cobbles. The stratigraphic unit has been folded locally and dips as steeply as 55° (ABA, 1965; Page and Tabor, 1967). It should be noted that the Santa Clara Formation as mapped at

SLAC remains undated by either radiometric or biostratigraphic methods and was mapped on the basis of regional correlation and superposition.

One area of Santa Clara Formation exposure is located in the south-central part of SLAC. It appears to be completely surrounded and underlain by the Ladera Sandstone. Another area of Santa Clara Formation exposure is located in the northeast corner of SLAC (Figure 2). The results of on-site drilling indicate that the Santa Clara at the latter location occurs entirely above the water table.

The water quality and hydrologic data demonstrate that the Santa Clara Formation, although geologically distinct, does not play a major role in groundwater transport at SLAC. This is because:

1) the sediments are not present in significant quantities,
2) they are not connected to other permeable, unconsolidated deposits, with the exception of a small area on the eastern margin of SLAC, and
3) they occur mainly above the water table.

The distribution of Santa Clara Formation shown on Figure 2 is significantly different than the distribution shown on your *Figure 3: Surficial Geology*. The distribution of Santa Clara Formation shown on Figure 2 is based on Page (1993), Pampeyan (1993), SLAC (1994), and our unpublished field work.

The references on your *Figure 3: Surficial Geology* are listed as *USGS (1997), (1998),* and *(2000),* and *SFEI Ecoatlas v1.50b4.* These references are not included in your reference list at the end of your document or in the relevant Appendices B and/or C.

<u>Recent Alluvium</u>

Recent alluvium, consisting of sedimentary fan, stream channel, and overbank deposits, has been mapped along the southern boundary of the eastern end of SLAC (Figure 2). The alluvium on site is generally believed to be as much as 10 feet thick in the southeastern margin of the site.

<u>Artificial Fill</u>

Fill material is locally encountered in the subsurface at SLAC. The fill typically consists of native material that was moved during construction and grading activities at SLAC. Fill is not typically saturated with groundwater. One exception is the area beneath and adjacent to the linear accelerator that consists of sands and backfill material that are part of a subsurface drainage system.

Groundwater Flow at SLAC

Prior to the construction of SLAC, regional groundwater flow was estimated to mimic topography, with a groundwater divide near Sand Hill Road (HNS, 1965). The land slopes generally to the south from an east-west topographic high along Sand Hill Road. This pattern for groundwater flow continues today, with the majority of SLAC's groundwater flowing generally south and southeast (Figure 3).

Local Groundwater Flow

SLAC groundwater elevation data have been collected quarterly since 1991, providing an extensive database of local groundwater piezometric conditions for analysis. Additional hydrogeologic information has been gained from site-specific fracture studies that were conducted in two different areas at SLAC in the Ladera Sandstone (SLAC, 1998; SLAC, 1999).

Groundwater gradients and elevations across the SLAC site have been modified locally by earthwork associated with the grading and construction of the SLAC facility. In addition, local gradients and groundwater elevations have been altered to varying degrees by the presence of three major underground structures at SLAC:

- the linear accelerator;
- the PEP Tunnel; and
- the SLC Tunnel.

The linear accelerator and the PEP and SLC tunnels (Figures 2 and 3) are large-scale underground concrete structures constructed in the Whiskey Hill Formation and the Ladera Sandstone. The linear accelerator was excavated, whereas the PEP and SLC tunnels were primarily bored and excavated (cut and cover) through the bedrock. The linear accelerator is two miles long and traverses the SLAC site in a generally east-west direction. The PEP and SLC tunnels are circular in plan view and are located beneath the eastern part of SLAC.

The linear accelerator extends to approximately 35 feet below ground surface. A subdrainage or under-drain system consisting of two parallel drainpipes with coarse permeable backfill was constructed below the linear accelerator to limit groundwater infiltration into the structure. Much of the linear accelerator was constructed by excavation into the bedrock. After construction, the structure was buried with the excavated material. The compacted backfill likely has a higher permeability than the undisturbed bedrock.

This subdrainage system appears to exert a significant local effect on groundwater flow, by locally reversing the natural groundwater gradient south of the linear accelerator (Figure 3).

The SLC and PEP Tunnels also have subdrainage systems constructed beneath the tunnels to limit groundwater influx into the tunnels. These are not as elaborate as the subdrainage system beneath the linear accelerator (i.e., one drain was installed in each of the tunnels, instead of two, and a smaller quantity of pervious backfill was used in each). In addition, these tunnels were constructed primarily by boring into the bedrock, and were only excavated at specific areas.

Groundwater elevation data are limited in the area of the PEP and SLC Tunnels, and thus the effects of these structures on local groundwater flow patterns are not well understood. Based on the current data, groundwater flow near the tunnels does not appear to be substantially different from predevelopment flow patterns.

<u>Fractures and Local Groundwater Flow</u>

Fractures occur in outcrop and in core samples within the bedrock Ladera Sandstone and Whiskey Hill Formation at SLAC. Borehole observations of fractures and groundwater flow indicate that fractures may have an influence on groundwater flow at a local scale. However, quantitative fracture studies conducted at SLAC have not resulted in the correlation of fracture density with significant zones of enhanced groundwater flow or perturbed groundwater gradients. The data suggest that groundwater flow occurs within fractures as well as within the rock matrix, so that the subsurface acts in a hydraulically similar fashion to a low permeability porous medium. This view is supported by results from groundwater monitoring well responses to pumping during long-term pumping tests (EKI, 2000a, EKI, 2000b).

<u>Hydraulic Conductivity and Sustained Well Yield</u>

SLAC has conducted groundwater well pumping tests, slug tests, packer tests, and laboratory tests of hydraulic conductivity. Most of these tests have been within the Ladera Sandstone. Figure 4 presents hydraulic conductivity data for groundwater monitoring wells at SLAC from long-term pumping tests, slug tests, packer tests, and laboratory measurements. The most representative data regarding sustained well yield are from three long-term pumping tests that were conducted at different areas of SLAC.

<u>Pumping Tests</u>

The three pumping tests conducted at SLAC (Figure 4) have generally included a month of field data collection, including background water level and barometric monitoring, pumping phase monitoring, and recovery monitoring. At two of the three locations, the pumping well was selected primarily because it had a higher specific capacity than other wells in the area, and could be pumped. At the third location, the well was selected because it was located within a potential remediation area. All three pumping tests required extension beyond the planned pumping period in order to observe a response in at least one observation well. No significant hydraulic responses (i.e., drawdowns) were observed in the more distant observation wells.

The results of the pumping tests are summarized in Table 1, with the average hydraulic conductivity value from these tests on the order of 4.1 x 10^{-5} cm/sec. The range of hydraulic conductivity from the three tests using the different analytical methods was 4.4 x 10^{-6} cm/sec to 1.4 x 10^{-4} cm/sec. The data agree reasonably well for all three areas, and are typical of published hydraulic conductivity values for low permeability media.

Using the pumping rate for each test, the average well yield is approximately 55 gallons per day.

Only 10 of the 68 SLAC groundwater monitoring wells can be purged of 4 casing volumes and fully recover immediately after purging. Fifty-eight wells require from about one to 26 hours to recover to 80 percent of the initial water level prior to purging, indicating that for most wells at SLAC, sustained yield would be very low.

Partially saturated, isolated remnants of the Santa Clara Formation have been mapped at one of the locations of the pumping tests. The results of the pumping test at this location (FHWSA on Figure 4) did not reveal significant differences in the hydraulic properties of the Santa Clara at this location compared to the Ladera Sandstone.

Slug Tests

There have been eight slug tests performed at SLAC, six in 1992 and two in 1985. Hydraulic conductivity values calculated on the basis of slug tests are shown on Figure 4. The wells tested in 1992 were selected with the objective of obtaining a wide range in values for hydraulic properties and to provide coverage of the eastern part of SLAC. The range of hydraulic conductivities estimated from the slug tests was 1.4 x 10^{-6} to 2.3 x 10^{-4} cm/sec, similar to the range determined from the long-term pumping tests.

Packer Tests

Approximately two dozen packer tests were performed in boreholes prior to the construction of the SLC Tunnel (Figure 4). In addition, five packer tests were attempted in 1996 in the Former Solvent Underground Storage Tank Area. The 1996 tests did not yield results due to leakage around the packers, and subsequent packer tests have not been included as an element in drilling investigations. The range of hydraulic conductivity values determined during the investigations for the SLC Tunnel was 8.3 x 10^{-7} to 3.2 x 10^{-5} cm/sec. This range is somewhat less conductive than the range determined from the long-term pumping tests.

Geotechnical Rock-Core Tests

There have been 51 ex situ laboratory measurements of hydraulic conductivity based on core samples collected during drilling programs at SLAC. The range of hydraulic conductivity values based on laboratory measurements is 1.0×10^{-7} to 6.97×10^{-4} cm/sec. This is the largest range in measured hydraulic conductivity values; however, the laboratory measurements represent the smallest area spatially since the measurements are from six-inch core samples.

Pump and Treat System Performance

In 2001, SLAC installed a groundwater extraction and treatment system at a site of a former solvent underground storage tank (FSUST Area on Figure 4). This system includes five extraction wells. The system has been running continuously since start up in August 2001, with a very small amount of down time because of mechanical and other problems. Typical cumulative flow rates of the five wells range from 0.11 to 0.22 gpm. When calculated to a per well average, each well produces approximately 31.7 to 63.4 gallons of groundwater per day, depending on the time of year. This range is very similar to the average sustained yield of 55 gallons per day calculated from the pump test data (Table 1).

Summary of Hydrologic Data

The hydrologic data collected at SLAC, based on the long-term pumping tests, slug tests, packer tests and laboratory measurements, are in the range of 10^{-7} to 10^{-4} cm/s, with an average value of approximately 4×10^{-5} cm/s and a median value of approximately 9×10^{-6} cm/s. These values agree with published values for silty sandstone, and are typical of low permeability media. This range of hydraulic conductivity values is out of the range that is generally accepted as aquifer material (Driscoll, 1986). These hydraulic conductivity values are consistent with the sustained well yields measured during the three on-site pumping tests of approximately 55 gallons per day and the extraction well field (Table 1).

In summary, on the basis of low well yield at SLAC and the overall very low hydraulic conductivities, SLAC should not be included within the San Mateo Groundwater Basin. SLAC is outside the basin and is dominated by bedrock geology.

Groundwater Chemistry

Groundwater chemistry data from SLAC demonstrate that groundwater is strongly affected by the bedrock. Total dissolved solids (TDS) data have been collected at SLAC as part of site characterization since 1990. Elevated TDS data reflect the presence of calcium, sodium, magnesium, chloride, sulfate, and carbonate in groundwater based on mass balance of these constituents with the TDS results. These constituents likely reflect the dissolution of minerals in the Ladera Sandstone and the Whiskey Hill Formation due to the marine origin of these bedrock formations.

A summary of the TDS data is presented in SLAC (2001), and the average TDS value through time for each sample location is shown on Figure 5. The data demonstrate that two-thirds of groundwater sample locations at SLAC have TDS concentrations in excess of the 3,000 mg/L.

TDS concentrations in groundwater range from 250 mg/L (in monitoring well EW-1) to 18,000 mg/L (in monitoring well MW-46). The site-wide average TDS concentration in groundwater is 4,532 mg/L. This value was calculated by taking the average TDS concentration for groundwater from each well and then using these representative well values to compute the site average. The site-wide median TDS concentration in groundwater is 3,775 mg/L.

There is no spatial correlation between elevated TDS concentrations in groundwater and the occurrence of volatile organic compounds in groundwater (SLAC, 2001).

Based on the available 10 years of data for TDS in groundwater, there does not appear to be any clear increasing or decreasing trend in TDS concentrations in groundwater over time. Variations through time may reflect seasonal variations in water quality, and possibly differences in the analytical performance of laboratory.

In summary, the ten years of groundwater monitoring data at SLAC demonstrate that for approximately two-thirds of the groundwater sampling locations, the TDS concentrations in groundwater exceed 3,000 mg/L. The site-wide average TDS concentration is 4,532 mg/L. Based on analytical data for groundwater collected by SLAC, the high TDS concentrations in groundwater are not related to contamination but rather reflect elevated concentrations of calcium, sodium, magnesium, chloride, sulfate, carbonate, and other ions, that most likely have been dissolved from the Santa Clara Formation and the Ladera Sandstone.

Current Off-Site Groundwater Use

Groundwater resources developed within the SLAC area are restricted to where unconsolidated sediments of San Francisquito Creek rest above bedrock. Two well use surveys have been conducted at and in the vicinity of SLAC, one in 1992 (SLAC, 1993), and a 1998 update (EKI, 1998). The 1992 survey perimeter extended more than three miles downgradient of SLAC. The 1998 update focused on verifying the existence of wells that were identified to be closest to SLAC through field checks and interviews with well owners.

The closest downgradient well to SLAC is located along the stream margin of San Francisquito Creek, across San Francisquito Creek from SLAC (i.e., well 26 shown on Figures 6 and 7). The well is used for agricultural purposes.

The closest community water well is about 4,000 feet south and across San Francisquito Creek from SLAC (i.e., well 51 shown on Figure 6 and 7). It supplies water to the three Webb Ranch residences and to the public in drinking fountains at the Webb Ranch Stables.

In summary, the available information indicates that viable groundwater resources developed in the vicinity of SLAC have been limited to where unconsolidated sediments of San Francisquito Creek (and tributaries) rest above bedrock. Despite a historical need for additional local sources of water, groundwater resources have not been developed within the Miocene bedrock units that dominate the geologic setting at SLAC. A more complete discussion of past and current off-site groundwater use is found in SLAC (2001).

Discussion

The geology and hydrogeology of the SLAC area provides critical information regarding the boundary of the San Mateo Plain Groundwater Basin in southern San Mateo County. This boundary impacts the definition of the priority protection areas in the south San Francisco Bay area, and should reflect the known geology and hydrogeology of the region. Because of our experience and our data sets at SLAC, we feel that we can provide you with more accurate information regarding the groundwater geology of this part of southern San Mateo County. With the information from the SLAC area, we recommend you modify your document to reflect the known geology and hydrogeology of the area.

Thank you for providing us the opportunity to comment on your document. We hope you have found our suggestions useful and that you will consider modifying your document to reflect our current understanding of the geology and hydrogeology of the SLAC area. If you have any questions or would like to discuss any of the information we have presented, please contact us.

Sincerely,

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Attachments

Table 1. Summary of Long-Term Pumping Tests Performed at SLAC

Figure 1. Location of Stanford Linear Accelerator Center (SLAC)
Figure 2. Site Geology
Figure 3. SLAC Piezometric Surface Contours May 2000
Figure 4. Location and Results of Hydraulic Testing at SLAC Wells
Figure 5. Average Total Dissolved Solids Concentrations in SLAC Groundwater Samples
Figure 6. Approximate Locations of Groundwater Supply Wells in the Vicinity of SLAC
Figure 7. Locations of Groundwater Wells Within One Mile of SLAC
Figure 8. *Figure 3: Surficial Geology (revised)*
Figure 9. *Figure 9: San Mateo Plain Groundwater Basin (revised)*
Figure 10. *Figure 26: Interim Prioritization Approach for Groundwater Protection (revised)*

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cc:
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Table 1

Summary of Long-Term Pumping Tests Performed at SLAC [1]

SLAC Area	Dates	Pumping period (days)	Hydraulic Conductivity Range (cm/sec)	Transmissivity (cm^2/sec)	Average Pumping Rate	Sustained Yield [2]
Plating Shop	June 27 - July 19, 2000	8 days	1.9×10^{-5} to 2.3×10^{-5}	0.043 - 0.051	0.035 gal/min	50.4 gal/day
Former Hazardous Waste Storage Area ("FHWSA")	August 6 - August 23, 1999	5 days	3.3×10^{-5} to 1.4×10^{-4}	0.020 - 0.084	0.037 gal/min	53.2 gal/day
Former Solvent Underground Storage Tank ("FSUST")	April 19 - May 28, 1997	7 days	4.4×10^{-6} to 2.4×10^{-5}	0.0098 - 0.054	0.042 gal/min	60.5 gal/day
Approximate Mean Values:			**4.1×10^{-5} cm/sec**	**0.044**		**55 gal/day**

Notes:

1. Data from EKI (1997), EKI (2000a), and EKI (2000b)
2. Sustained yield estimate is calculated from average pumping rate.

Abbreviations:

cm/sec = centimeters per second

gal/day = gallon per day

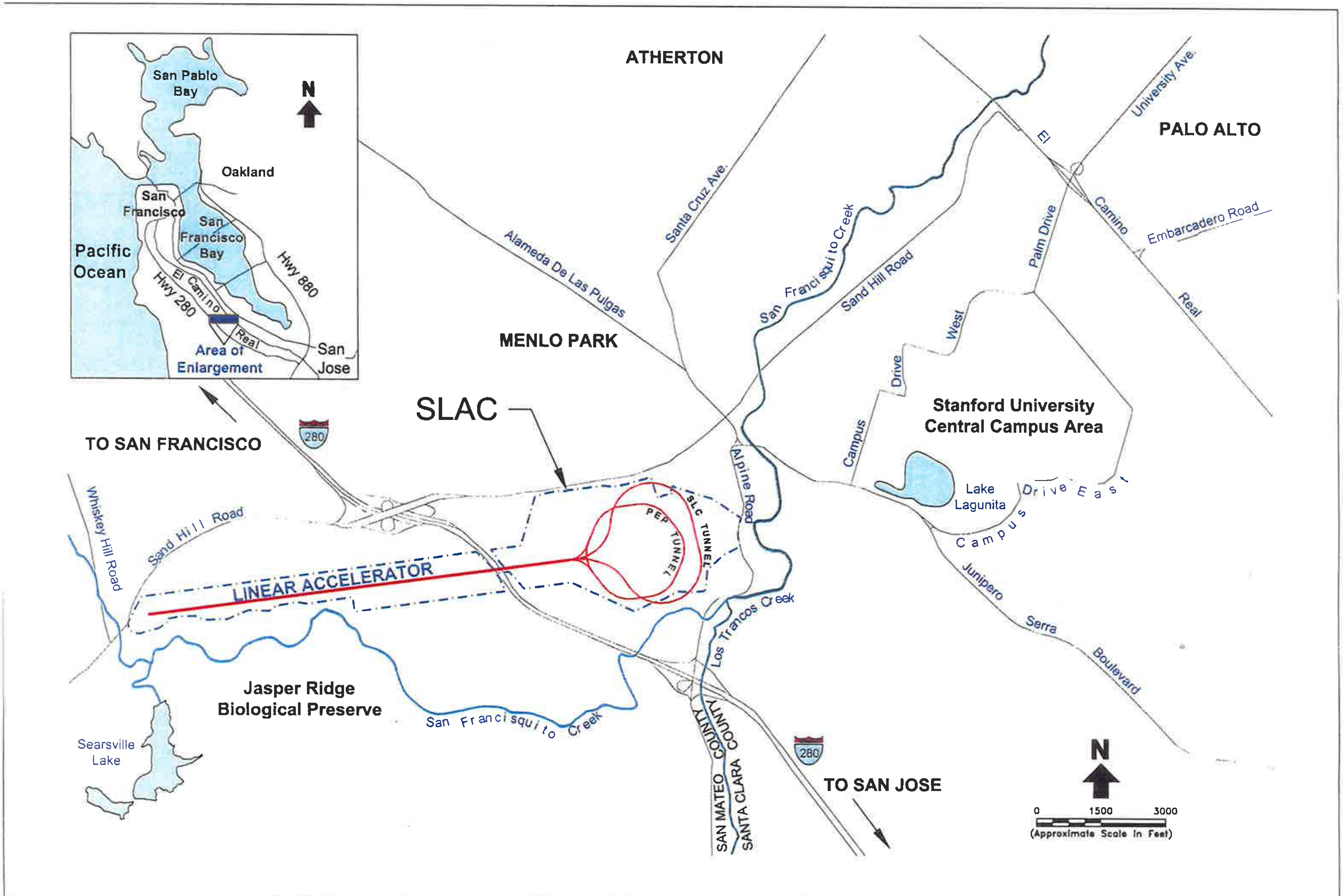


Figure 1. Location of Stanford Linear Accelerator Center (SLAC)

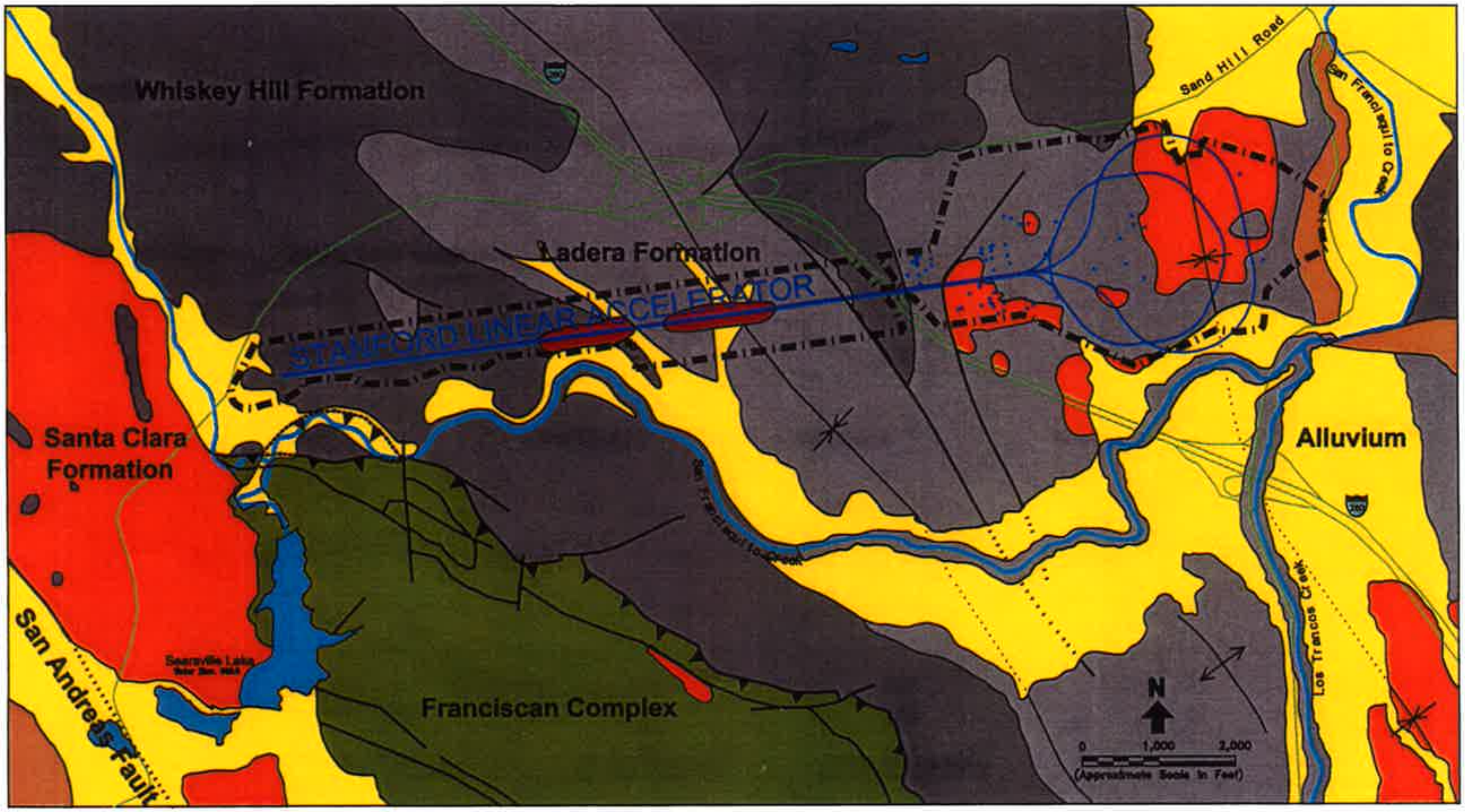


Figure 2. Site Geology

Explanation

- Monitoring Well
- Property Boundary
- Thrust Fault
- Fault
- Road
- Contact
- Creek
- Anticline
- Syncline
- Artificial Fill *
- Alluvium and Colluvium
- Santa Clara Formation
- Ladera Formation
- Whiskey Hill Formation
- Franciscan Complex
- Other Undifferentiated Bedrock Units

* Artificial Fill shown only along Linear Accelerator. Large areas of Artificial Fill on eastern part of of SLAC not shown.

Modified after Page (1993); Pampeyan (1993); ESA (1994)

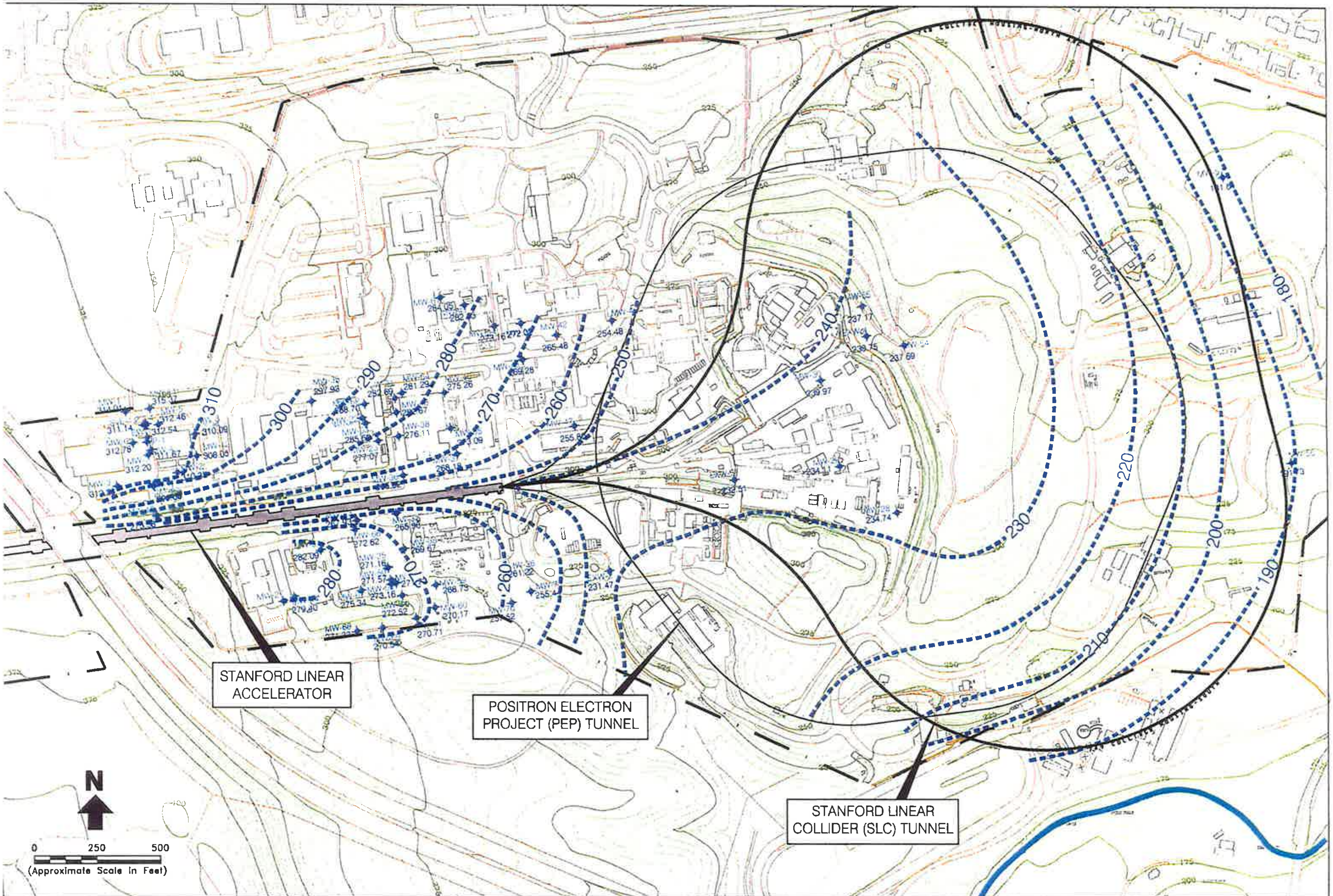


Figure 3 SLAC Piezometric Surface Contours, May 2000

Explanation

- Topographic contour
- Piezometric surface contour
- Property boundary
- Road or trail
- San Francisquito Creek
- Building

Notes: Piezometric contour interval 10 feet. Topographic contour interval 5 feet. Elevations in feet relative to mean sea level.

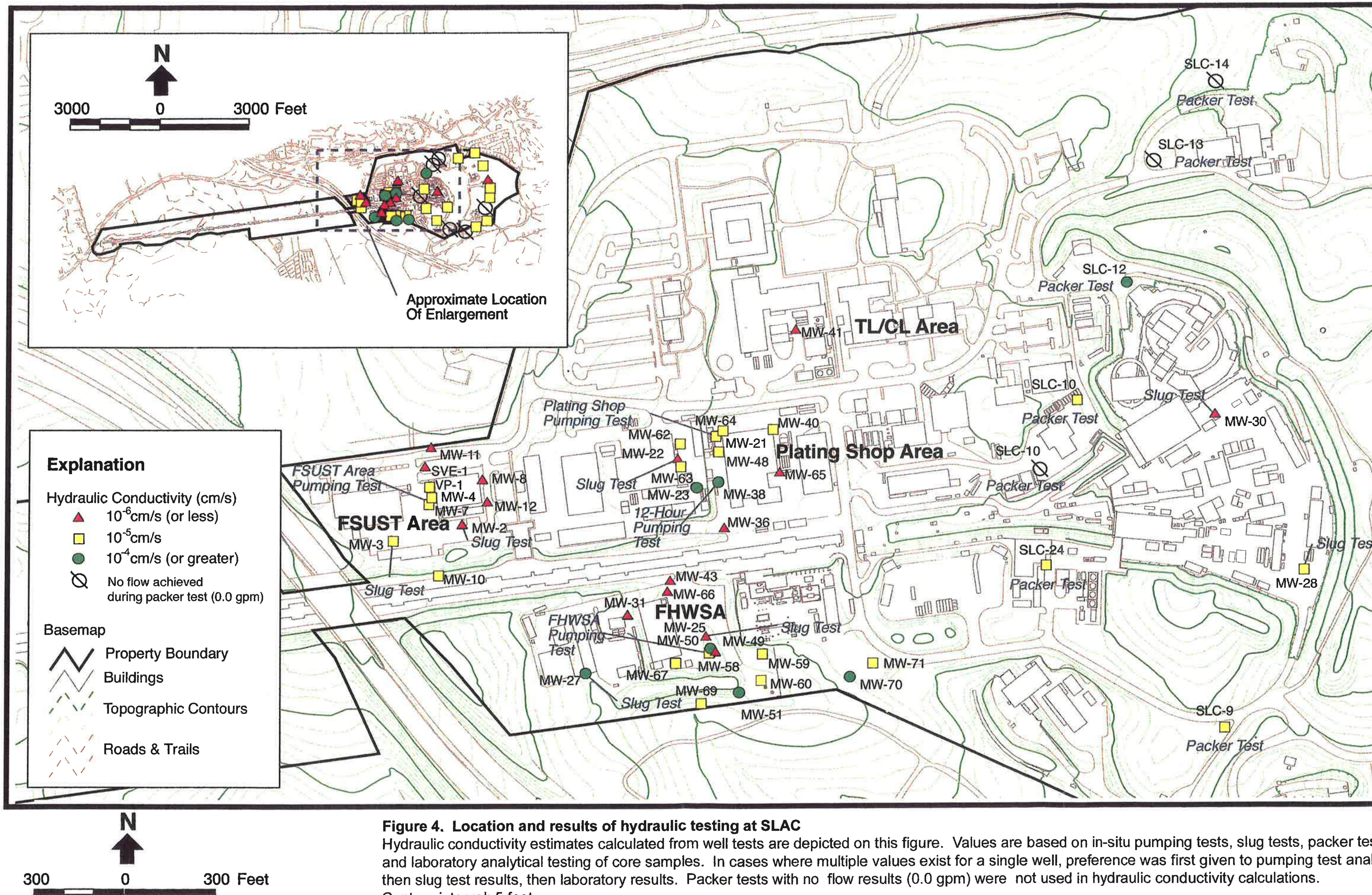


Figure 4. Location and results of hydraulic testing at SLAC
Hydraulic conductivity estimates calculated from well tests are depicted on this figure. Values are based on in-situ pumping tests, slug tests, packer tests, and laboratory analytical testing of core samples. In cases where multiple values exist for a single well, preference was first given to pumping test analyses, then slug test results, then laboratory results. Packer tests with no flow results (0.0 gpm) were not used in hydraulic conductivity calculations.
Contour interval: 5 feet

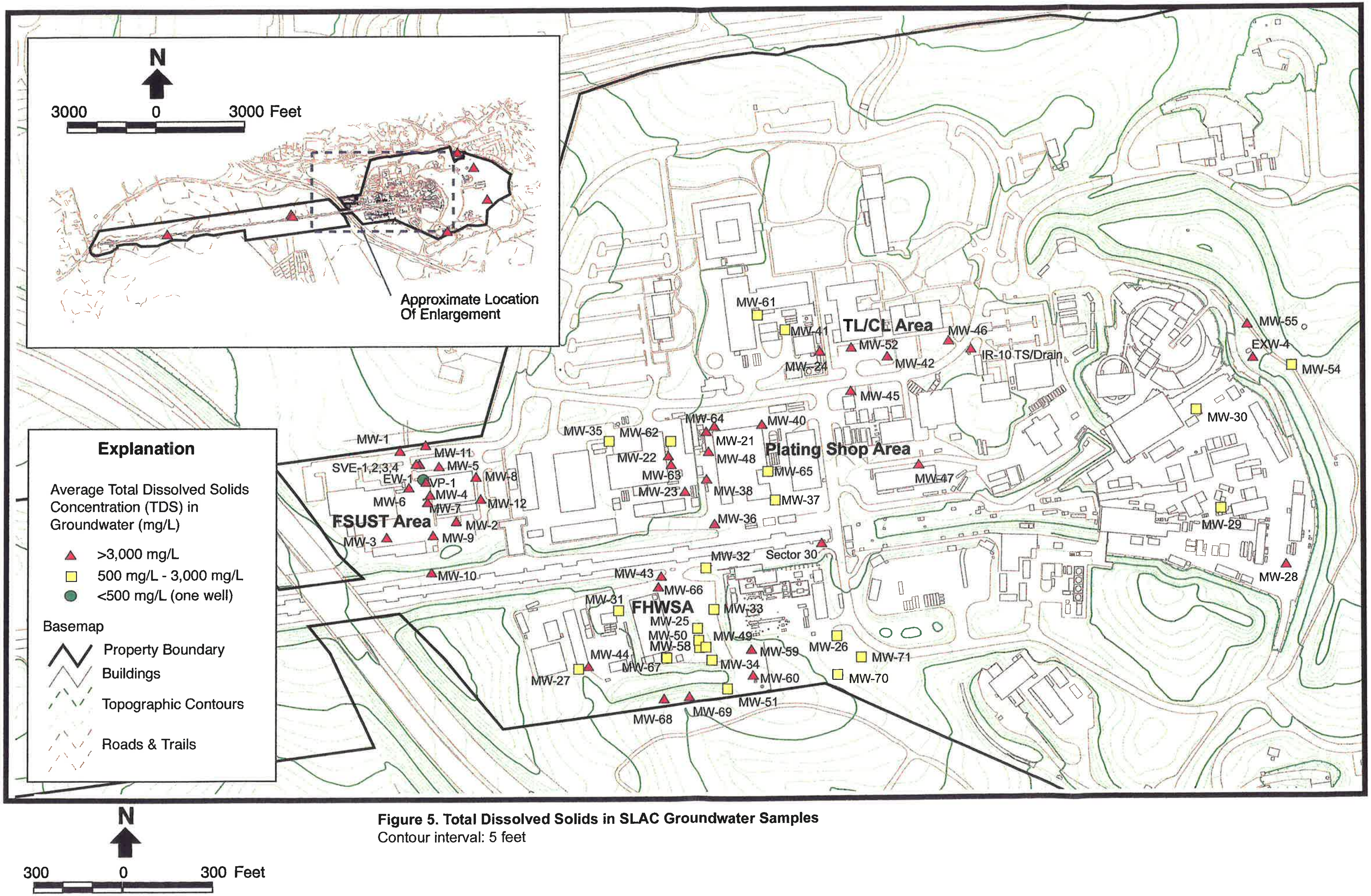


Figure 5. Total Dissolved Solids in SLAC Groundwater Samples
Contour interval: 5 feet

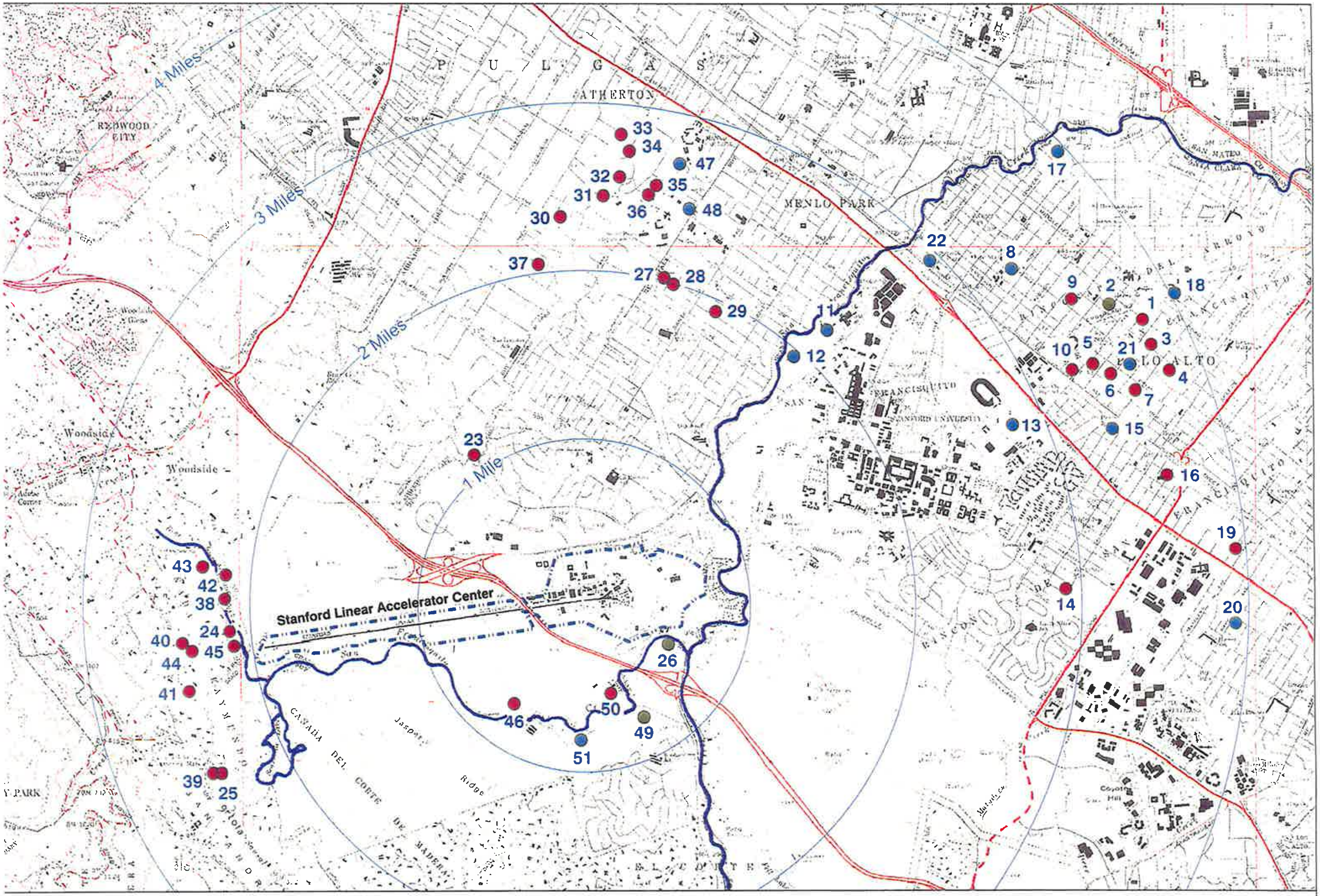
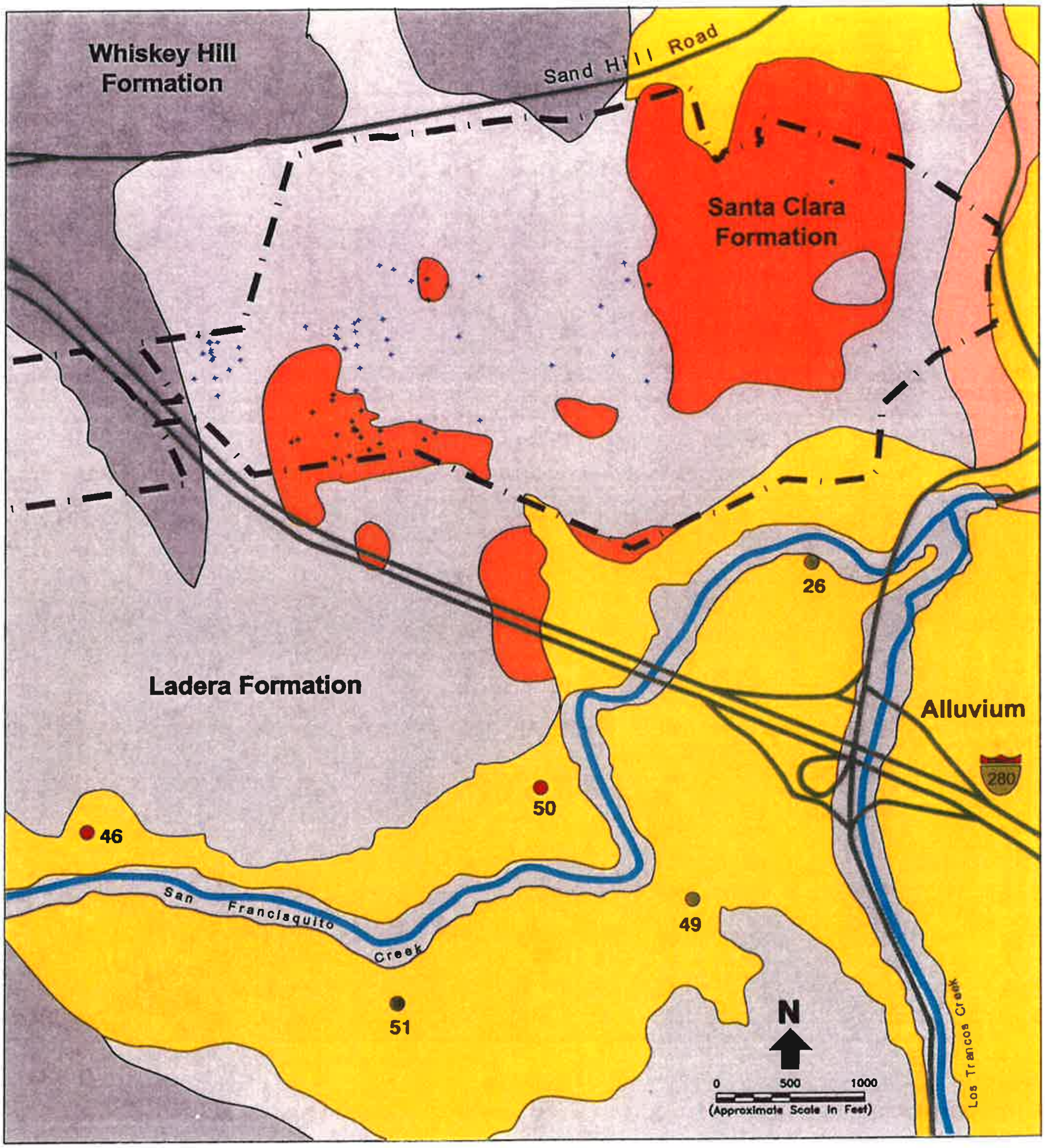


Figure 6. Approximate Locations of Groundwater Supply Wells in the Vicinity of SLAC

Explanation
- Private Well
- Municipal/Community Well
- Agricultural Well

N

0 2000 4000
(Approximate Scale In Feet)



Explanation

Unconsolidated Sediments:

- Alluvium and Colluvium
- Santa Clara Formation

Bedrock:

- Ladera Formation
- Whiskey Hill Formation
- Other Undifferentiated Bedrock Units

Groundwater Wells:

- SLAC Monitoring Well
- Private Well *
- Municipal/Community Well *
- Agricultural Well *

- Road
- Contact
- Creek
- Property Boundary

* Wells were field verified in 1998.

Figure 7. Locations of Groundwater We
Within One Mile of SLAC

Modified after Page (1993); Pampeyan (1993); ESA (1994); EKI (19

Revised boundary

This area mainly bedrock

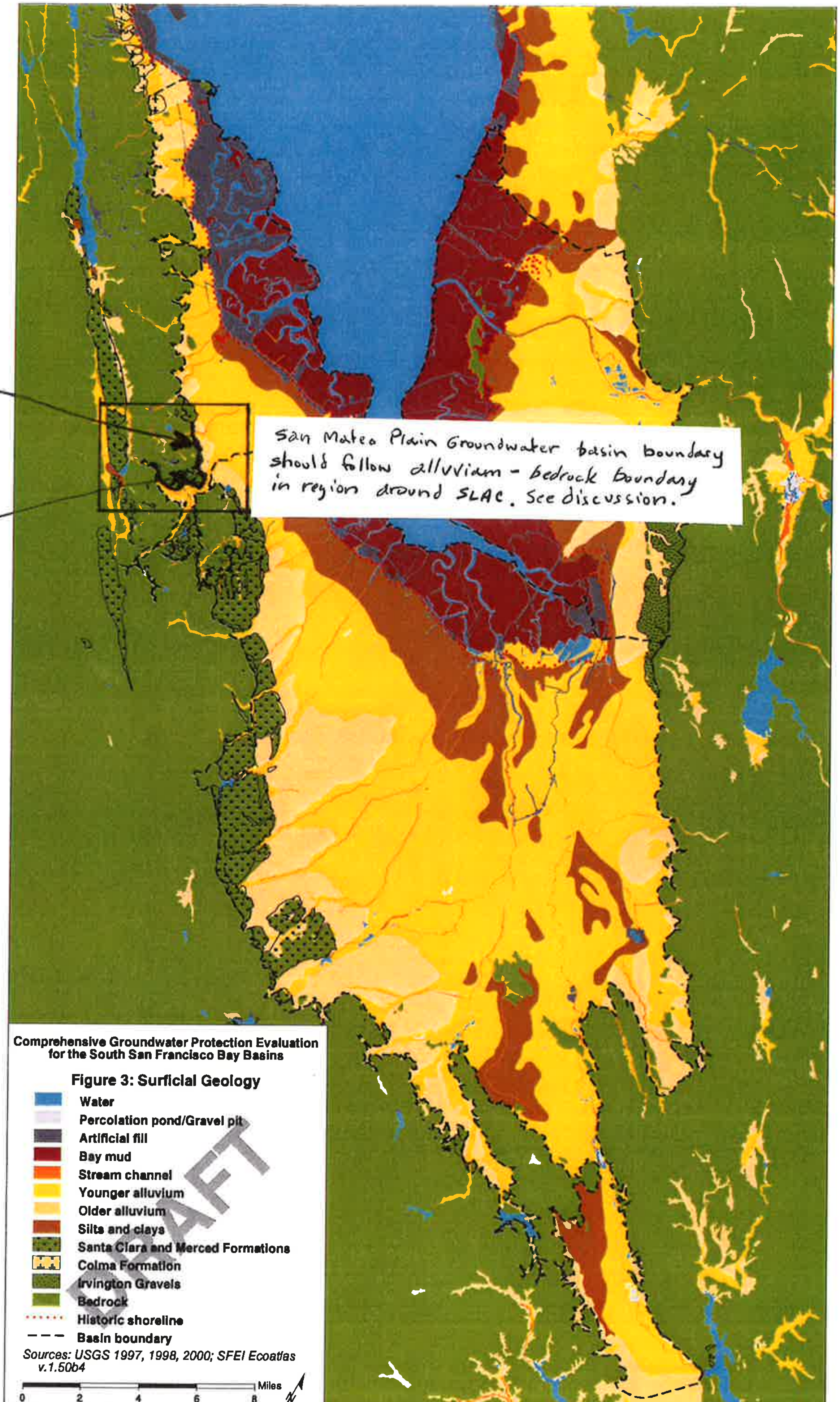


FIGURE 8

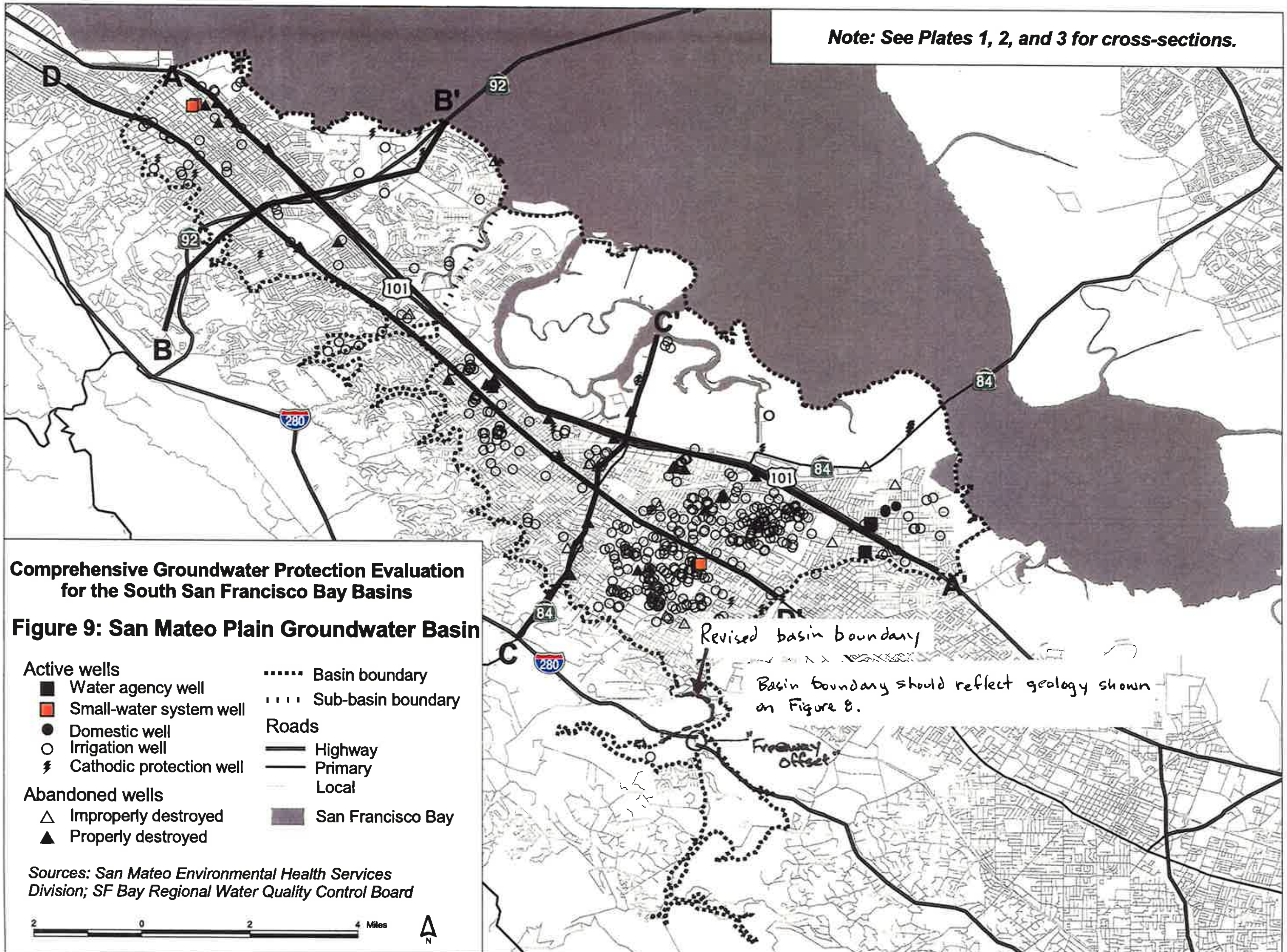
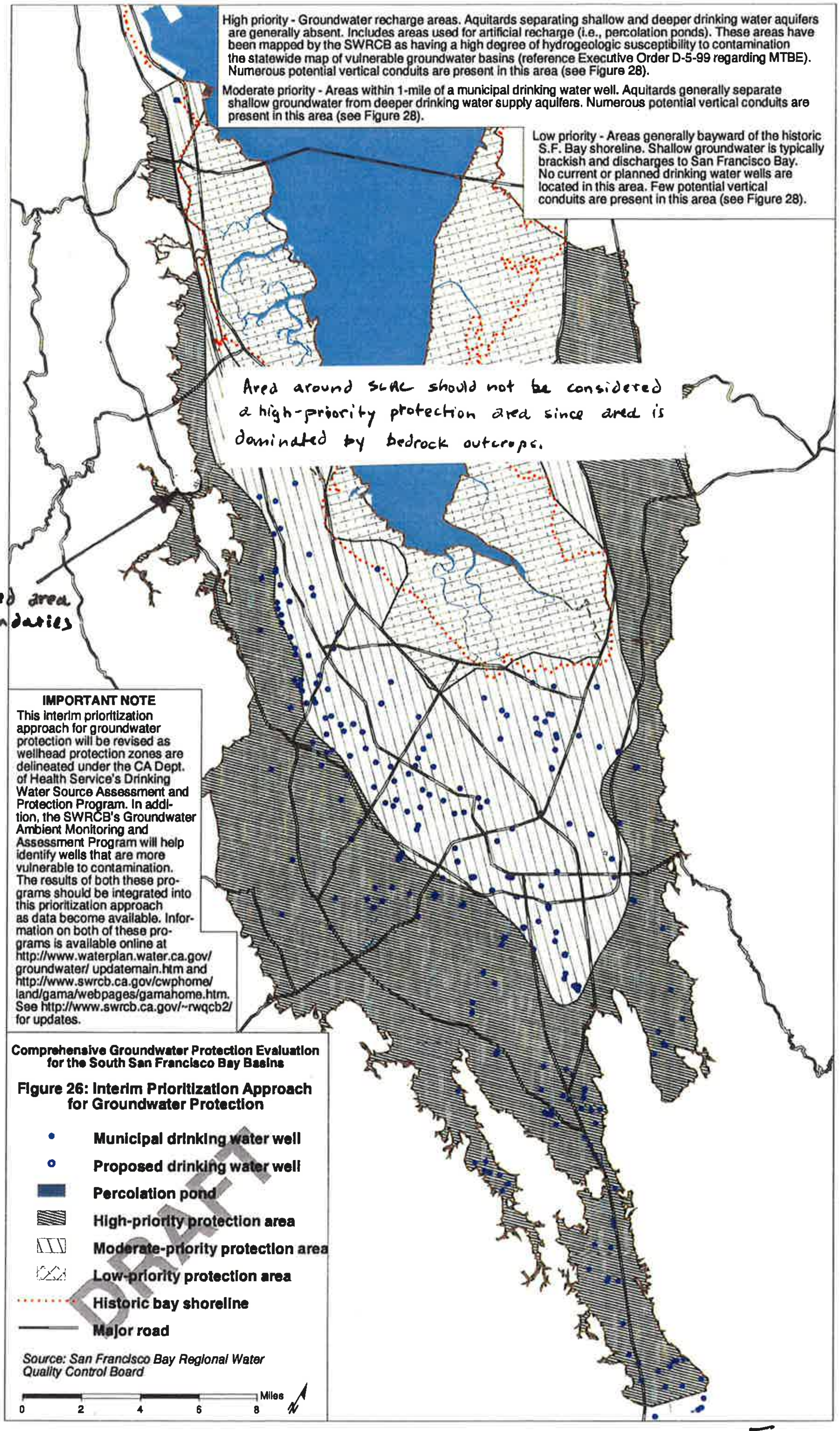

Note: See Plates 1, 2, and 3 for cross-sections.
Comprehensive Groundwater Protection Evaluation for the South San Francisco Bay Basins
Figure 9: San Mateo Plain Groundwater Basin
Active wells
Water agency well
Small-water system well
Domestic well
Irrigation well
Cathodic protection well
Abandoned wells
Improperly destroyed
Properly destroyed
Basin boundary
Sub-basin boundary
Roads
Highway
Primary
Local
San Francisco Bay
Sources: San Mateo Environmental Health Services Division; SF Bay Regional Water Quality Control Board
2
0
2
4 Miles
N
92
101
280
84
A
A'
B
B'
C
C'
D
Revised basin boundary
Basin boundary should reflect geology shown on Figure 8.
"Freeway offset"

FIGURE 9



Revised area boundaries

Figure 26: Interim Prioritization Approach for Groundwater Protection

FIGURE 10