# County of San Diego
# Department of Planning and Land Use
# Pine Valley Cumulative Groundwater Study

*Prepared by:*

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Department of Planning and Land Use
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San Diego, CA 92123

**June 18, 2009**

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**ATTACHMENT**

Selected Data from Woodward, Clyde, Sherard and Associates, 1961

**LIST OF ACRONYMS**

afy acre-feet per year
bgs below the ground surface
CEQA California Environmental Quality Act
CIMIS California Irrigation Management Information System
CWA San Diego County Water Authority
DEH San Diego County, Department of Environmental Health
DPLU San Diego County, Department of Planning and Land Use
DWR California Department of Water Resources
EPA Environmental Protection Agency
ETo Potential Evapotranspiration
ft feet
GIS Geographical Information Systems
GP General Plan
GPEIR General Plan Environmental Impact Report
gpm Gallons per Minute
GWET Groundwater Evapotranspiration

| | |
|---|---|
| msl | Mean Sea Level |
| PVMWC | Pine Valley Mutual Water Company |
| USDA | United States Department of Agriculture |

# 1 INTRODUCTION

On May 21, 2003, on motion of Supervisor Jacob, and seconded by Supervisor Horn, the County of San Diego Board of Supervisors unanimously directed the Chief Administrative Officer to conduct a comprehensive groundwater study for the Pine Valley area. This directive was part of confirmation of direction for staff's activities being conducted on the General Plan 2020 (now known as the General Plan Update). This groundwater study has been prepared to satisfy that request. The report evaluates the impacts of existing and proposed land uses on groundwater resources within Pine Valley, a groundwater dependent unincorporated community of San Diego County (Figure 1).

## 1.1 Objectives

The objectives of this report are to:

1) Evaluate current impacts to groundwater resources from existing land uses in Pine Valley;

2) Evaluate the impacts to groundwater resources from the maximum build-out of the current General Plan (GP) and the proposed GP Update in Pine Valley;

3) Provide potential mitigation and alternatives to proposed GP Update land use densities in the event of predicted significant unavoidable impacts to groundwater resources.

## 1.2 Scope of Work

To meet the objectives of this report, the study included the following tasks:

1) Compiling and summarizing existing groundwater conditions in Pine Valley. This includes a discussion of topography, climate, land use, groundwater demand, geology, soils, aquifer types, hydrologic inventory, well inventory, and historical groundwater levels.

2) Application of a Geographical Information Systems (GIS) analytical tool to apply the Thornthwaite Method soil moisture balance methodology and obtain an estimate of groundwater recharge through 34 years of precipitation including severe droughts and wet periods. This includes compilation of historical precipitation and evapotranspiration rates, estimates of surface water runoff rates, and soil types and soil moisture capacity of soils;

3) Estimation of groundwater demand from existing land uses, additional demand from current discretionary permits in process at the County of San Diego Department of Planning and Land Use (DPLU), land uses proposed under the current GP, and land uses proposed under the GP Update;

4) Mapping of aquifer types and estimation of groundwater storage capacity of aquifers in basins which serve Pine Valley;

5) An evaluation of long-term groundwater availability by comparison of estimated monthly groundwater recharge estimated over a 34 year period of record to groundwater demand from (1) existing land uses, (2) existing land uses plus groundwater demand from discretionary permits currently in process, (3) land uses proposed under the current GP, and (4) land uses proposed under the GP Update. Each of the two evaluated basins will indicate predicted changes of groundwater in storage for the various land-use scenarios through 34 years;

6) Compile estimates of the minimum volume of groundwater in storage in each of two basins in Pine Valley under the various land-use scenarios: existing groundwater demand, proposed groundwater demand under the current GP, and proposed groundwater demand under the GP update. If at any time, groundwater in storage is reduced to a level of 50% or less of maximum theoretical storage capacity as a result of groundwater extraction, groundwater impacts would be considered potentially significant; and

7) Development of possible mitigation measures, recommendations, and alternatives to reduce any potentially significant and unavoidable impacts to groundwater resources.

### 1.3 Study Boundaries

The Pine Valley study area comprises approximately 29.3 square miles which is entirely groundwater dependent. The study area contains two separate basins which are referred to in this study as "Pine North" and "Pine South" (Figure 2). The community of Pine Valley is surrounded by the Cleveland National Forest. The study area is bounded by the Laguna Mountains to the east, and Guatay Mountain and the Cuyamaca Mountains to the west. It is assumed that no imported water is, or will likely be available for the foreseeable future within the study area. This is due to the lack of infrastructure, the limited availability of water in the desert southwest, the cost of providing these services, and the political approval needed to extend the San Diego County Water Authority (CWA) boundaries further to the east.

# 2 EXISTING CONDITIONS

The following subsections include details describing the physical, geologic, and hydrogeologic characteristics of the Pine Valley study area. This includes a discussion of topography, climate, land use, groundwater demand, geology, soils, aquifer types, well inventory, and historical groundwater levels.

## 2.1 Topographic Setting

The study area lies within the Peninsular Ranges Physiographic Province of Southern California, which is characterized by mountainous ridges and hills interspersed by intermountain valleys and basins. According to the State Water Resources Control Board (SWRCB), Pine Valley lies within the Pine Hydrologic sub-area of the Monument Hydrologic area of the Tijuana Hydrologic Unit. For this groundwater study, the 29.3 square-mile Pine hydrologic sub-area was further subdivided into two basins (Pine North and Pine South) to assess local groundwater conditions at maximum build out in Pine Valley (Figure 2). The subdivision between the two basins was aligned with Pine Valley Creek, and then follows a local ridge line eastward until it encounters the regional watershed ridge line of the Laguna Mountains. The 1.8 square-mile community of Pine Valley lies within an intermountain valley with land surface elevations ranging from approximately 3,650 feet mean sea level (ft msl) to 3,800 ft msl. The discharge point of the two basins along Pine Valley Creek is at an elevation of approximately 3,628 ft msl. Ridge line elevations exceed 5,600 ft msl in the northern and eastern headwaters of Pine North basin, and exceed 5,200 ft msl in the northeastern headwaters of Pine South basin.

## 2.2 Climate

For the purposes of this study, climate is defined as the areal and temporal rainfall distribution and evapotranspiration within each of the basins. In 2004, DPLU produced an updated County-wide average precipitation map known as the Groundwater Limitations Map on file with the Clerk of the Board of Supervisors as Document No. 195172 (County of San Diego, 2004). The map utilized 95 rainfall stations to depict average annual precipitation based on over 50,000 monthly records collected from July 1971 through June 2001 (Pine Valley area of map, Figure 3). The methodology used rainfall data combined with environmental variables such as elevation and location in a spatial autoregressive model that employed maximum likelihood estimation to produce a precipitation surface. The resulting precipitation map is the most accurate representation of average precipitation ever produced for the County of San Diego. Potential evapotranspiration rates were obtained from the California Irrigation Management Information System [CIMIS) (DWR, 1999)].

### 2.2.1 Precipitation

Based on the DPLU Groundwater Limitations Map, the Pine North and Pine South basins receive on average approximately 26.5 inches and 24 inches per year of precipitation respectively (Figure 3). Average annual precipitation within the country town boundaries of the community of Pine Valley ranges between 21 and 24 inches per year, while upper elevations receive between 24 to 30 inches per year on average. The higher precipitation in the mountainous regions is attributed to the orographic effect created by the relatively high elevation of the Laguna and Cuyamaca Mountains, which raises and cools moist marine air as it moves inland over the mountains. Most rainfall occurs between the months of November and April, with infrequent precipitation events occurring in the summer, often as thunderstorms.

There is no long-term government sanctioned precipitation records available within the study area. Precipitation values were simulated for the Pine North and South basins results by taking the 30-year average rainfall estimate as calculated on the County Groundwater Limitations Map and utilizing data from nearby government sanctioned precipitation stations to fractionalize the data into yearly and monthly values. Looking at these simulated annual precipitation values in Pine Valley from 1971 to 2005, it is readily apparent that year-to-year rainfall has been highly variable (Figure 4). In only a few years precipitation approximated average rainfall, with most years either above or below-average. The current below average rainfall period began in the 1998-1999 rainfall season punctuated by one significantly above-average year of precipitation in 2004-2005 and one fairly-average rainfall season in 2002-2003. The dry period between 1998 and 2004 has included at least two of the driest years on record for the region since 1948. This below average period is similar to conditions in the late 1950s to early 1960s, which included three of the driest years on record in the County in the past 60 years.

### 2.2.2 Evapotranspiration

The term "evapotranspiration" refers to the total transfer of moisture to the atmosphere from the soil, water bodies, vegetative canopy, and plants. Evapotranspiration represents a significant portion of water lost from a given watershed. Types of vegetation and land use significantly affect evapotranspiration and therefore, the amount of water leaving a watershed. Factors that affect evapotranspiration include the plant type (root structure and depth), the plant's growth or level of maturity, percentage of soil cover, solar radiation, humidity, temperature, and wind. No direct measurements of evapotranspiration occur within the watershed. Monthly reference evapotranspiration (ETo), which is a measure of potential evapotranspiration from a known surface, such as irrigated grass or alfalfa has been estimated for San Diego County by CIMIS. As would be expected, the lowest ETo rates are typically during the cooler and wet winter months and highest during the summer. Both Pine North

and Pine South basins lay within CIMIS Zone 16 in which average monthly ETo rates are as follows:

**CIMIS Zone 16 ETo rates (inches/month)**

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.55 | 2.52 | 4.03 | 5.70 | 7.75 | 8.70 | 9.30 | 8.37 | 6.30 | 4.34 | 2.40 | 1.55 |

## 2.3 Water Demand

An estimation of existing groundwater demand is provided below for Pine South and Pine North basins based on the current land uses known to utilize groundwater within each basin:

**Pine South Existing Conditions Water Demand**

| Land Use | Quantity | Water Demand Per Unit (afy) | Total Water Demand (afy) |
|---|---|---|---|
| Single-Family Residential | 530 | 0.5 | 265 |
| Second Dwelling Units | 8 | 0.25 | 2 |
| Commercial Uses | 12 | 0.3 | 4 |
| County Park | 5.2 acres | 3.1 | 16.1 |
| Total Existing Estimated Water Demand | | | 287 |

**Pine North Existing Conditions Water Demand**

| Land Use | Quantity | Water Demand Per Unit (afy) | Total Water Demand (afy) |
|---|---|---|---|
| Single-Family Residential | 125 | 0.5 | 62.5 |
| Second Dwelling Units | 1 | 0.25 | 0.25 |
| Pine Valley Bible Conference Center | 1 | 19.9 | 19.9 |
| United State Forest Service Cabins | 37 | 0.1 | 3.7 |
| Total Existing Estimated Water Demand | | | 86 |

## 2.4 Geology and Soils

### 2.4.1 Geology

The study area is located within the Peninsular Ranges Province of Southern California, a geomorphic province with a long and active geologic history. The Peninsular Ranges are underlain by an extensive Mesozoic-aged plutonic complex known as the Southern California batholith. The batholith contains hundreds of individual plutons that were intruded into pre-existing older rocks such as the Triassic Julian Schist and late Triassic-Jurassic gneissic and granitic rocks in the Cuyamaca-Laguna Mountain belt (Walawender, 2000). The intrusive rocks of the Southern California batholith consist largely of granitic and gabbroic rocks.

Intrusive rocks within the study area consist largely of granitic and gabbroic rocks, along with a wide band of older metasedimentary rocks (Figure 5).

The Peninsular Ranges were subject to regional uplift and erosion throughout the Tertiary Period. Continued erosion and down cutting of drainage courses through the Quaternary Period have resulted in the present topography. In general, trends of several of the major drainage courses that have developed appear to be controlled by ancient fractures or major joint systems within the crystalline bedrock. Drainages and the valley area within the study area are underlain by thin to moderate thicknesses of sandy stream-deposited alluvium.

A weathering profile of variable thickness has developed upon bedrock that underlies the valley floor within the study area. The ongoing weathering process has created a layer of residuum (decomposed granite), which typically consists of moderately to highly decomposed rock material that grades erratically downward to unweathered bedrock material. Residuum is generally deeper in flat and valley bottom areas, and thinner to non-existent in the steeper upland areas.

### 2.4.2 Soils

The United States Department of Agriculture Soil Conservation Service (USDA, 1973) mapped 44 soil types within the Pine South and Pine North basins (Figure 6). Soil moisture capacities are shown for each of the soil types.

## 2.5 Hydrogeologic Units

Water is stored within four different hydrogeologic units within the study area. These include: 1) moderately fractured rocks, 2) slightly fractured rocks 3) alluvium, and 4) residuum (Figure 7). To estimate groundwater in storage for each hydrogeologic unit, estimates of specific yield, the potential saturated thickness, and the areal extent of each unit were required. Specific yield is the ratio of volume of water that rock or soil will yield by gravity drainage to the volume of rock or soil. Estimates of groundwater in storage for Pine South and Pine North basins are provided below along with a discussion of each hydrogeologic unit.

**Pine South Estimated Maximum Groundwater in Storage**

| Hydrogeologic Unit | Estimated Area (acres) | Estimated Specific Yield | Assumed Saturated Thickness (feet) | Maximum Storage Capacity (acre-feet) |
|---|---|---|---|---|
| Moderately Fractured Crystalline Rock | 1,129 | 0.1% | 500 | 565 |
| Slightly Fractured Crystalline Rock | 2,486 | 0.01% | 500 | 124 |
| Alluvium | 268 | 10% | 28.4 | 761 |
| Residuum - underlying alluvium | 268 | 5% | 45 | 603 |
| Residuum - valley outside of alluvium) | 85 | 5% | 20 | 85 |
| **Estimated Maximum Groundwater Storage Capacity (acre-feet)** | | | | **2,138** |

**Pine North Estimated Maximum Groundwater in Storage**

| Hydrogeologic Unit | Estimated Area (acres) | Estimated Specific Yield | Assumed Saturated Thickness (feet) | Maximum Storage Capacity (acre-feet) |
|---|---|---|---|---|
| Moderately Fractured Crystalline Rock | 3,636 | 0.1% | 500 | 1,818 |
| Slightly Fractured Crystalline Rock | 11,553 | 0.01% | 500 | 578 |
| Alluvium | 186 | 10% | 10 | 186 |
| Residuum - underlying alluvium | 186 | 5% | 10 | 93 |
| Residuum - Pine Creek outside of alluvium) | 37 | 5% | 10 | 19 |
| **Estimated Maximum Groundwater Storage Capacity (acre-feet)** | | | | **2,694** |

Moderately Fractured Crystalline Rock (Figure 7): The entire study area is underlain by fractured bedrock. The areal extent of this unit was limited to areas underlain by fractured rock with slopes less than 25%. While the actual range of specific yield in rock likely ranges from about 0.0001% to 1%, a value of 0.1% in valley areas is a generally accepted estimate of average conditions in fractured rock aquifers in the County.

Slightly Fractured Crystalline Rock (Figure 7): The areal extent of this unit was limited only to areas underlain by fractured rock with slopes greater than 25%. While the actual range for specific yield in rock likely ranges from about 0.0001% to 1%, a value of 0.01% in steep slope areas is a generally accepted estimate of average conditions in the County.

Alluvium (see Attachment, and Figures 8 & 9): Recent alluvial deposits overlie both residuum and granitic rock. The alluvium is largely confined to active drainage channels and the valley floor. Woodward, Clyde, Sherard, and Associates (WCSA, 1961) collected core samples from borings drilled through the alluvium. The porosity of the sediment from 10 samples collected from four borings ranged from 31 to 38%. An analysis of the site-specific porosity measurements by WCSA from three borings and a van Genuchten curve fit of moisture content and soil sample height above the water table, indicate that the alluvium has a specific

yield of approximately 29% (Wiedlin, 2006). Though this approach is technically valid, the site-specific data is limited to only a few areas and it may potentially provide specific values that are biased high relative to specific yield measurements derived from aquifer pumping tests. Aquifer pumping tests are the industry standard for measuring specific yield. In the absence of site-specific aquifer test data, a specific yield of 10% for alluvium was used for this study.

Based on eighteen test borings logged by WCSA (WCSA, 1961), the alluvium consists of loose silty sands, sandy silts, and locally gravelly sands (see Attachment). The test borings indicated that the maximum thickness of the alluvium ranges from 30 to 60 feet. WCSA prepared a structure contour map depicting the bottom of the alluvium based on their exploratory drilling (See Attachment).

Pine South Basin: The volume of saturated alluvium was estimated for the Pine South basin by comparing the WCSA structure contour map (See Attachment) and groundwater elevations prepared by DPLU from spring 1998 groundwater data collected by the Pine Valley Mutual Water Company (PVMWC) (Figure 8). The two surfaces were digitized and the volume between the two surfaces was calculated using Geographic Information Systems (GIS) software. An isopach contour map was produced to visually represent the results of the estimated saturated thickness of alluvium (Figure 9). Based on this calculation, the storage capacity of the alluvium (using a specific yield of 10%) under the high groundwater conditions existing in the spring of 1998 was approximately 761 acre-feet within the 268-acre area underlain by alluvium in the Pine South basin. The average saturated alluvium thickness is estimated to be approximately 28.4 feet within the Pine South basin.

Pine North Basin: The volume of saturated alluvium was estimated for the Pine North basin by taking the area WCSA structure contour map (See Attachment) and conservatively assuming a saturated thickness of 10 feet would occur under high groundwater conditions within the 186- acre area of alluvium underlying the Pine North basin. Based on this estimate, the storage capacity of the alluvium (using a conservative specific yield of 10%) is approximately 186 acre-feet within the Pine North basin.

Residuum (Figure 10): Differential weathering of bedrock, due to non-uniform fracturing and differences in mineralogy, produce an undulating contact between unweathered bedrock and decomposed granite (residuum). Due to these factors, it is not possible to accurately predict the thickness of residuum underlying a specific region without site-specific information such as boring or well logs.

In borings advanced by WCSA, two residuum samples had porosity values of 26 and 31%. Specific yield values within this unit were not estimated by WCSA. As is the case with alluvium, there is no site-specific aquifer test data available to verify the specific yield of the residuum within Pine Valley. In the absence of site-specific aquifer test data, a specific yield of 5% for residuum was used for this study.

Pine South Basin: Over 1,100 acres of land is located in valley areas with slopes less than 25%, which is more likely to contain appreciable thicknesses of residuum when compared to the nearly 2,500 acres of steep slope area within the Pine South basin. For this study, the areal extent of potentially saturated residuum is assumed to be limited to (1) the same 268-acre area as the alluvial deposits, and (2) an approximately 85-acre area to the southwest of the alluvial deposits in which data was available to document that amount of residuum that occurs below the water table.

The estimate of saturated residuum underlying the 268-acre alluvial aquifer was evaluated by inspecting well and boring logs. Figure 10 shows the locations of the wells reviewed and the estimated thickness of saturated residuum at each location. The saturated thickness, based on high groundwater levels documented in the spring of 1998, ranged from 49 to 74 feet. Based on this review, a saturated thickness of 45 feet was conservatively applied to residuum underlying the alluvial aquifer.

Data was compiled from three drilling logs within an approximately 85-acre area to the southwest of the alluvial deposits. The saturated thickness of three wells reviewed in this area ranged from 15 to 40 feet. Based on this review, a saturated thickness of 20 feet was applied to residuum in this 85-acre area.

Since no data is available over the rest of the Pine South basin to substantiate saturated residuum, the rest of the basin is assumed to have no saturated residuum. This is conservative and likely results in an underestimation of the amount of groundwater in storage. As an example, if there was a potential of 10 to 20 feet of saturated residuum underlying the rest of the 750+ acres of valley areas in the Pine South basin, this would result in an additional 375 to 750 acre-feet of groundwater in storage which was unaccounted for in this study.

Pine North Basin: The areal extent of potentially saturated residuum is assumed to be limited to (1) the same 186-acre area as the alluvial deposits, and (2) 37 acres along the alignment of Pine Creek further to the north of the documented alluvial deposits. Both areas were confined to 10 feet saturated thickness.

## 2.6 Inventory of Wells

Water well information within Pine Valley was identified through information provided by the Pine Valley Mutual Water Company (PVMWC), the DPLU groundwater level records database, and the County of San Diego Department of Environmental Health (DEH) database of parcels with permitted water wells (Figure 11).

The PVMWC owns 10 water supply wells within their service area which are spread throughout the Pine South and Pine North basins (Figure 11). Eight of these wells are currently in operation. Two wells (Well No.s 2 and 8) are not in production due to an underground fuel storage tank (LUFT) release at a local service station. As of 2008, the water company provided water service to approximately 695 service connections, of which 675

were residential users and 20 were commercial entities including a County park with 5.2 acres of irrigated grass. It appears that nearly all residences within Pine Valley have water service from the PVMWC, although a small number of homeowners also may be utilizing groundwater to supplement their water obtained by the PVMWC. There are records of 19 domestic well permits in the Pine South basin, and 10 permits recorded within the Pine North basin. Between 1999 and 2005, PVMWC's highest annual production was 311 acre-feet in 2002 (approximately 0.45 acre-feet per service connection), and averaged approximately 274 acre-feet per year. There has been a slow increase per service connection demand that has occurred through this time period. According to PVWMC personnel, this increase may be attributable to more residences going to full-time use as more people make home in Pine Valley their permanent residence. Approximately 19% (average of 52 acre-feet per year, maximum of 59 acre-feet per year) came from wells located in the Pine North basin, and approximately 81% (average of 222 acre-feet per year, maximum of 252 acre-feet in 2002) came from wells located in the Pine South basin. The land use based water demand estimate in Section 2.3 estimated that the Pine North basin currently uses approximately 63 acre-feet per year from residential uses. This is approximately 20% more water than that drawn on average by the PVMWC. For the Pine South basin, the demand from the land use based analysis estimated approximately 287 acre-feet per year of demand. This is approximately 29% more water than that drawn on average by the PVMWC. It can be concluded that the estimation of water demand in Section 2.3 accounts for more than the water demand of the PVMWC within each basin. Since there are private domestic wells being utilized in each basin by residences as shown on Figure 11, the additional water estimated by the land use based method allows for additional unaccounted water use by these private well users.

One other notable groundwater user in the study area is the Pine Valley Bible Conference Center in the Pine North basin. No records of groundwater wells or production from the facility are available. According to County DEH records, there is an average of 356 guests year-round at the facility. Assuming 50 gallons per day per guest results in a groundwater demand estimate of approximately 19.9 acre-feet per year, which will be used to estimate demand for this facility in this study. As shown on Figure 11, since 1983 the County has monitored a well designated as "PIN-04" 200 feet east of the Bible Center. Depth to groundwater in the well has fluctuated between 6 and 30 feet below the ground surface (bgs), with the most recent water level recorded in April 2009 at 12.3 feet bgs.

## 2.7 Historical Groundwater Levels

### Well Hydrographs

To provide an understanding of groundwater level trends, well hydrographs have been generated from wells monitored by the PVMWC and DPLU. Figure 11 depicts locations of wells with historical water level data. The legend on each well hydrograph figure indicates whether wells have been actively used ("active") versus unused ("inactive") at any point

during its period of record. Water levels were obtained from "active" wells when the well was not pumping, but it is possible in some cases that water levels were collected before the well had fully recovered to static water level conditions. Therefore, it is likely that some "active" wells water levels were recorded as deeper than actual static water level conditions.

Figures 12 through 16 depict groundwater levels from wells with records ranging from 1981 to 2008. The wells are located within the valley area of the community of Pine Valley, which is underlain by an alluvial basin and residuum over fractured bedrock. The water level trends from the five figures provide a more detailed understanding of groundwater conditions within different hydrogeologic settings in Pine Valley.

Figure 12 depicts groundwater levels of PVMWC Well No.s 2 and 8 in the southern end of the valley. These wells are underlain by 35 and 87 feet of residuum, respectively, overlying fractured bedrock. These two wells were taken out of production in the 1990s due to contamination of the aquifer from a nearby LUFT. The water levels have varied between 13 and 58 feet bgs, with historic lows reached in 1996, 2002, and 2007. Groundwater levels were shallowest during each of the three well above-average rainfall years in the 1990s. Water levels in the spring of 2005 following the above average precipitation in 2004-2005 rebounded 17 and 25 feet respectively, but remained about 10 to 15 feet below water levels recorded in the spring of 1998.

Figure 13 depicts groundwater levels of wells PVMWC Well No.s 1 and 10, which recently have accounted for approximately 65% of PVMWC well production. These wells are underlain by 75 to 80 feet of alluvium and residuum overlying fractured bedrock. The water levels have varied between 10 and 131 feet bgs, with historic lows reached in 2003 and 2004. Water levels rebounded in 2005 and 2006 in response to well above-average rainfall in the rainfall season of 2004-2005. Overall, the water levels show the stress of pumping large amounts of groundwater from these wells during the extended drought period from 1998 to 2004. Water levels in early 2006 were at approximately 20 feet bgs, which is approximately 10 feet deeper than historic shallow groundwater levels recorded in the spring of 1998. This indicates that the wells have shown a significant recovery of the water table from one above-average rainfall season in 2004-2005.

Figure 14 depicts groundwater levels of PVMWC Well No.s 4 and 5. Well No. 4 is located at the discharge point of the Pine watershed near Pine Creek. Well No. 5 is also located near Pine Creek within the Pine North basin. These two wells have recently accounted for approximately 15% of PVMWC well production and are underlain by as much as 98 feet of alluvium and residuum overlying fractured bedrock. The water levels have varied between 6 and 51 feet bgs, with historic lows reached between 2002 and 2004. The water levels show the stress of pumping of groundwater from these wells during the extended drought period from 1998 to 2004. However, recharge was evident during each wet season through the dryer

years of 1998-2004. This is likely due to the wells proximity to Pine Creek. Water levels in early 2005 were at approximately 27 and 7.1 feet bgs in Well No. 4 and 5, which is approximately 1 to 2 feet deeper than historic shallow groundwater levels recorded in the spring of 1998. The wells have shown nearly a full recovery of the water table from one above-average rainfall season in 2004-2005.

Figure 15 depicts groundwater levels of PVMWC Well No. 3. This well is underlain by fractured bedrock with likely very little (if any) saturated alluvium/residuum. PVMWC Well No.7 and Well No.9 (not shown as well hydrographs) are located near PVMWC Well No.3 and are also underlain by fractured bedrock with little to no saturated alluvium/residuum. Well No.7 has had similar historic water level patterns, although Well No.9 has had much less drawdown relative to drawdown seen in Well No.3. The water levels in Well No.3 have varied between 18 and 293 feet bgs, with historic lows reached in 2004. Water levels rebounded approximately 270 feet in March 2005 to 23 feet bgs. Summer groundwater pumping routinely draws down groundwater levels more than 150 feet (and over 200 feet in the driest years). In most years, water levels recover during the wet season to approximately 20 to 30 feet bgs. The three PVMWC wells in this area are heavily pumped and draw from a fractured rock aquifer with little saturated sediments. This area is subject to rapid declines in water table elevation during the summer months. However, based on the water level records, recharge to these wells appears rapid and reliable in the wet season, with the water table recovering each winter.

Figure 16 depicts groundwater levels of well PIN-04. Well PIN-04 is a private domestic well which provides water for a single-family residence across the street from the Pine Valley Bible Conference Center in the Pine North basin. Water levels have varied between 6 and 30 feet bgs. The shallowest groundwater levels were recorded in 1982, 1995, and 2005 in response to above average rainfall in those years. Historic lows were reached in 1990 and 2003.

**Spring 1998 Groundwater Elevations**

Using static groundwater depths from the spring of 1998 which are representative of shallow groundwater conditions within Pine Valley, DPLU prepared a groundwater contour map of groundwater elevations in map view (Figure 8). It should be noted that nearly all the points used are data from actively pumped wells and water levels may be at various degrees from achieving complete static equilibrium. These data indicate that from the southern portion of Pine Valley, groundwater flows from south to north toward the Pine Creek outlet on the west side of the valley, where it crosses US 80. Limited water level data were obtained outside of the PVMWC service area. However, from this data it can be reasonably inferred that groundwater in the northern portion of Pine Valley flows from north to south towards the same point. Hence groundwater flow is converging toward the center of the valley and exits to the west.

**Summer/Fall 2004 Groundwater Drawdown**

In the spring of 1998, groundwater levels could be considered to be close to representative of full groundwater storage capacity for Pine Valley. From 1999 through the fall of 2004, a six year drought occurred and resulted in a progressive increase in drawdown of wells throughout the valley each year. Some groundwater recharge was in evidence during the winter months of each year. The recharge however occurred at a rate less than the groundwater production rate. To depict groundwater drawdown at the peak of the six year drought DPLU prepared a groundwater drawdown map for the summer/fall of 2004 (Figure 17), which was plotted in reference to the high groundwater conditions that occurred in the Spring of 1998 (Figure 9).

The worst area of drawdown in the summer/fall of 2004 centers around PVMWC Well No.s 3 and 7, which have contributed only 7% of PVMWC's total production, respectively. Each summer, drawdown at these two wells peaked, ranging from over 100 feet at the beginning of the drought cycle, to nearly 300 feet toward the end of the drought cycle. However, water levels recovered each winter and drawdown would often be near zero during the winter despite below average rainfall seasons that occurred (Figure 15). These water level recoveries may be attributable to their proximity to Pine Creek. The low production capacity of these two wells and their wide fluctuations of water levels are attributable to the wells being installed within fractured bedrock with little to no saturated sediments unlike most other wells utilized by the PVMWC.

PVMWC Well No.s 1, 9, and 10, which have contributed approximately 77% of PVWMC's total production, all have similar drawdown of over 100 feet in 2004, with Well No. 9 having the most (over 140 feet of drawdown).

PVWMWC Well No.s 4, 5, and 6, which have contributed approximately 16% of PVMWC's total production, experienced the least amount of drawdown of the producing wells. Of these three wells, Well No.s 5 and 6 experienced the greatest amount of drawdown; approximately 40 feet in the summer of 2004. Well No. 4 experienced approximately 13 feet of drawdown in the summer of 2004. As in other wells in the study area, peak drawdown increased each summer of the drought leading to the summer of 2004.

PVWMWC Well No.s 2 and 8 are inactive wells that are located on the southern edge of the PVMWC service area. The drawdown in these wells is least affected by the actively pumped wells drawdown. Maximum drawdown in these wells was 30 to 35 feet.

DPLU monitors water levels at Well PIN-04 located north of the PVWMC wells in the Pine North basin. While not included on the groundwater drawdown map due to its isolated location to the north, groundwater drawdown in the summer of 2004 was about 7 feet relative to the spring of 2008. This data suggests that the groundwater drawdown in the Pine South

basin induced by the PVMWC well field does not measurably extend to the northern end of the valley.

**Spring 2005/Spring 2006 Groundwater Drawdown**

To depict groundwater drawdown following the well above average precipitation that occurred between October 2004 and April 2005, DPLU prepared a groundwater drawdown map for the spring of 2005/spring of 2006 (Figure 18), which was plotted in reference to the high groundwater conditions that occurred in the spring of 1998 (Figure 9). The depth to groundwater in some wells was shallower in 2006, indicating a possible delayed response to the recharge that occurred in 2004-2005. To include full recovery from this apparent delayed recharge response in some of the wells, the shallowest groundwater levels recorded during those two years was utilized in construction of the map.

Looking at all the wells, groundwater levels in the spring of 2005 and spring of 2006 were approximately 1 to 16.5 feet deeper than those recorded in the spring of 1998. It is apparent that from just one year of well above average precipitation, that the rapid rise of water levels resulted in a near full recovery of drawdown that had occurred during the six year extended drought period. PVMWC Well No.s 3 and 7, which had the worst area of drawdown in the summer/fall of 2004, recovered to within 3 feet of water levels recorded in the spring of 1998. PVMWC Well No. 9, above the valley floor had the greatest amount of drawdown compared to Spring of 1998, with water levels about 16.5 feet deeper than in the spring of 1998.

**PVMWC Well Field Discussion**

The six year drought between 1999 and 2004 was among one of the worst drought periods in the past 50 years and provided a significant test on the ability for the PVMWC to supply groundwater to its 695 service connections. According to discussions with PVWMC personnel, groundwater production continued unabated through the drought with no interruptions in service or mandated conservation measures. It can be concluded that PVMWC production at its current rates is sustainable through a 6 year drought. However, progressive increases in drawdown through the drought period, particularly at less productive wells (PVMWC No.s 3 and 7) are an indication that recent groundwater production rates in these wells are approaching their limit in the context of drought condition. However, with the exception of Well No.1, which has a relatively shallow depth to the bottom of the well, high production wells are less impacted by drawdown and appear to be able to continue pumping through a more extended drought period. Based on an evaluation by Wiedlin & Associates (2006) of groundwater production capacity of the PVMWC well field, it appears that Well No.s 4, 5, and 6 are underutilized and could produce additional groundwater to make up for any potential impacts to production from Well No.s 3 and 7. Additionally, Well No. 9, though subject to drawdown greater than 100 feet, also appears to have the capability to handle additional drawdown and produce additional groundwater if its pump intake were lowered. As additional development occurs and groundwater demand increases, improved

well production management would likely be necessary to keep up with the increased demand. The most likely worst case scenario would be that additional wells may need to be installed to more evenly distribute the extent of drawdown across the PVMWC well field in response to increased water demand.

Several of the PVMWC wells were installed between the late 1950s and early 1970s. Water wells over time typically experience decreased well yield from chemical incrustation or bio-fouling of the well screen and the formation materials around the intake portion of the well. Without proper maintenance, individual well performance may be substantially reduced and cause individual wells to fail. Even with maintenance, wells have a limited practical service life and eventually require replacement to optimize production capacity. As PVMWC wells lose well production capability over time in individual wells, it is recommended that PVMWC provide routine maintenance and rehabilitation of these wells. Additionally, with increased demand and lower production capacity from its existing well field, PVMWC may need to drill additional production wells to keep up with demand.

# 3 LONG-TERM GROUNDWATER AVAILABILITY ANALYSIS

To evaluate the long-term groundwater availability of a given basin, the County Guidelines for Determining Significance – Groundwater Resources contains the following guideline that if met, would be considered a significant impact to groundwater resources as a result of project implementation:

***For proposed projects in fractured rock basins, groundwater impacts will be considered significant if a soil moisture balance, or equivalent analysis, conducted using a minimum of 30 years of precipitation data, including drought periods, concludes that at any time groundwater in storage is reduced to a level of 50% or less as a result of groundwater extraction. (County of San Diego, 2007)***

This guideline was applied to the two basins which underlie the community of Pine Valley, to evaluate whether there would be sufficient long-term groundwater supplies under the following four land use scenarios:

1. Existing Conditions
2. Existing Conditions plus all discretionary permits currently in process at DPLU
3. Current GP Buildout
4. GP Update Buildout (Referral Map alternative)

## 3.1 Methodology

The soil moisture balance analysis of the Pine South and Pine North basins involved estimating groundwater recharge a 34-year period, comparing monthly recharge with proposed extraction through the 34-year period, tracking cumulative depletion of storage during successive years of storage depletion (drought), and determining if extraction is in excess of sustained yield if the cumulative depletion of storage exceeds 50% of the total storage capacity of a given basin. The 50% criterion was established to address the unique characteristics of the County fractured rock aquifers which are characterized by limited storage capacity and very limited groundwater recharge during droughts and excess recharge during wet periods. These unique characteristics typically cause large fluctuations of the groundwater table over the short-term which are generally not observed in aquifers with large storage capacity. Such short-term changes are evident in wells monitored within Pine Valley. Such an analysis incorporates climate variability and provides assurance that groundwater use, even during periods of limited recharge in extended drought periods, does not produce a significant impact to groundwater users dependent on groundwater. During drought years, recharge may be negligible, and water extracted from the aquifer may be derived solely from storage. The available storage in the aquifer must be large enough to supply water throughout the duration of the drought. To assure sustainable groundwater use through drought conditions, the resulting sustainable yield for a basin as calculated from the water balance analysis is a fraction of average annual groundwater recharge.

### 3.1.1 Basin Approach

Groundwater typically occurs within a basin, which is defined as a hydrologic unit of groundwater storage more or less separate from neighboring groundwater storage areas. For fractured rock aquifers, which include the entire Pine watershed, the edges of the basin are presumed to be the topographic divides or watershed boundaries.

As discussed in Section 2.1, the 29.3 square-mile Pine hydrologic sub-area was subdivided into two basins (Pine North and Pine South) to assess local groundwater conditions at maximum build out in Pine Valley (Figure 2). The subdivision between the two basins was aligned with Pine Valley Creek, and then follows a local ridge line eastward until it encounters the regional watershed ridge line of the Laguna Mountains.

### 3.1.2 Groundwater Recharge

**Recharge Equation**

The equation used to calculate groundwater recharge using the Thornthwaite Method (soil moisture balance methodology) is:

$$R(i) = P(i) - RO(i) - PET(i) - (SMC - SM(i))$$

where

| | |
|---|---|
| R(i) = | Recharge during the $i^{th}$ month. |
| P(i) = | Precipitation during the $i^{th}$ month. |
| RO(i) = | Run-off during the $i^{th}$ month |
| PET(i) = | Potential evapotranspiration during the $i^{th}$ month. |
| SMC = | Soil moisture capacity |
| SM(i) = | Soil moisture at beginning of $i^{th}$ month. |

Conceptually, this equation states that any precipitation in excess of runoff (infiltration) is available for evapotranspiration up to a limiting rate, called the potential evapotranspiration. If infiltration exceeds potential evapotranspiration in any month, excess moisture can be stored by the soil, up to the soil moisture capacity. Any infiltration in excess of potential evapotranspiration which increases the soil moisture above the soil moisture capacity results in groundwater recharge. Water stored in the soil during periods of excess precipitation is available for evapotranspiration during periods when potential evapotranspiration exceeds infiltration.

The recharge estimation for this study was taken from recharge calculations that were programmed into computer code and integrated with GIS software as part of the County of San Diego GP Update Groundwater Study (DPLU, 2009). Estimation of groundwater recharge required data compilation to estimate monthly precipitation, runoff, potential

evapotranspiration, and soil moisture capacity. Utilizing 408 unique monthly values of precipitation from July 1971 to June 2005, groundwater recharge was estimated for each month through the 34 year period evaluated.

**Recharge Processes in Pine Valley**

Groundwater recharge to the study area may occur from both basin-wide rainfall infiltration, and from infiltration of surface water runoff along the creek beds that drain the watershed. Recharge from surface water runoff may be the dominant recharge process in the study area. However, because this process has not been adequately quantified through long-term stream gauging records, it is not included in the water balance calculation presented later herein.

**Data Compilation**

Estimation of groundwater recharge required data compilation to estimate monthly precipitation, runoff, potential evapotranspiration, and soil moisture capacity.

Precipitation: Rainfall is the principal means for replenishment of soil moisture and groundwater recharge. The County's Groundwater Limitations Map as described in Section 2.2 provides an estimate of the 30-year average rainfall throughout the County from July 1971 through June 2001. The map was produced at a resolution of 300 feet, with average precipitation contained within individual 300-foot-by-300-foot grid cells in GIS. Since the soil moisture balance methodology requires monthly precipitation data in order to estimate groundwater recharge, further work was needed to provide an estimation of monthly values of precipitation for each 300-foot-by-300-foot grid. P(i) was derived by multiplying the average precipitation value within each grid by a fractional statistical yearly and monthly distribution obtained from precipitation records utilized in creation of the County Groundwater Limitations Map. Additional precipitation data were also obtained from July 2001 through June 2005 to include the end of a severe drought through October 2004 and the very wet winter of 2004-2005. Table 1 shows the 34 yearly fractions and 408 monthly fractions of precipitation from July 1971 through June 2005. This table was then applied to the 30-year average precipitation value contained within each 300-foot-by-300-foot to provide 408 unique monthly values of precipitation.

Runoff: Measurements of runoff from stream gauging stations provide the most accurate depiction of runoff occurring within a given watershed. Since long-term runoff records are unavailable for Pine Valley, runoff must be estimated. The United States Department of Agriculture (USDA) Soil Conservation Service (SCS) developed the Curve Number Method which considers the hydrologic soil group and land use type in determining an antecedent runoff condition (USDA, 1986). The technique is based on a simplified infiltration model of runoff and empirical approximations. The method is based on selection of a curve number that has been developed by empirically rating the hydrologic performance of a large number of soils and vegetative covers throughout the United States. The type of land use dictates the

amount of impervious cover and greatly influences the ability of water to infiltrate the soil surface. While the method was designed for a single storm event, it can be scaled to find average monthly runoff values.

With the exception of Rancho Cuyamaca State Park, infiltration rates of soils have been classified by the USDA into four hydrologic soil groups according to their minimum infiltration rate throughout the study area. Runoff curves were developed for various combinations of hydrologic soil groups and land uses (Table 2) which was then incorporated into GIS to code each 300-foot-by-300-foot grid cell with a unique curve number. RO(i) was calculated by using the SCS runoff equation for each cell based on the amount of rainfall that occurred in a given month.

As documented within Appendix D of the GP Update Groundwater Study (DPLU, 2009), the calibrated results of recharge which are being utilized in this study resulted in an overestimation of surface water runoff. For the Pine South basin, an average of 27% of all precipitation that was estimated to occur in the 34 year period was assumed to be runoff. Runoff was utilized as a lumped parameter to incorporate elements of the water balance that are not explicitly quantified (e.g., groundwater evapotranspiration [GWET] from phreatophyte consumption, potential surface water base flow supported by groundwater, and/or groundwater discharge out of the basin). Since data does not exist in which to more accurately quantify these parameters, runoff as calculated is subject to substantial uncertainty.

Evapotranspiration: ETo, which is a measure of potential evapotranspiration from a known surface, such as grass or alfalfa has been estimated for San Diego County by CIMIS (see Section 2.2.2). For this study, the ETo rates published by CIMIS were used as a surrogate for PET rates required by the Thornthwaite method. PET(i) was calculated from the ETo rates to code each 300-foot-by-300-foot grid. Using these values is conservative because they are based on irrigation needs of grass/alfalfa crops which assume a continuous source of moisture and does not consider summer dormancy (caused by decreased soil moisture beyond the wilting point) exhibited by many native species.

Soil Moisture Capacity: The USDA mapped nearly 250 soil types in their study of the County. The USDA included a range of SMC for nearly all of these soil types. SMC was estimated for as the mean value from the USDA data to code each 300-foot-by-300-foot grid (Figure 6). For cases where no SMC was listed by the USDA, an estimation of SMC was made for that particular soil type based on similar soil types.

### 3.1.3 Groundwater Demand

Groundwater demand was estimated in Pine South and Pine North basins for the four land use scenarios (existing conditions, existing conditions plus all discretionary permits currently in process at DPLU, current GP build-out, and GP Update build-out) evaluated in this study.

The current GP Map for Pine Valley is included as Figure 19 and the GP Update Referral Map is included as Figure 20. Tables 3 and 4 provide a summary of all water uses within Pine South and Pine North basins, and the estimated amount of groundwater demand for each land use scenario. Additionally, the annual demand was broken into monthly fractions to account for seasonal patterns of groundwater usage.

A number of constraints were taken into consideration to provide a more realistic expectation of future development potential under the GP scenarios. Constraints included already built lands, 100-year flood plains, wetlands, public lands, future roads, habitat preserves, forest conservation initiative lands, slopes greater than 25%, Tier I and II vegetation, and pre-approved mitigation areas.

### 3.1.4 Groundwater in Storage

Because groundwater recharge does not occur at a constant rate from year to year, there must be sufficient drainable groundwater in storage to provide water during years of below average recharge. Groundwater is stored within five hydrogeologic units as defined, quantified and discussed in detail in Section 2.5.

### 3.1.5 Long-Term Groundwater Availability

In order to estimate long-term groundwater availability within the project's watershed, the recharge calculations were first programmed into computer code that was integrated with GIS software. Groundwater demand for each of the four land use scenarios was input into GIS, and groundwater in storage was also input. The computer code and GIS tools were used to calculate inflow to groundwater storage and outflow from groundwater storage on a month-by-month basis for the project watershed over a 34-year period. The output was an Excel spreadsheet, which indicates whether groundwater in storage will be reduced to 50% or less at any time as a result of groundwater extraction over a 34-year period. A summary of the long-term groundwater availability results for the Pine South and Pine North basins is included in Tables 5 and 6.

## 3.2 Significance of Impacts Prior to Mitigation

A summary of long-term groundwater availability results for the Pine South and Pine North basins and is provided in Tables 5 and 6. The results presented indicate the minimum groundwater in storage estimated to occur in any given month over the 34-year period for each land use scenario analyzed.

### 3.2.1 Pine South Basin Impacts

Impacts Under Existing Conditions Plus Discretionary Permits in Process: Under existing conditions, the South Pine basin is estimated to have a groundwater consumptive use of approximately 287 acre-feet per year, and would increase to 302 acre-feet per year with addition of the proposed discretionary projects currently in process at DPLU. The minimum groundwater in storage estimated during any given month under existing conditions with the

addition of the discretionary projects would be 59%, which is above the 50% threshold. The 50% threshold is not exceeded until 341 acre-feet of groundwater per year are used.

Impacts Under Current GP Buildout: Under the worst-case scenario of maximum build out of the current GP taking into consideration environmental constraints, the Pine South basin would have an estimated 247 additional homes with an estimated total consumptive use of approximately 410 acre-feet per year (assumes 0.5 acre-feet per year per each new residence). Under this scenario, the minimum groundwater in storage estimated in any given month would be 35% of maximum storage, which exceeds the 50% threshold. Therefore, cumulative impacts to the Pine South basin under theoretical maximum build out of the current GP are considered to be significant.

Impacts Under Proposed GP Update Buildout: Under the scenario of maximum build out of the proposed GP Update (Referral Map alternative), the Pine South basin would have an estimated 224 additional homes with an estimated total consumptive use of approximately 399 acre-feet per year (assumes 0.5 acre-feet per year per each new residence). Under this scenario, the minimum groundwater in storage estimated in any given month would be 37% of maximum storage, which exceeds the 50% threshold. Therefore, cumulative impacts to the project watershed under theoretical maximum build out of the proposed GP Update (Referral Map alternative) are considered to be significant.

The GP Update also includes a number of alternatives including the Environmentally Superior alternative, which provides the lowest land use densities of any of the alternatives. Under the scenario of the GP Update Environmentally Superior alternative, the Pine South basin would have an estimated 178 additional homes with an estimated total consumptive use of 376 acre-feet per year (assumes 0.5 acre-feet per year per each new residence). Under this scenario, the minimum groundwater in storage estimated in any given month would be 43% of maximum storage, which while an improvement over the GP Update Referral Map alternative, still exceeds the 50% threshold. Therefore, cumulative impacts to the Pine South basin under theoretical maximum build out of the GP Update Environmentally Superior alternative are considered significant.

### 3.2.2 Pine North Basin Impacts

Impacts under Existing Conditions plus Discretionary Permits in Process: Under existing conditions, the project watershed is estimated to have a groundwater consumptive use of approximately 86 acre-feet per year, and would increase to 87 acre-feet per year with addition of the one proposed discretionary project currently in process at DPLU. The minimum groundwater in storage estimated during any given month under existing conditions with the addition of the discretionary projects would be 94%, which is well above the 50% threshold.

Impacts Under Current GP Buildout: Under the worst-case scenario of maximum build out of the current GP taking into consideration environmental constraints, the Pine North basin would have an estimated 52 additional homes with an estimated total consumptive use of approximately 112 acre-feet per year (assumes 0.5 acre-feet per year per each new residence). Under this scenario, the minimum groundwater in storage estimated in any given month

would be 92% of maximum storage, which is well above the 50% threshold. The average groundwater in storage through the 34 year period analyzed is estimated at approximately 98% of maximum storage of the basin. Cumulative impacts to the Pine North basin under theoretical maximum build out are considered to be less than significant.

Impacts Under Proposed GP Update Buildout: Under the scenario of maximum build out of the proposed GP Update (Referral Map alternative), the Pine North basin would have an estimated 26 additional homes with an estimated total consumptive use of approximately 100 acre-feet per year (assumes 0.5 acre-feet per year per each new residence). Under this scenario, the minimum groundwater in storage estimated in any given month would be 93% of maximum storage, which is well above the 50% threshold. The average groundwater in storage through the 34 year period analyzed is estimated at approximately 99% of maximum storage of the basin. Cumulative impacts to the Pine North basin under theoretical maximum build out of the proposed GP Update (Referral Map alternative) are considered to be less than significant.

### 3.2.3 Conclusions

Pine South: Using the soil moisture balance methodology and conservative assumptions based on data availability, the Pine South basin, which is more heavily used than the Pine North basin is calculated to have a significant cumulative impact to groundwater resources at the theoretical maximum build out of the current GP and the proposed GP Update. Under the current GP scenario, groundwater was estimated to drop below 50% of maximum storage from May 1990 to February 1991, from April 2002 to January 2003, from August 2003 to January 2004, and from June 2004 to November 2004. This equates to 32 months, or 2.7 years out of 34 years in which groundwater would exceed the 50% threshold. For the GP Update Referral Map alternative, impacts are similar but slightly less with 24 months, or 2 years out 34 years in which groundwater would exceed the 50% threshold.

The sustainable yield as calculated for Pine South basin is approximately 340 acre-feet per year. This is short of the amount of water estimated to be consumed at theoretical build out of the current GP (410 acre-feet per year), the GP Update Referral Map alternative (399 acre-feet per year), or the GP Update Environmentally Superior alternative (376 acre-feet per year). However, the current discretionary permits in process in DPLU when added to the existing conditions water use would result in a total consumptive use of 302 acre-feet per year, within the calculated sustainable yield of 340 acre-feet per year for the Pine South basin.

Pine North: Using the soil moisture balance methodology, the Pine North basin, which is less used than the Pine South basin, is calculated to have a sufficient water supply under all scenarios analyzed. Under the worst-case scenario of maximum build out of the current GP, the basin is anticipated to have on average approximately 98% of maximum storage through the 34 year period analyzed, with the minimum groundwater in storage in any month estimated at 92% of maximum storage in November 2002. As a comparison to this calculated value, the deepest water levels ever recorded in well PIN-04 were recorded in November 2002 and February 2003 (Figure 16).

Data Limitations: Due to data limitations, the following conservative assumptions were taken in the long-term groundwater availability calculations:

1. Assumed no saturated residuum or alluvium in areas where no data was available (i.e., well or boring logs).
2. In the absence of site-specific aquifer test data, a specific yield of 10% for alluvium was used.
3. Recharge from surface water runoff may be the dominant recharge process in the study area. Since this process has not been adequately quantified through long-term stream gauging records, it was not directly calculated and included in the water balance calculations.

## 3.3 Mitigation Measures and Alternatives

As calculated, the Pine South basin is anticipated to have a significant cumulative impact to groundwater resources before approaching maximum build out of the current GP as well as any of the alternatives proposed for the GP Update. Conversely, the Pine North basin is anticipated to have an adequate groundwater supply under all scenarios analyzed. For potentially significant cumulative impacts to a given groundwater basin, mitigation would be limited to finding a water source elsewhere to import into the basin. The one measure available to mitigate groundwater impacts to a level of less than significant in the Pine South basin would be for the PVWMC to install additional production wells in the Pine North basin for use within their service area in the Pine South basin. Under the worst-case scenario of maximum build out of the current GP, an additional 70 acre-feet of groundwater per year would be needed (approximately 43 gallons per minute) beyond the calculated sustainable yield of the Pine South basin of 340 acre-feet per year. This could likely be accommodated by one to three additional production wells in the Pine North basin.

Additionally, the GP Update Environmentally Superior alternative could be selected to minimize future development potential in the Pine South basin. Land use densities within the Environmentally Superior alternative could be revised to allow only large rural lots and thereby limit growth to within the calculated sustainable yield of the basin.

# 4 SUMMARY OF GROUNDWATER IMPACTS AND MITIGATION

The water balance analysis provided in the report indicates that groundwater resources are adequate in both Pine South and Pine North basins to meet the demands under existing conditions and with the addition of additional residences if all discretionary permits currently in process at DPLU were approved. The sustainable yield for the Pine South basin as calculated in this study is 340 acre-feet per year, which would be exceeded under the theoretical build out of the GP or any of the land use alternatives of the proposed GP Update.

Mitigation of the potentially significant impact to groundwater resources in the Pine South basin is possible by the PVMWC potentially drilling additional production wells in the Pine North basin and distributing the water to users in the Pine South basin. This could likely be accommodated by one to three additional production wells in the Pine North basin.

The GP Update Environmentally Superior alternative could also be selected (and revised as necessary) to minimize future development potential in the Pine South basin to within the sustainable yield calculated within this study.

# 5 RECOMMENDATIONS AND LIMITATIONS

## 5.1 Recommendations to the PVMWC

The majority of Pine Valley is served by the PVMWC, which provides water to 695 service connections from eight existing wells. While groundwater resources appear adequate to meet the current demands of the Pine South and North basins, the following issues should be addressed to maximize availability of groundwater resources for the community as groundwater demand increases:

Water Conservation Measures: Water demand per service connection has increased from 1999 through 2004, which PVMWC attributes to an increase in permanent residences in the valley. Water use has been as high as 0.45 acre-feet per service connection. It is unknown and speculative to predict whether water demand per service connection will continue to increase. DPLU recommends that the PVMWC implement water conservation measures as necessary to maximize the availability of groundwater resources for the community as it continues to grow. If groundwater demand per service connection were to continue to increase unabated, future groundwater problems could develop.

Management of Well Field: In the December 22, 2006 Analysis of Pine Valley Mutual Water Company's Groundwater Resources by Wiedlin & Associates, several recommendations were made to increase the overall efficiency of the PVMWC well field. These recommendations could result in increased production abilities from the existing well field as groundwater demand increases over time.

Maintenance of Well Field: Several of the PVMWC wells were installed between the late 1950s and early 1970s. Water wells over time typically experience decreased well yield from chemical incrustation or bio-fouling of the well screen and the formation materials around the intake portion of the well. Without proper maintenance, individual well performance may be substantially reduced and cause individual wells to fail. As PVMWC wells lose well production capability over time in individual wells, it is recommended that PVMWC provide routine maintenance and rehabilitation of these wells. Additionally, with increased demand and lower production capacity from its existing well field, PVMWC may need to drill additional production wells to keep up with demand.

## 5.2 Limitations

Hydrogeologic studies are characterized by their uncertainties due to the non-uniformity of geologic formations, the unpredictability of precipitation magnitude and duration, and the extent of groundwater use within and beyond the study area boundaries. No guarantees regarding the performance of individual water wells and resultant water table drawdown are

made herein. This study does not address the infrastructure requirements that may or may not be necessary to distribute water within the PVMWC service area.

Due to data limitations, there were a number of conservative assumptions made in the long-term groundwater availability calculations. The following items that were not possible to implement due to budgetary constraints are presented as future possibilities of better refining the knowledge of groundwater resources within Pine Valley.

- Long-term stream gauging stations in Pine Valley would greatly aid in calculating groundwater recharge from stream flow infiltration and in more accurately estimating the amount of runoff occurring. This would also aid in evaluation of elements of the water balance that were not explicitly quantified (e.g., groundwater evapotranspiration [GWET] from phreatophyte consumption, potential surface water base flow supported by groundwater, and/or groundwater discharge out of the basin). Since the data does not exist in which to more accurately quantify these parameters, runoff calculated is subject to substantial uncertainty and therefore was overestimated to indirectly account for the elements above that were not explicitly quantified.

- Long-term aquifer pumping tests are needed to provide more accurate estimates of the specific yield of the alluvium and residuum. This would likely require the drilling of new wells to evaluate each specific hydrogeologic unit.

- As new wells are drilled in Pine Valley, the well logs may provide new information to explore other valley areas where saturated residuum may be present.

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# *Tables*

## Table 1
## Yearly and Monthly Precipitation Fractions

| Precipitation Year | Yearly Fraction of 30-Year Average Precipitation | Monthly Fraction of Annual Precipitation | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
| 1971-1972 | 0.49 | 0.00 | 0.03 | 0.02 | 0.16 | 0.03 | 0.54 | 0.00 | 0.03 | 0.00 | 0.03 | 0.05 | 0.10 |
| 1972-1973 | 1.11 | 0.00 | 0.00 | 0.02 | 0.07 | 0.18 | 0.12 | 0.15 | 0.18 | 0.26 | 0.01 | 0.01 | 0.00 |
| 1973-1974 | 0.62 | 0.00 | 0.02 | 0.00 | 0.00 | 0.21 | 0.02 | 0.49 | 0.01 | 0.20 | 0.04 | 0.01 | 0.00 |
| 1974-1975 | 0.90 | 0.02 | 0.00 | 0.01 | 0.13 | 0.02 | 0.14 | 0.03 | 0.11 | 0.32 | 0.19 | 0.01 | 0.01 |
| 1975-1976 | 0.80 | 0.00 | 0.00 | 0.02 | 0.02 | 0.11 | 0.05 | 0.01 | 0.46 | 0.16 | 0.14 | 0.01 | 0.00 |
| 1976-1977 | 0.88 | 0.04 | 0.00 | 0.20 | 0.04 | 0.07 | 0.09 | 0.23 | 0.03 | 0.12 | 0.01 | 0.17 | 0.00 |
| 1977-1978 | 1.90 | 0.00 | 0.08 | 0.00 | 0.02 | 0.01 | 0.11 | 0.29 | 0.19 | 0.24 | 0.05 | 0.01 | 0.00 |
| 1978-1979 | 1.43 | 0.00 | 0.00 | 0.04 | 0.01 | 0.15 | 0.15 | 0.28 | 0.12 | 0.23 | 0.00 | 0.01 | 0.00 |
| 1979-1980 | 1.78 | 0.01 | 0.01 | 0.00 | 0.04 | 0.01 | 0.01 | 0.37 | 0.31 | 0.15 | 0.06 | 0.03 | 0.00 |
| 1980-1981 | 0.68 | 0.01 | 0.00 | 0.00 | 0.03 | 0.00 | 0.08 | 0.15 | 0.23 | 0.39 | 0.07 | 0.04 | 0.00 |
| 1981-1982 | 1.03 | 0.00 | 0.00 | 0.01 | 0.02 | 0.09 | 0.04 | 0.31 | 0.10 | 0.34 | 0.06 | 0.01 | 0.01 |
| 1982-1983 | 1.74 | 0.00 | 0.01 | 0.03 | 0.01 | 0.14 | 0.10 | 0.10 | 0.18 | 0.34 | 0.09 | 0.01 | 0.00 |
| 1983-1984 | 0.58 | 0.00 | 0.10 | 0.05 | 0.08 | 0.31 | 0.31 | 0.04 | 0.01 | 0.01 | 0.08 | 0.00 | 0.01 |
| 1984-1985 | 0.87 | 0.07 | 0.04 | 0.01 | 0.03 | 0.14 | 0.43 | 0.07 | 0.10 | 0.09 | 0.03 | 0.00 | 0.00 |
| 1985-1986 | 1.17 | 0.02 | 0.00 | 0.02 | 0.02 | 0.33 | 0.09 | 0.05 | 0.21 | 0.23 | 0.03 | 0.00 | 0.00 |
| 1986-1987 | 0.76 | 0.02 | 0.01 | 0.10 | 0.09 | 0.09 | 0.12 | 0.18 | 0.16 | 0.15 | 0.04 | 0.01 | 0.01 |
| 1987-1988 | 1.03 | 0.00 | 0.01 | 0.03 | 0.18 | 0.11 | 0.17 | 0.15 | 0.10 | 0.04 | 0.19 | 0.01 | 0.00 |
| 1988-1989 | 0.50 | 0.01 | 0.03 | 0.01 | 0.00 | 0.16 | 0.34 | 0.10 | 0.15 | 0.17 | 0.01 | 0.02 | 0.00 |
| 1989-1990 | 0.59 | 0.00 | 0.01 | 0.03 | 0.04 | 0.02 | 0.02 | 0.36 | 0.18 | 0.09 | 0.10 | 0.06 | 0.08 |
| 1990-1991 | 0.97 | 0.00 | 0.01 | 0.00 | 0.00 | 0.06 | 0.05 | 0.07 | 0.19 | 0.60 | 0.01 | 0.00 | 0.00 |
| 1991-1992 | 1.05 | 0.03 | 0.01 | 0.02 | 0.04 | 0.01 | 0.13 | 0.16 | 0.28 | 0.28 | 0.02 | 0.02 | 0.00 |
| 1992-1993 | 1.74 | 0.00 | 0.02 | 0.00 | 0.02 | 0.00 | 0.14 | 0.51 | 0.22 | 0.05 | 0.00 | 0.01 | 0.02 |
| 1993-1994 | 0.83 | 0.00 | 0.00 | 0.00 | 0.01 | 0.10 | 0.07 | 0.09 | 0.33 | 0.25 | 0.12 | 0.01 | 0.00 |
| 1994-1995 | 1.53 | 0.00 | 0.01 | 0.00 | 0.01 | 0.04 | 0.05 | 0.38 | 0.11 | 0.29 | 0.06 | 0.03 | 0.02 |
| 1995-1996 | 0.53 | 0.01 | 0.01 | 0.01 | 0.00 | 0.02 | 0.07 | 0.22 | 0.34 | 0.24 | 0.06 | 0.01 | 0.00 |
| 1996-1997 | 0.79 | 0.01 | 0.00 | 0.01 | 0.09 | 0.19 | 0.17 | 0.42 | 0.08 | 0.00 | 0.02 | 0.00 | 0.01 |
| 1997-1998 | 1.79 | 0.00 | 0.00 | 0.06 | 0.00 | 0.07 | 0.09 | 0.11 | 0.39 | 0.13 | 0.08 | 0.06 | 0.00 |
| 1998-1999 | 0.63 | 0.02 | 0.02 | 0.02 | 0.02 | 0.15 | 0.12 | 0.20 | 0.09 | 0.09 | 0.24 | 0.00 | 0.03 |
| 1999-2000 | 0.54 | 0.04 | 0.01 | 0.02 | 0.00 | 0.00 | 0.05 | 0.10 | 0.52 | 0.15 | 0.10 | 0.01 | 0.01 |
| 2000-2001 | 0.75 | 0.00 | 0.02 | 0.02 | 0.09 | 0.04 | 0.00 | 0.26 | 0.34 | 0.10 | 0.12 | 0.01 | 0.00 |
| 2001-2002 | 0.30 | 0.01 | 0.02 | 0.01 | 0.00 | 0.23 | 0.23 | 0.12 | 0.04 | 0.21 | 0.13 | 0.00 | 0.00 |
| 2002-2003 | 0.96 | 0.00 | 0.01 | 0.02 | 0.01 | 0.13 | 0.17 | 0.01 | 0.35 | 0.14 | 0.12 | 0.04 | 0.00 |
| 2003-2004 | 0.58 | 0.02 | 0.04 | 0.01 | 0.00 | 0.11 | 0.14 | 0.05 | 0.46 | 0.08 | 0.09 | 0.00 | 0.00 |
| 2004-2005 | 1.75 | 0.00 | 0.00 | 0.00 | 0.24 | 0.04 | 0.13 | 0.24 | 0.24 | 0.07 | 0.03 | 0.01 | 0.00 |

Note: Yearly and monthly precipitation fractions are based on data obtained and averaged from 89 government sanctioned precipitation stations in San Diego County west of desert areas. The fractions were applied to the 30-year average precipitation in each 300-foot by 300-foot cell used to calculate recharge within the groundwater study area. The 30-year average precipitation value within each cell is based on the period July 1971 to June 2001 as was calculated in creation of the Groundwater Limitations Map on file with the Clerk of the Board of Supervisors as Document 195172. Applying the fractions produced 408 unique monthly precipitation values (for each cell) from July 1971 to June 2005.

## Table 2
## Linking Land Uses and Hydrologic Soil Groups to Soil Curve Number

| Cover Code | Hydrologic Soil Group and Associated Curve Numbers | | | | SANDAG Land Use Code | SANDAG Land Use Description |
|---|---|---|---|---|---|---|
| | A | B | C | D | | |
| Open space (parks/golf), 50% to 75% cover | 49 | 69 | 79 | 84 | 7204 | Golf Course |
| | | | | | 7606 | Landscape Open Space |
| Paved parking lots | 98 | 98 | 98 | 98 | 4116 | Park and Ride Lot |
| | | | | | 4119 | Other Transportation |
| Paved roads (including right-of-way) | 83 | 89 | 92 | 93 | 4112 | Freeway |
| | | | | | 4104 | Airstrip |
| | | | | | 4118 | Road Right of Way |
| Commercial | 89 | 92 | 94 | 95 | 1501 | Hotel/Motel (Low-Rise) |
| | | | | | 1503 | Resort |
| | | | | | 4113 | Communications and Utilities |
| | | | | | 5005 | Specialty Commercial |
| | | | | | 5007 | Arterial Commercial |
| | | | | | 5009 | Other Retail Trade and Strip |
| | | | | | 6002 | Office (Low-Rise) |
| | | | | | 6003 | Government Office/Civic Center |
| | | | | | 6101 | Cemetary |
| | | | | | 6102 | Religious Facility |
| | | | | | 6103 | Library |
| | | | | | 6104 | Post Office |
| | | | | | 6105 | Fire/Police Station |
| | | | | | 6108 | Mission |
| | | | | | 6109 | Other Public Services |
| | | | | | 6509 | Other Health Care |
| | | | | | 6701 | Military Use |
| | | | | | 6804 | Senior High School |
| | | | | | 6806 | Elementary School |
| | | | | | 6807 | School District Office |
| | | | | | 7205 | Golf Course Club House |
| | | | | | 7209 | Casino |
| Industrial | 81 | 88 | 91 | 93 | 1401 | Jail/Prison |
| | | | | | 1409 | Other Group Quarters Facility |
| | | | | | 2103 | Light Industry-General |
| | | | | | 2104 | Warehousing |
| | | | | | 2201 | Extractive Industry |
| | | | | | 2301 | Junkyard/Dump/Landfill |
| Field Crops | 72 | 81 | 88 | 91 | 8501 | Agriculture |
| | | | | | 8504 | Agriculture |
| Pasture | 68 | 79 | 86 | 89 | 8003 | Field Crops |
| | | | | | 9202 | Lake/Reservoir/Large Pond |
| Brush-weed-grass mix | 48 | 67 | 77 | 83 | 6702 | Military Training |
| | | | | | 7210 | Other Recreation-High |
| | | | | | 7603 | Open Space Park or Preserve |
| | | | | | 7607 | Residential Recreation |
| | | | | | 9101 | Vacant and Undeveloped Land |
| Woods-grass mix | 57 | 73 | 82 | 86 | 8001 | Orchard or Vineyard |
| | | | | | 8002 | Intensive Agriculture |
| | | | | | 8502 | Agriculture |
| | | | | | 8503 | Agriculture |

## Table 2
## Linking Land Uses and Hydrologic Soil Groups to Soil Curve Number

| Cover Code | Hydrologic Soil Group and Associated Curve Numbers | | | | SANDAG Land Use Code | SANDAG Land Use Description |
|---|---|---|---|---|---|---|
| | A | B | C | D | | |
| Residential: 8 du/ac | 77 | 85 | 90 | 92 | 1000 | Spaced Rural Residential |
| | | | | | 1100 | Residential |
| | | | | | 1200 | Multi-Family Residential |
| Residential: 4 du/ac | 61 | 75 | 83 | 87 | 1000 | Spaced Rural Residential |
| | | | | | 1100 | Residential |
| | | | | | 1300 | Mobile Home Park |
| Residential: 3 du/ac | 57 | 72 | 81 | 86 | 1000 | Spaced Rural Residential |
| | | | | | 1100 | Residential |
| Residential: 2 du/ac | 54 | 70 | 80 | 85 | 1000 | Spaced Rural Residential |
| | | | | | 1100 | Residential |
| Residential: 1 du/ac | 51 | 68 | 79 | 84 | 1000 | Spaced Rural Residential |
| | | | | | 1100 | Residential |
| Residential: 0.5 du/ac | 46 | 65 | 77 | 82 | 1000 | Spaced Rural Residential |
| | | | | | 1100 | Residential |
| Residential: 0.2 du/ac | 39 | 60 | 74 | 80 | 1000 | Spaced Rural Residential |
| | | | | | 1100 | Residential |

Note: Cover codes, hydrologic soil groups, and associated curve numbers were obtained from the United States Department of Agriculture, Soil Conservation Service,*Urban Hydrology for Small Watersheds, Technical Release No. 55,* June 1986.

SANDAG - San Diego Association of Governments
du - dwelling unit
ac - acre

## Table 3
## Pine South Basin
## Estimated Groundwater Demand

| Land Use Scenario | Land Use | Quantity | Water Demand Per Unit (afy) | Total Water Demand (afy) |
|---|---|---|---|---|
| **Existing Conditions** | Single-Family Residential | 530 | 0.5 | 265 |
| | Second Dwelling Units | 8 | 0.25 | 2 |
| | Commercial Uses | 12 | 0.3 | 4 |
| | County Park | 5.2 | 3.1 | 16 |
| | **Total Water Demand (Existing Conditions):** | | | **287** |
| **Existing Conditions Plus Discretionary Projects in Process** | Sum of Existing Conditions Water Demand | n/a | n/a | 287 |
| | Tentative Map 5236 | 3 | 0.5 | 2 |
| | Tentative Map 5318 | 20 | 0.5 | 10 |
| | Tentative Parcel Map 20765 | 4 | 0.5 | 2 |
| | Tentative Parcel Map 20951 | 4 | 0.5 | 2 |
| | **Total Water Demand (Existing Conditions Plus Discretionary Projects):** | | | **302** |
| **Current General Plan Buildout** | Sum of Existing Conditions Water Demand | n/a | n/a | 287 |
| | Additional Single-Family Residences at Theoretical Maximum Buildout | 247 | 0.5 | 123.5 |
| | **Total Water Demand (Current General Plan Buildout)** | | | **410** |
| **General Plan Update Buildout** | Sum of Existing Conditions Water Demand | n/a | n/a | 287 |
| | Additional Single-Family Residences at Theoretical Maximum Buildout | 224 | 0.5 | 112 |
| | **Total Water Demand (General Plan Update Buildout)** | | | **399** |

Notes:
afy - acre feet per year

## Table 4
## Pine North Basin
## Estimated Groundwater Demand

| Land Use Scenario | Land Use | Quantity | Water Demand Per Unit (afy) | Total Water Demand (afy) |
|---|---|---|---|---|
| **Existing Conditions** | Single-Family Residential | 125 | 0.5 | 62.5 |
| | Second Dwelling Units | 1 | 0.25 | 0.25 |
| | Pine Valley Bible Conference Center | 1 | 19.9 | 20 |
| | Forest Service Cabins | 37 | 0.1 | 4 |
| | **Total Water Demand (Existing Conditions):** | | | **86** |
| **Existing Conditions Plus Discretionary Projects in Process** | Sum of Existing Conditions Water Demand | n/a | n/a | 86 |
| | Tentative Parcel Map 20857 | 2 | 0.5 | 1 |
| | **Total Water Demand (Existing Conditions Plus Discretionary Projects):** | | | **87** |
| **Current General Plan Buildout** | Sum of Existing Conditions Water Demand | n/a | n/a | 86 |
| | Additional Single-Family Residences at Theoretical Maximum Buildout | 52 | 0.5 | 26 |
| | **Total Water Demand (Current General Plan Buildout)** | | | **112** |
| **General Plan Update Buildout** | Sum of Existing Conditions Water Demand | n/a | n/a | 86 |
| | Additional Single-Family Residences at Theoretical Maximum Buildout | 26 | 0.5 | 13 |
| | **Total Water Demand (General Plan Update Buildout)** | | | **99** |

Notes:
afy - acre feet per year

**Table 5**
**Pine South Basin**
**Groundwater in Storage Calculations**

| | |
|---|---|
| Size (Acres) | 3615 |
| Modeled Maximum GW in Storage (AF) | 2138 |
| Modeled Average GW Recharge (AFY) | 963 |

| Scenario | Estimated GW Demand (AFY) | Estimated Average GW in Storage | Estimated Minimum GW in Storage |
|---|---|---|---|
| Existing Conditions | 287 | 89% | 63% |
| Existing Conditions Plus Discretionary Permits | 302 | 88% | 59% |
| General Plan Buildout | 410 | 78% | 35% |
| GP Update Buildout - Referral | 399 | 80% | 37% |
| GP Update Buildout - Environmentally Superior | 376 | 82% | 43% |

**Note:** Future predicted change in the amount of groundwater in storage for scenarios is based upon historical precipitation from July 1971 to June 2005. Scenarios with estimated groundwater in storage at or below 50% at any time are considered to have a potentially significant impact to groundwater resources.
AF - Acre-Feet
AFY- Acre-Feet Per Year
GW - Groundwater

**Change of GW in Storage**

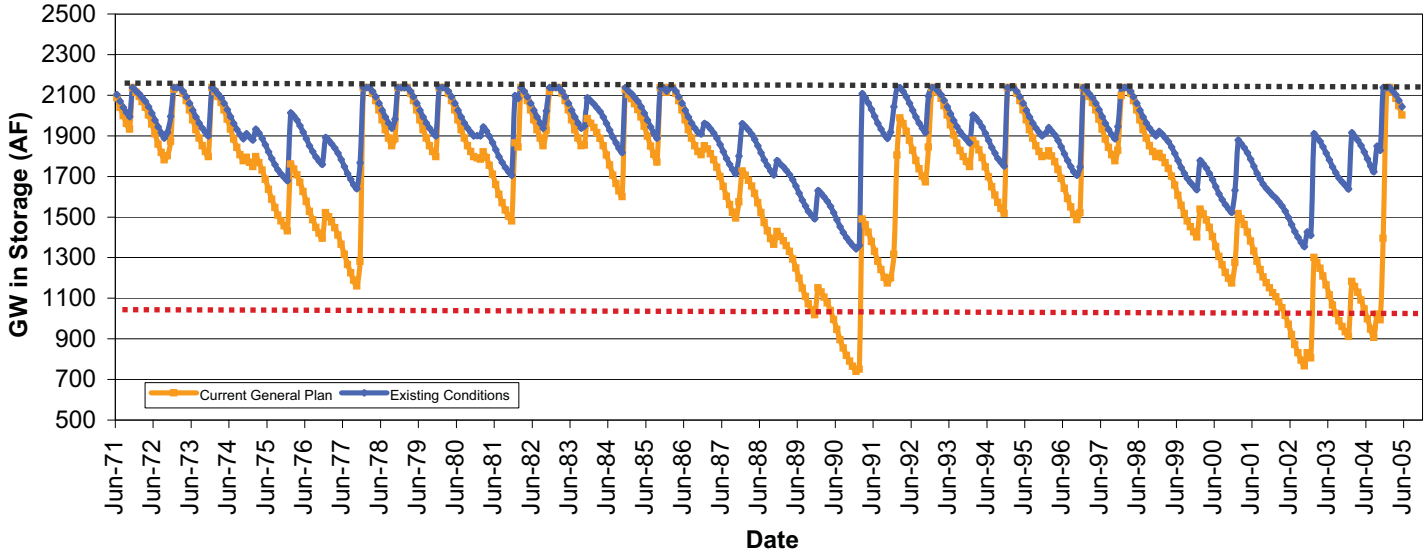


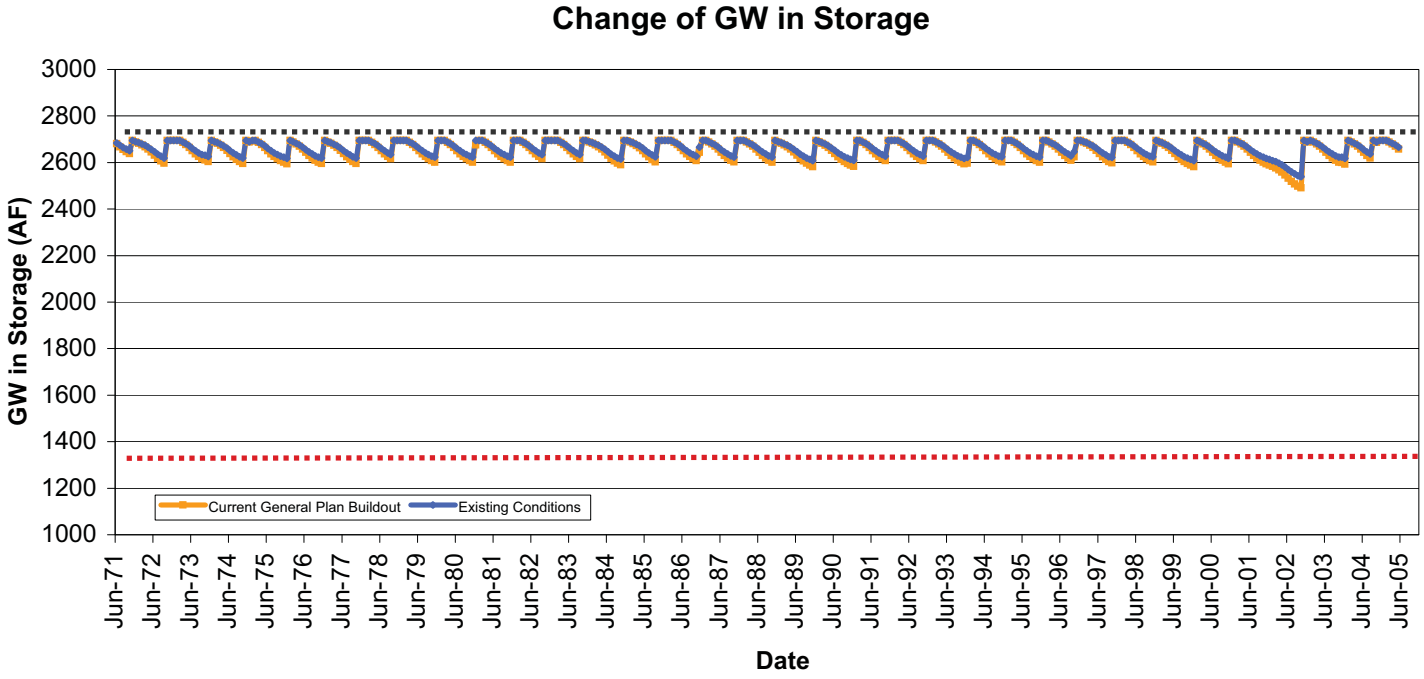
**Table 6**
**Pine North Basin**
**Groundwater in Storage Calculations**

| | |
|---|---|
| Size (Acres) | 15189 |
| Modeled Maximum GW in Storage (AF) | 2694 |
| Modeled Average GW Recharge (AFY) | 4462 |

| Scenario | Estimated GW Demand (AFY) | Estimated Average GW in Storage | Estimated Minimum GW in Storage |
|---|---|---|---|
| Existing Conditions | 86 | 99% | 94% |
| Existing Conditions Plus Discretionary Projects | 87 | 99% | 94% |
| Current General Plan Buildout | 112 | 98% | 92% |
| Referral Map Buildout | 99 | 99% | 93% |

**Note:** Future predicted change in the amount of groundwater in storage for scenarios is based upon historical precipitation from July 1971 to June 2005. Scenarios with estimated groundwater in storage at or below 50% at any time are considered to have a potentially significant impact to groundwater resources.
AF - Acre-Feet
AFY- Acre-Feet Per Year

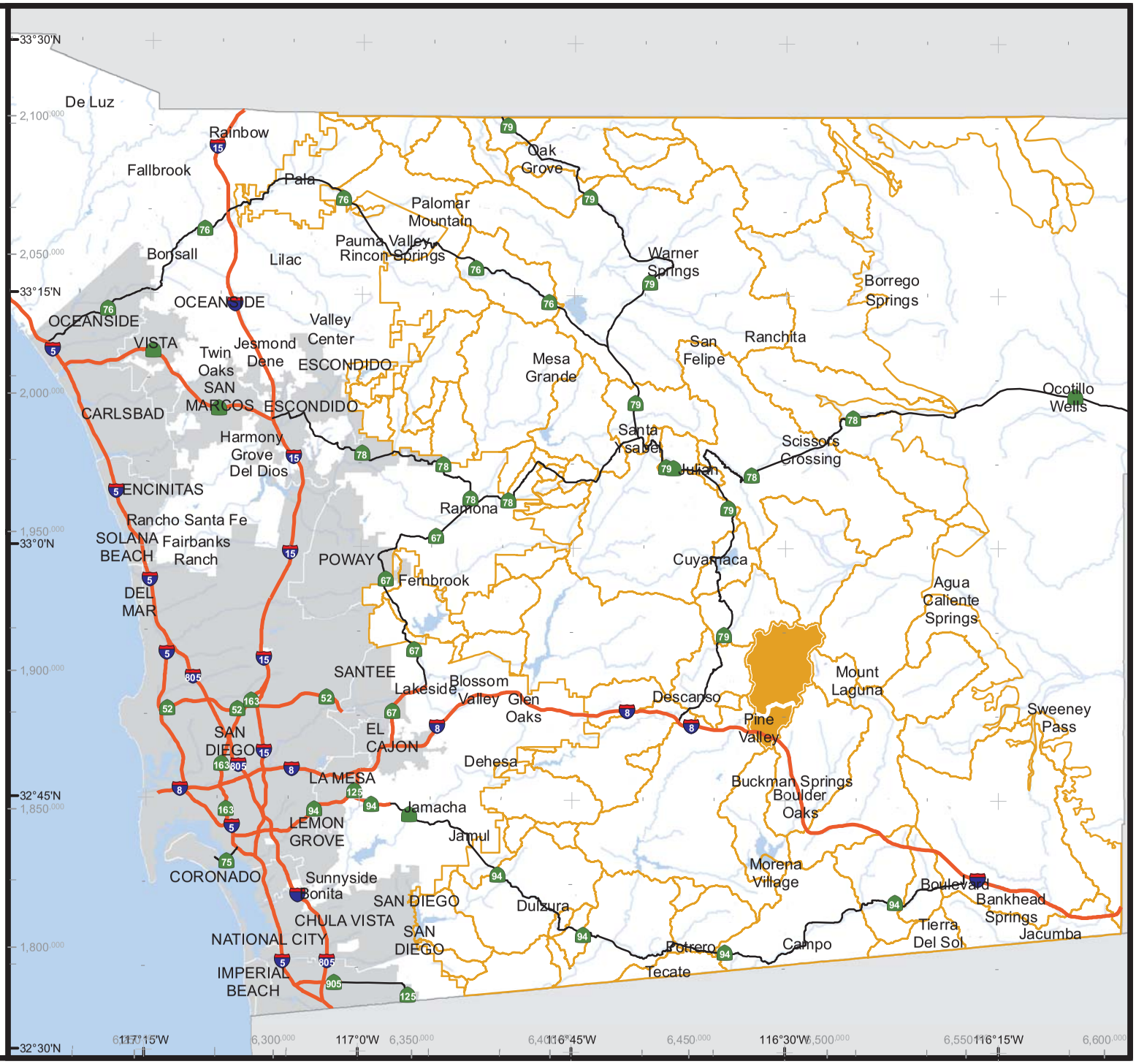
GW - Groundwater



# *Figures*

# Figure 1

## Regional Location




Freeways
Major Highways
Pine Valley Watershed
Rivers
Ocean/Lakes
Incorporated Land

0 7.5 15
Miles

DPLU GIS

May 2009
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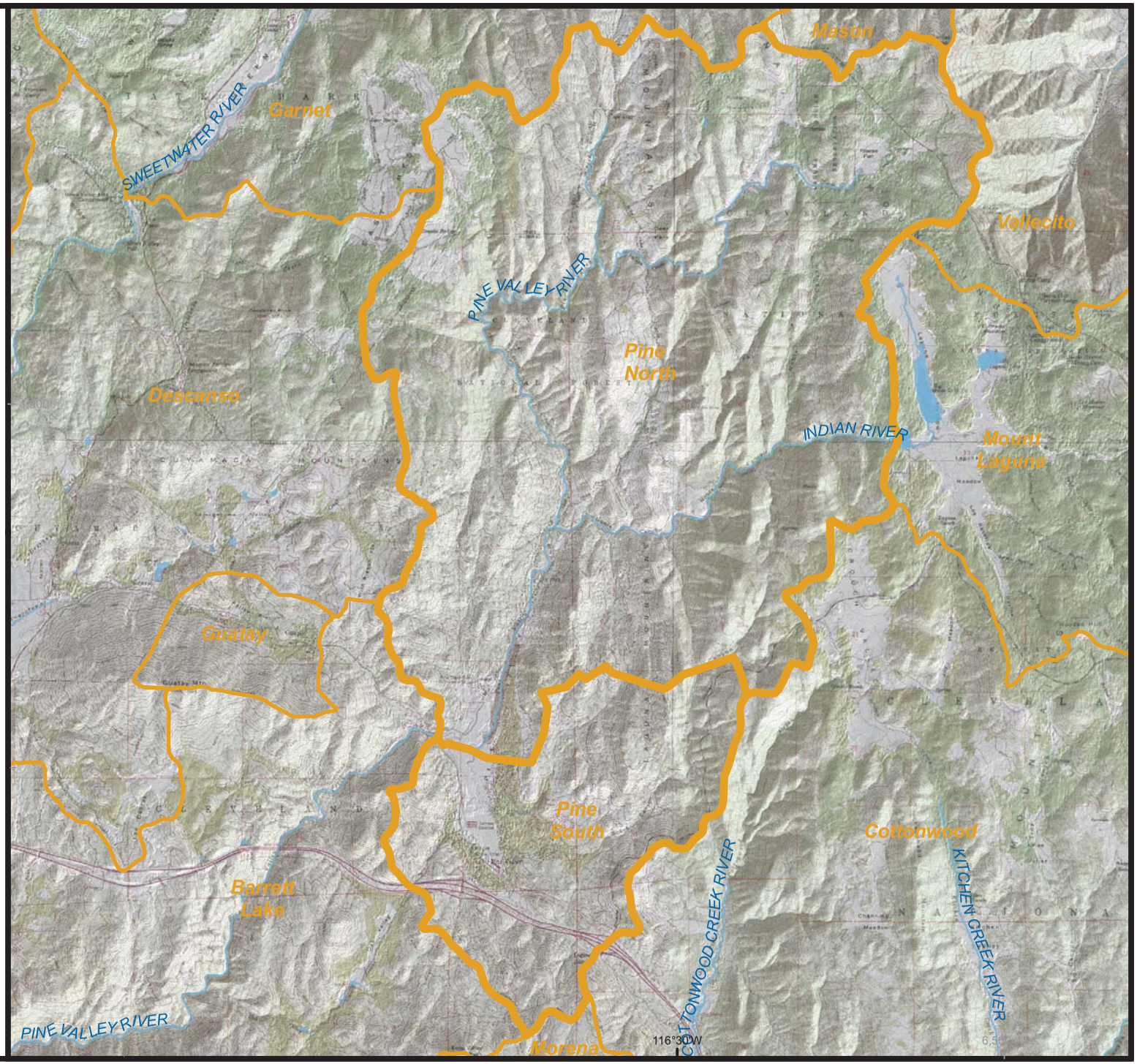
# Figure 2

## Groundwater Study Boundaries




Watershed Boundary
Rivers
Lakes

0 1 2
Miles

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# Figure 3

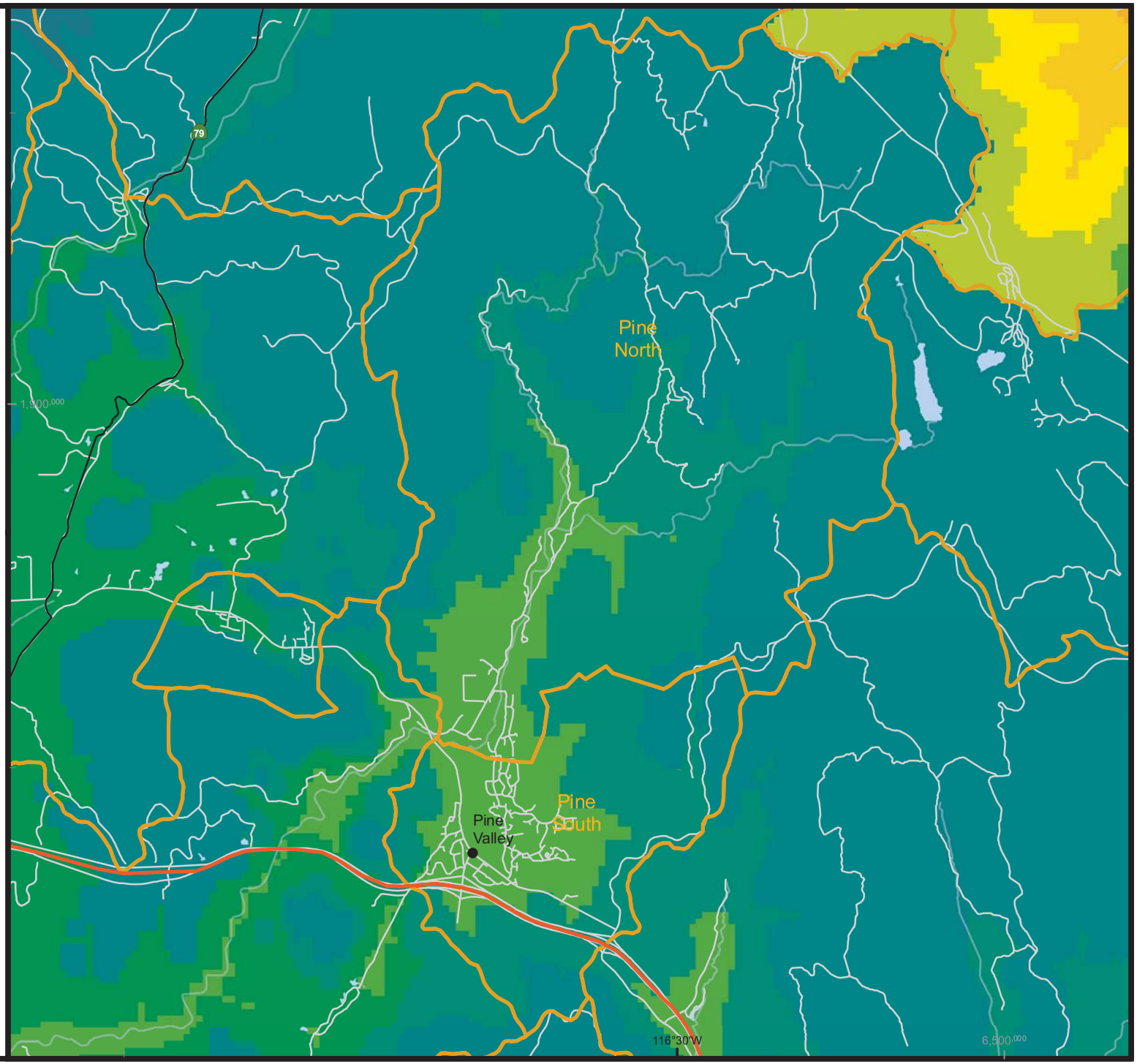
## Precipitation

30-Year Average
1971-2001

**Precipitation (Inches)**

- 6 - 9
- 9 - 12
- 12 - 15
- 15 - 18
- 18 - 21
- 21 - 24
- 24 - 27
- 27 - 30
- 30 - 33
- Communities
- Freeways
- Major Highways
- Roads
- Watershed Boundary
- Rivers
- Ocean/Lakes

0 1 2
Miles

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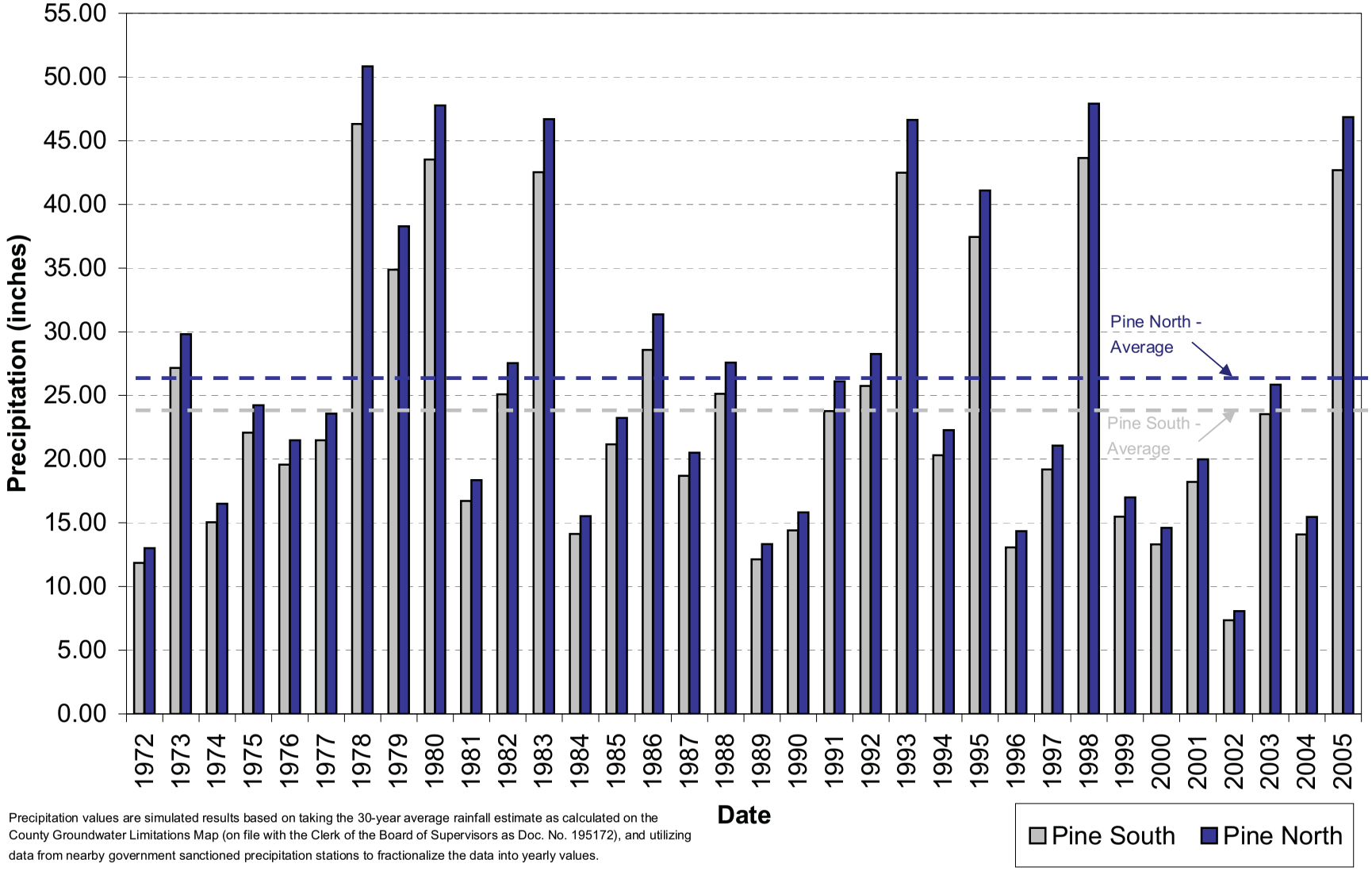
## Figure 4: Simulated Annual Precipitation in Pine Valley




Precipitation values are simulated results based on taking the 30-year average rainfall estimate as calculated on the County Groundwater Limitations Map (on file with the Clerk of the Board of Supervisors as Doc. No. 195172), and utilizing data from nearby government sanctioned precipitation stations to fractionalize the data into yearly values.

# Figure 5

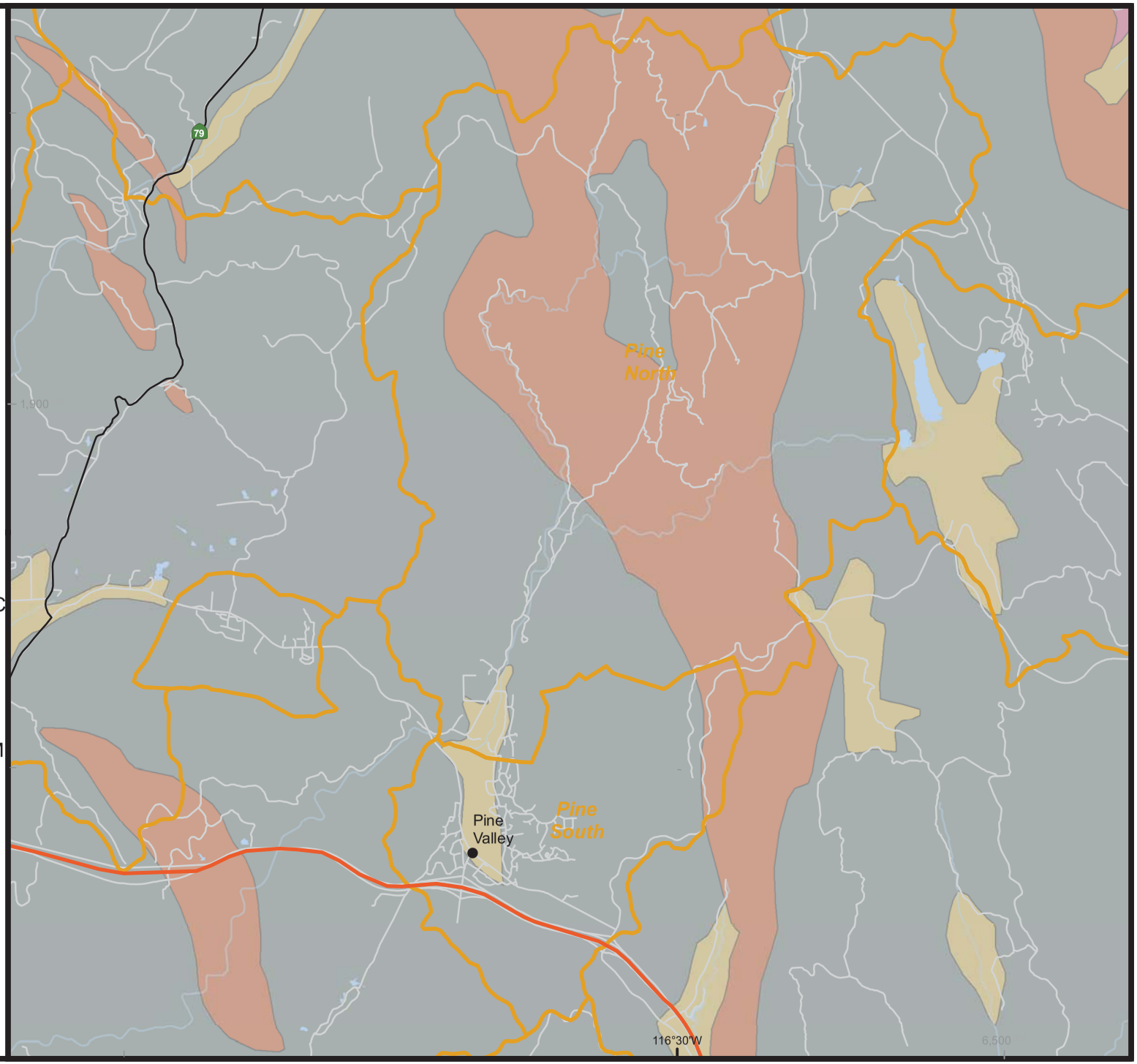
## Generalized Geology

- Communities
- Freeways
- Major Highways
- Roads
- Watershed Boundary
- Parcles ( >5ac )
- Rivers
- Ocean/Lakes

Generalized Geology

- CRETACEOUS PLUTONIC
- OLDER QUATERANARY ALLUVIUM, TERRACES AND FANGLOMERATES
- PRE-CRETACEOUS METASEDIMENTARY
- QUATERNARY ALLUVIUM

0 1 2
Miles

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# Figure 6

## Soils

- Communities
- Freeways
- Major Highways
- Roads
- Watershed Boundary
- Parcles ( >5ac )
- Rivers
- Ocean/Lakes

Soil Moisture Capacity

- 0.10" - 1.00"
- 1.50" - 3.25"
- 3.50" - 5.00"
- 5.50" - 6.75"
- 7.50" - 10.00"

0 1 2
Miles

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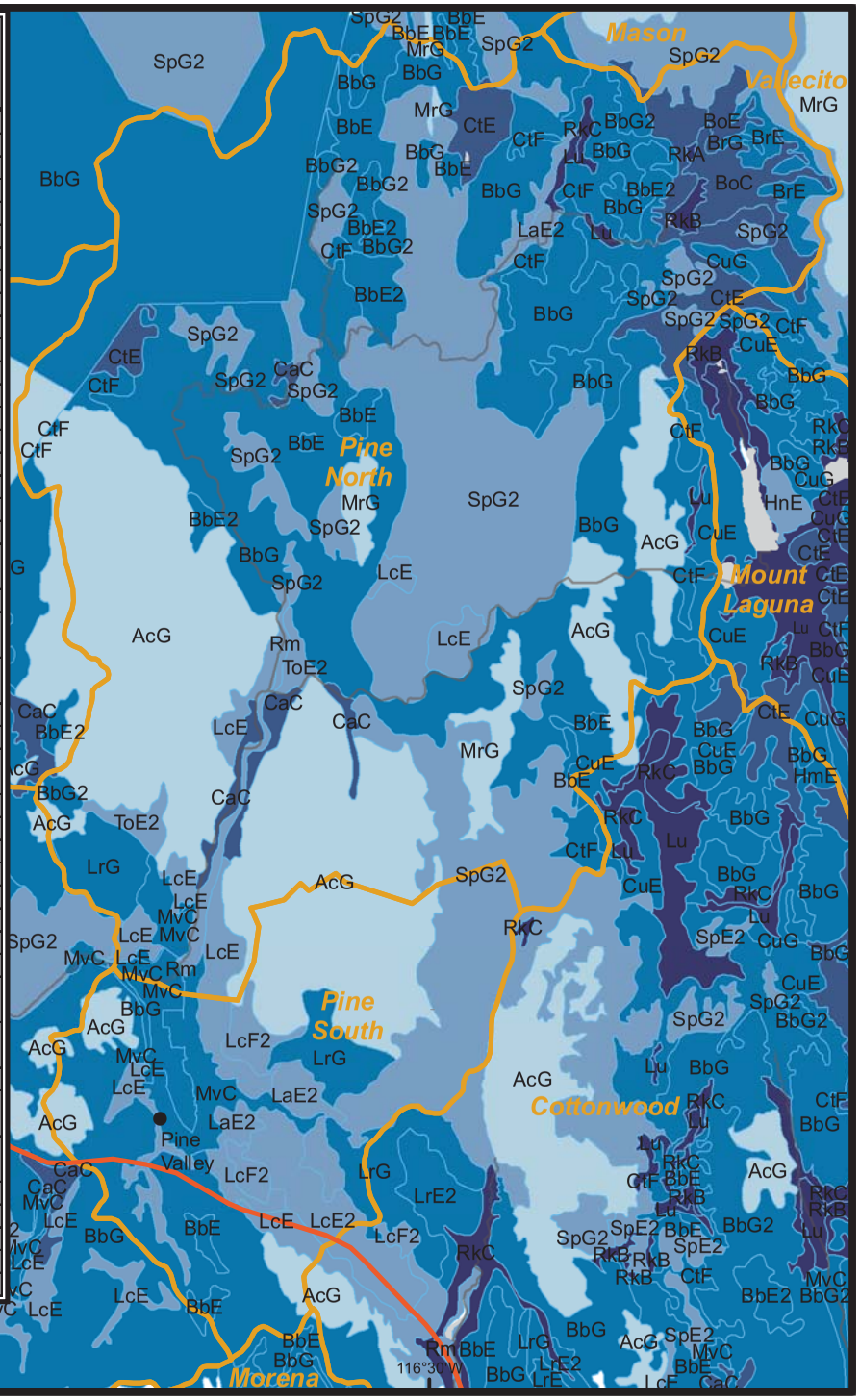
| Title | Description | Soil Moisture Capacity (inches) |
|---|---|---|
| AcG | Acid igneous rock land | 0.10 |
| BbE | Bancas stony loam, 5-30% slopes | 4.75 |
| BbE2 | Bancas stony loam, 5-30% slopes, eroded | 4.75 |
| BbG | Bancas stony loam, 30-65% slopes | 4.25 |
| BbG2 | Bancas stony loam, 30-65% slopes, eroded | 4.25 |
| BoC | Boomer loam, 2-9% slopes | 6.50 |
| BoE | Boomer loam, 9-30% slopes | 6.00 |
| BrE | Boomer stony loam, 9-30% slopes | 4.75 |
| BrG | Boomer stony loam, 30-65% slopes | 4.75 |
| BuC | Bull Trail sandy loam, 5-9% slopes | 6.75 |
| CaC | Calpine coarse sandy loam, 5-9% slopes | 5.50 |
| CtE | Crouch coarse sandy loam, 5-30% slopes | 6.00 |
| CtF | Crouch coarse sandy loam, 30-50% slopes | 5.00 |
| CuE | Crouch rocky coarse sandy loam, 5-30% slopes | 4.50 |
| CuG | Crouch rocky coarse sandy loam, 30-70% slopes | 4.50 |
| GrA | Greenfield sandy loam, 0-2% slopes | 6.50 |
| HmD | Holland fine sandy loam, 5-15% slopes | 5.00 |
| HmE | Holland fine sandy loam, 15-30% slopes | 5.00 |
| HnE | Holland stony fine sandy loam, 5-30% slopes | 3.25 |
| LaE2 | La Posta loamy coarse sand, 5-30% slopes, eroded | 2.50 |
| LcE | La Posta rocky loamy coarse sand, 5-30% slopes | 1.75 |
| LcE2 | La Posta rocky loamy coarse sand, 5-30% slopes, eroded | 1.50 |
| LcF2 | La Posta rocky loamy coarse sand, 30-50% slopes, eroded | 1.50 |
| LpD2 | Las Posas fine sandy loam, 9-15% slopes, eroded | 5.00 |
| LrE | Las Posas stony fine sandy loam, 9-15% slopes | 5.00 |
| LrE2 | Las Posas stony fine sandy loam, 9-30% slopes, eroded | 5.00 |
| LrG | Las Posas stony fine sandy loam, 30-65% slopes | 5.00 |
| Lu | Loamy alluvial land | 7.50 |
| MrG | Metamorphic rock land | 1.00 |
| MvC | Mottsville loamy coarse sand, 2-9% slopes | 4.50 |
| RkA | Reiff fine sandy loam, 0-2% slopes | 8.50 |
| RkB | Reiff fine sandy loam, 2-5% slopes | 8.50 |
| RkC | Reiff fine sandy loam, 5-9% slopes | 8.50 |
| Rm | Riverwash | 2.50 |
| SpE2 | Sheephead rocky fine sandy loam, 9-30% slopes, eroded | 2.50 |
| SpG2 | Sheephead rocky fine sandy loam, 30-65% slopes, eroded | 2.50 |
| SrD | Sloping gullied land | 1.00 |
| ToE2 | Tollhouse rocky coarse sandy loam, 5-30% slopes, eroded | 1.50 |
| ToG | Tollhouse rocky coarse sandy loam, 30-65% slopes | 1.50 |
| TuB | Tujunga sand, 0-5% slopes | 3.50 |
| VaA | Visalia sandy loam, 0-2% slopes | 8.75 |
| VaB | Visalia sandy loam, 2-5% slopes | 8.75 |
| VaC | Visalia sandy loam, 5-9% slopes | 8.75 |
| WmC | Wyman loam, 5-9% slopes | 10.00 |



# Figure 7

## Hydrogeologic Units

- Communities
- Freeways
- Major Highways
- Watershed Boundary
- Parcles ( >5ac )
- Rivers
- Ocean/Lakes
- Residuum
- Alluvium
- Slightly Fractured Rock
- Moderately Fractured Rock

0 1 2
Miles

May 2009
k:\groundwater\pine_valley\maps\hydrogeo.mxd

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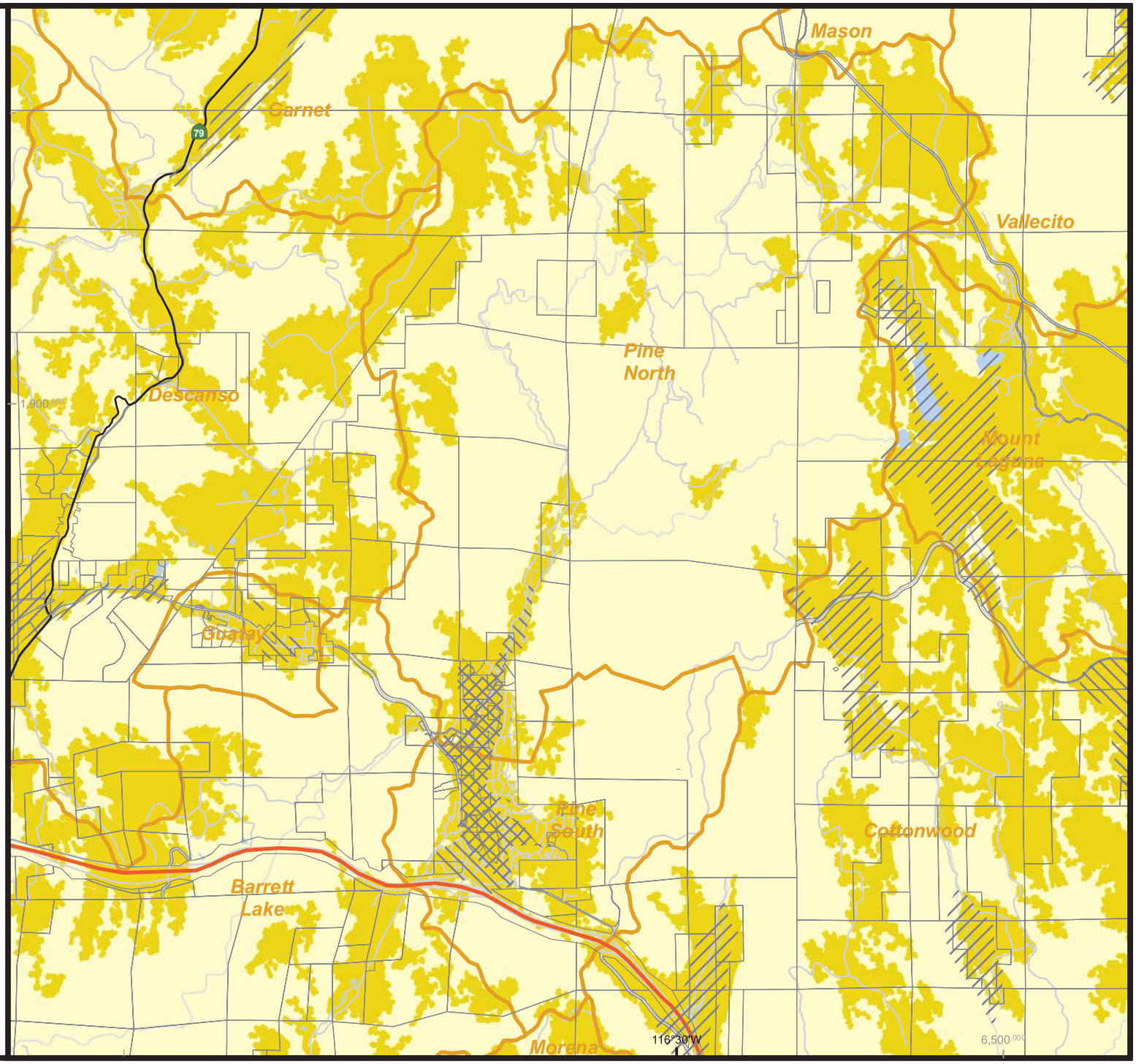
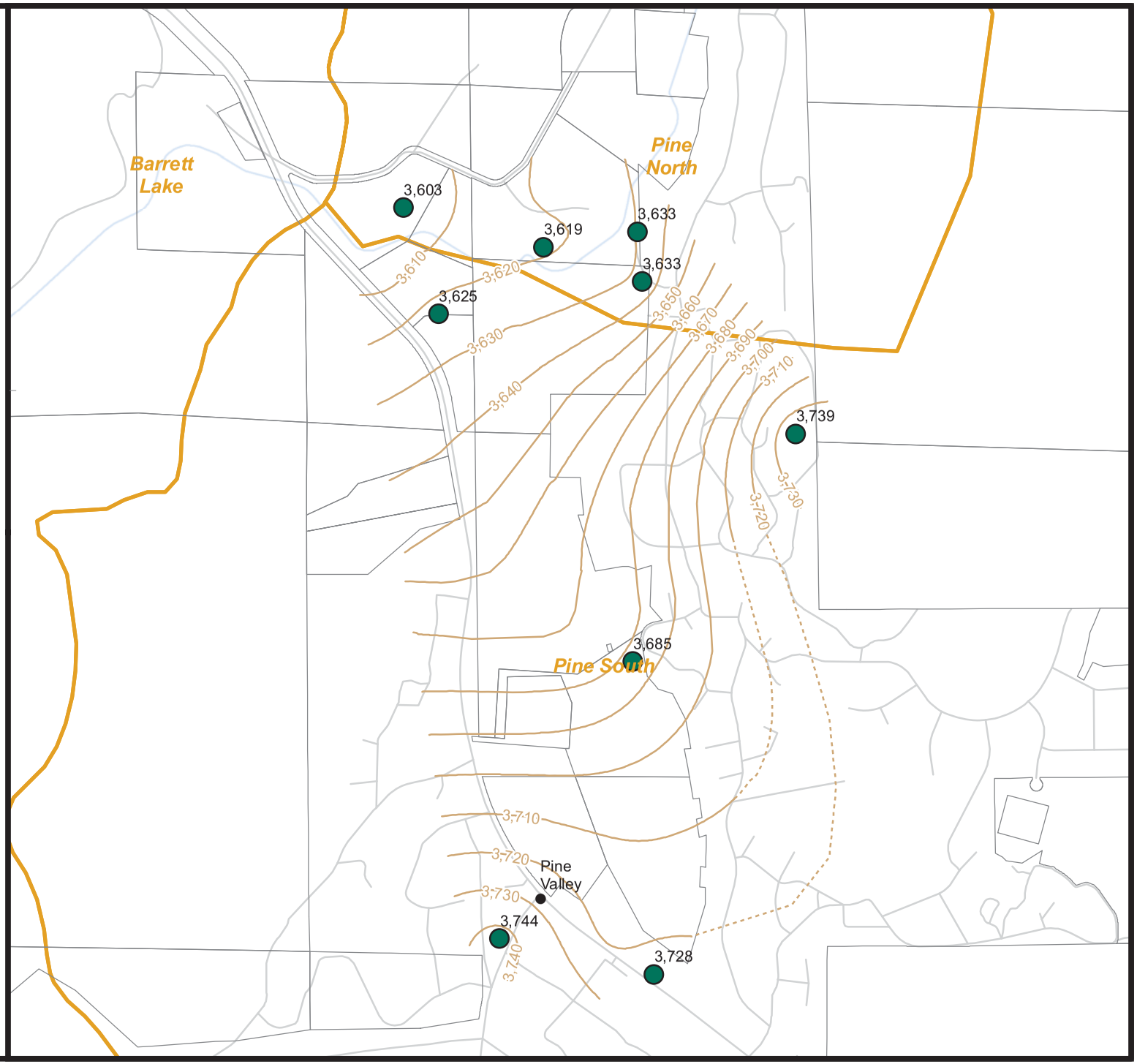


# Figure 8

## Groundwater Elevation

Spring 1998




- Communities
- Freeways
- Major Highways
- Roads
- Watershed Boundary
- Parcles ( >5ac )
- Rivers
- Ocean/Lakes
- Wells (Water Elevation, Feet)
- Groundwater Elevation
- Inferred Value

0 740 1,480
Feet

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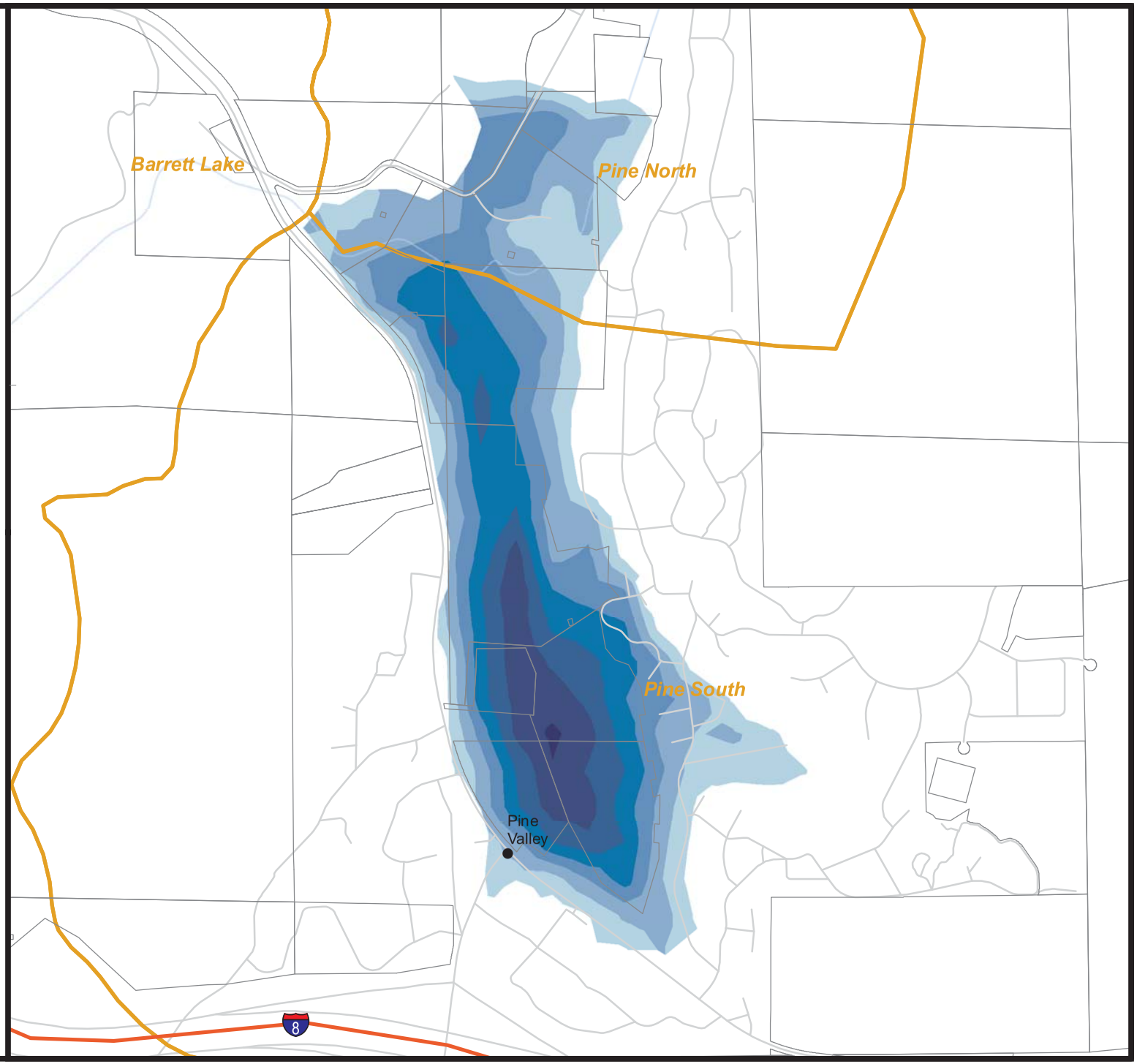
# Figure 9

## Saturated Alluvium Isopach




- Communities
- Freeways
- Major Highways
- Roads
- Watershed Boundary
- Parcles ( >5ac )
- Rivers
- Ocean/Lakes

Saturated Alluvium (Feet)

- 5
- 6 - 15
- 16 - 25
- 26 - 35
- 36 - 45
- 46 - 55
- 56 - 62

0 800 1,600
Feet

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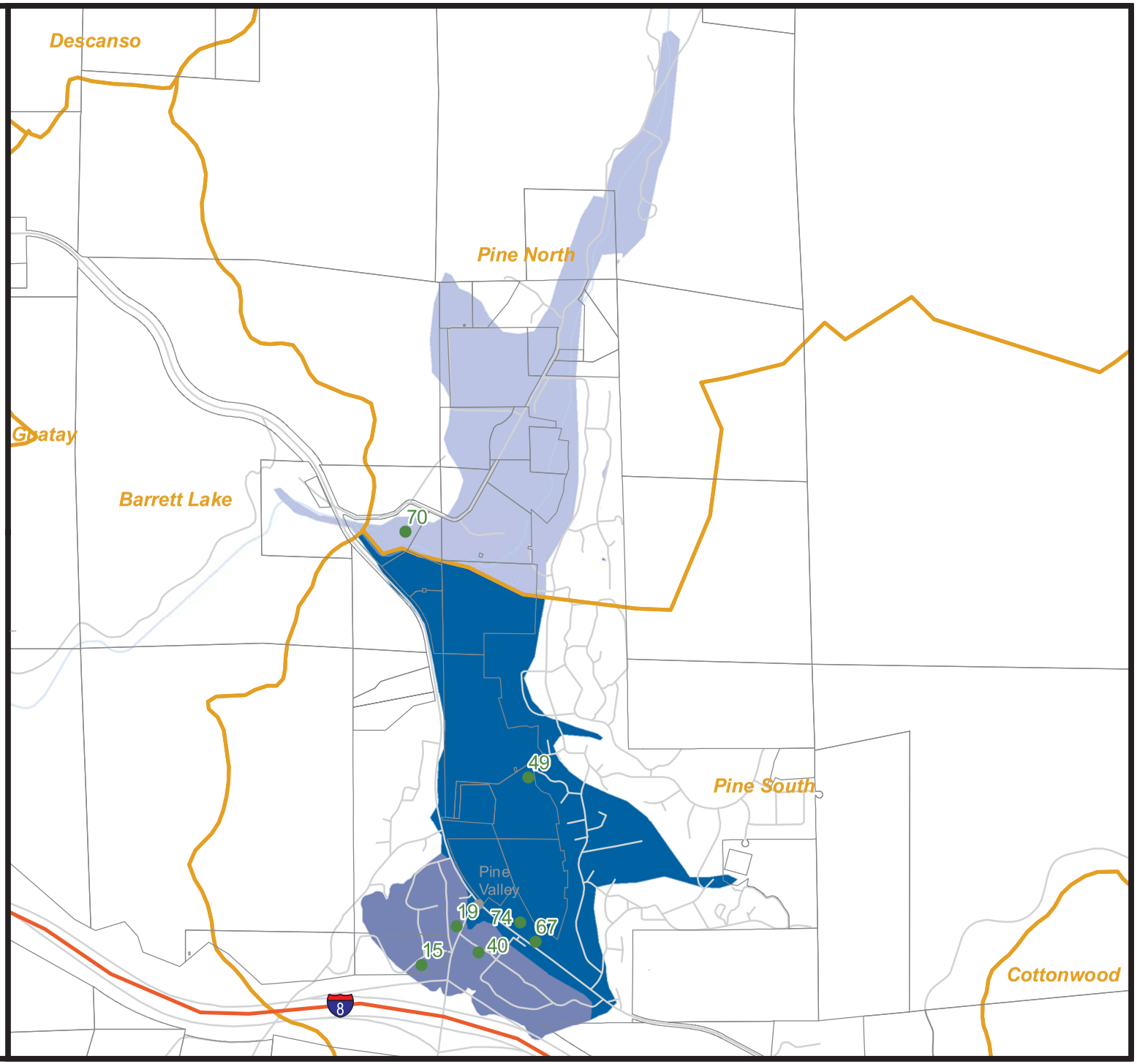
# Figure 10

## Saturated Residuum Thickness




- Communities
- Wells (Feet)
- Freeways
- Major Highways
- Roads
- Watershed Boundary
- Parcles ( >5ac )
- Rivers
- Ocean/Lakes

Residuum Thickness (Feet)

- 10
- 20
- 45

0 1,400 2,800
Feet

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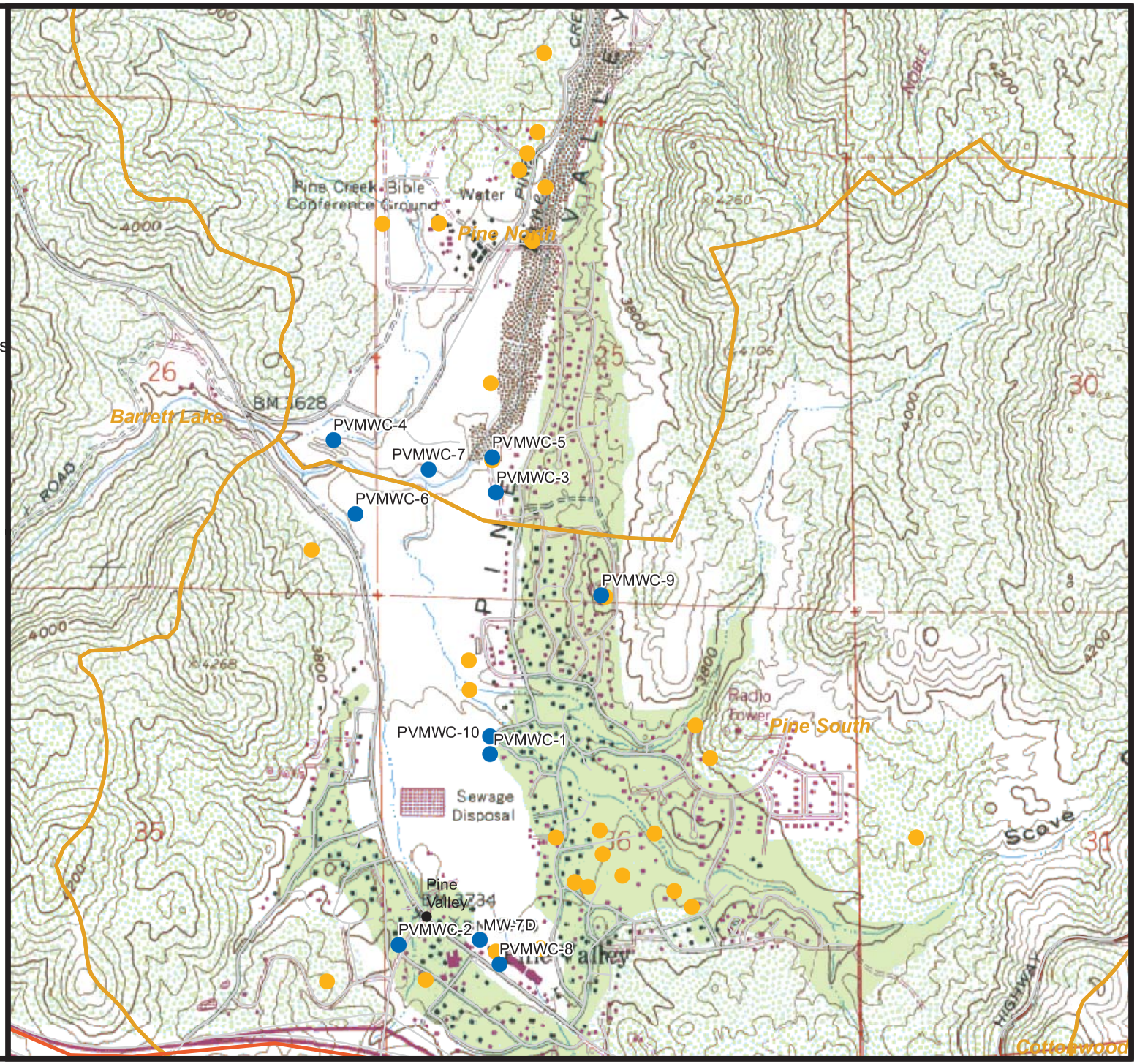
# Figure 11

## Well Inventory

- Wells
- DEH-Permitted Supply Wells
- Communities
- Freeways
- Major Highways
- Roads
- Watershed Boundary
- Rivers
- Ocean/Lakes

0 0.25 0.5
Miles

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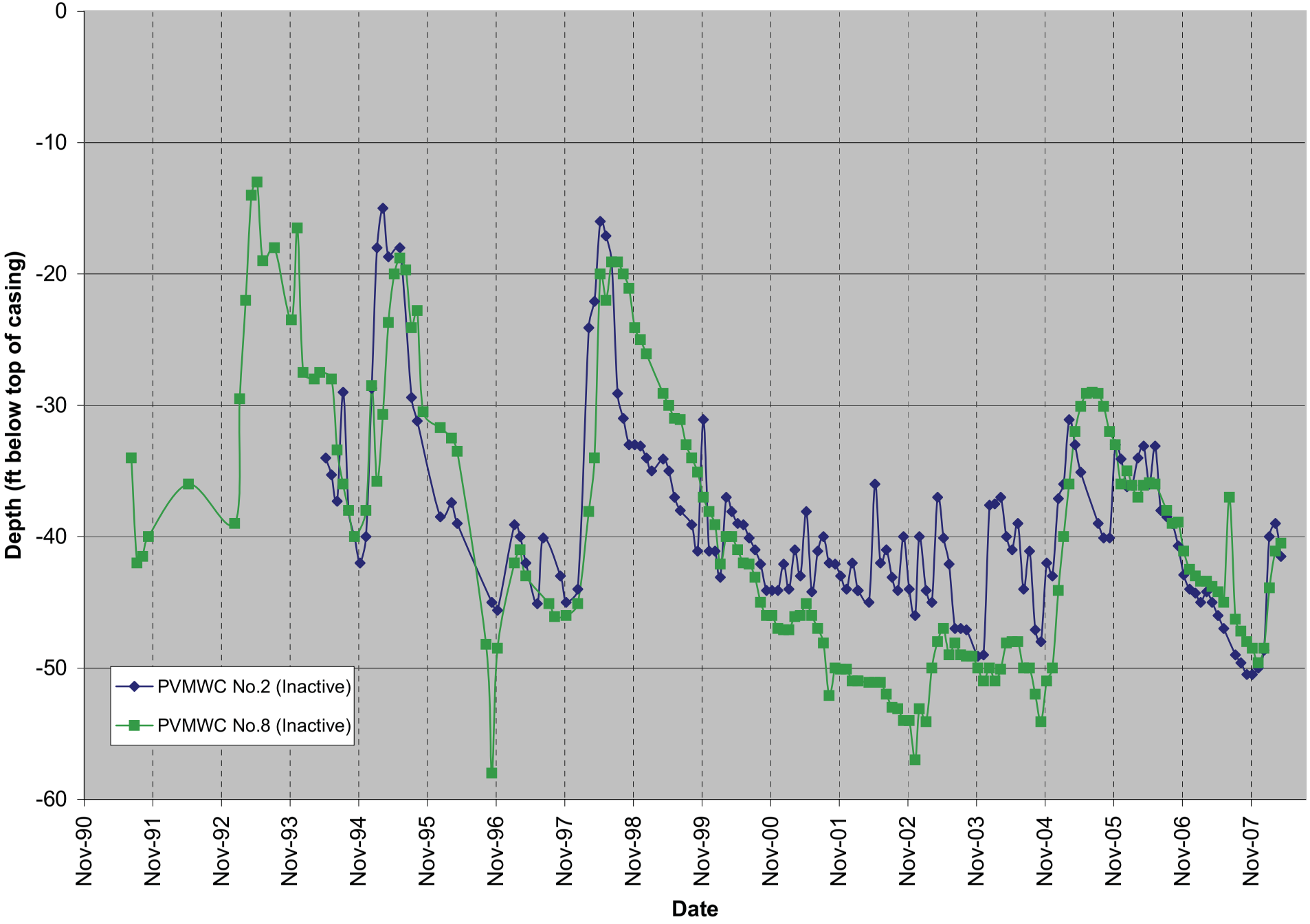
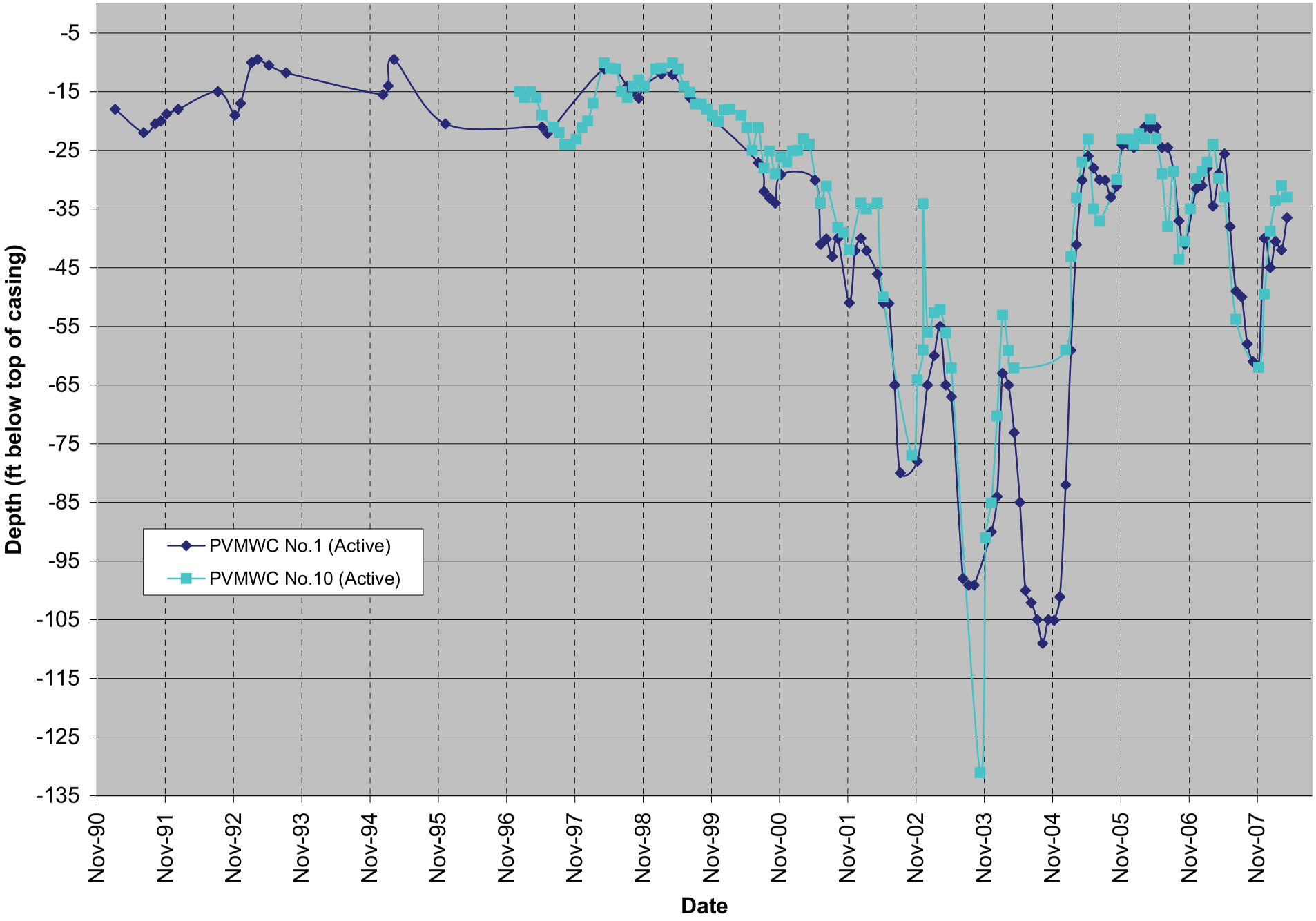
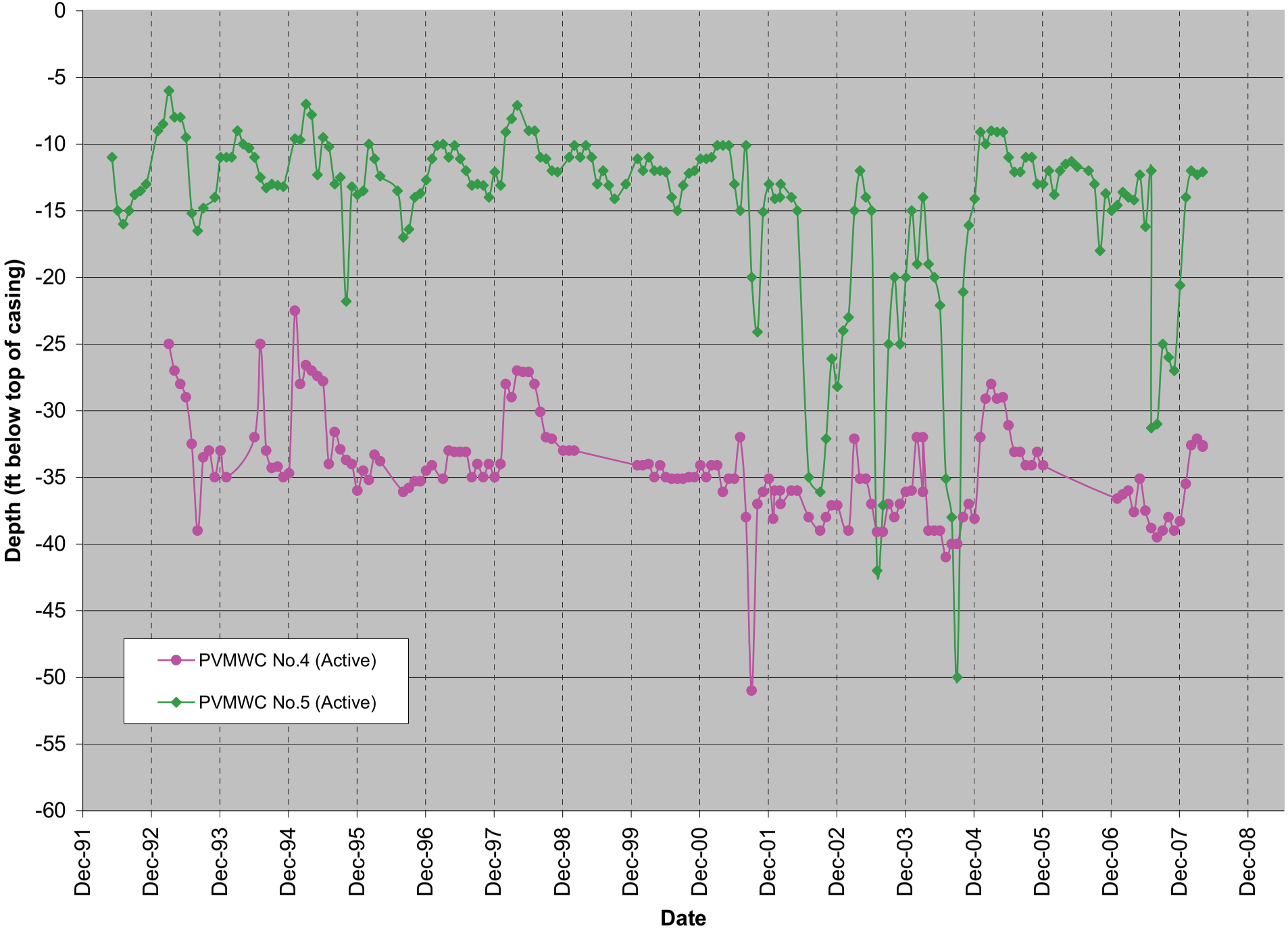
## Figure 12: Pine Valley Area 1 Well Hydrographs



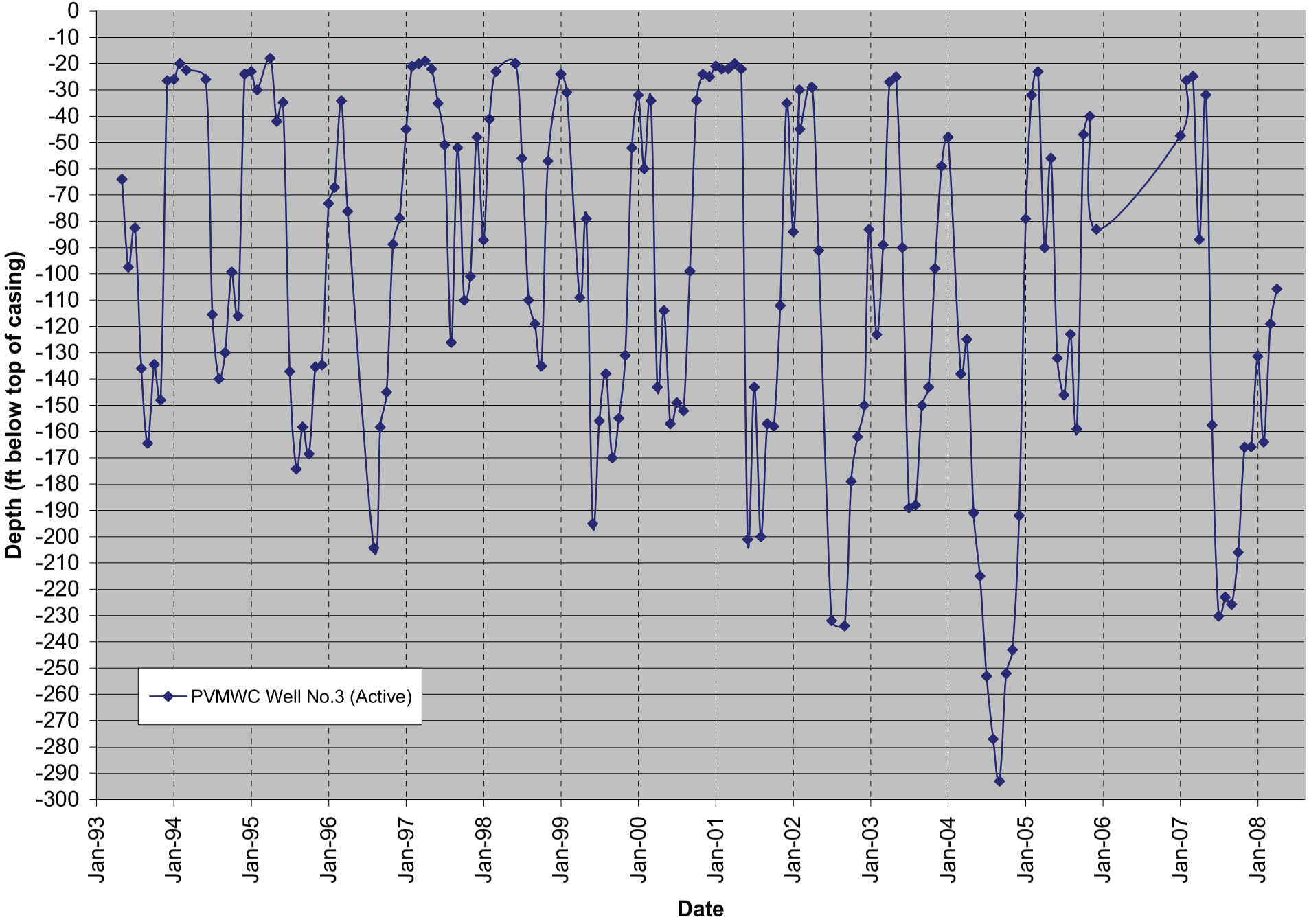
## Figure 13: Pine Valley Area 2 Well Hydrographs



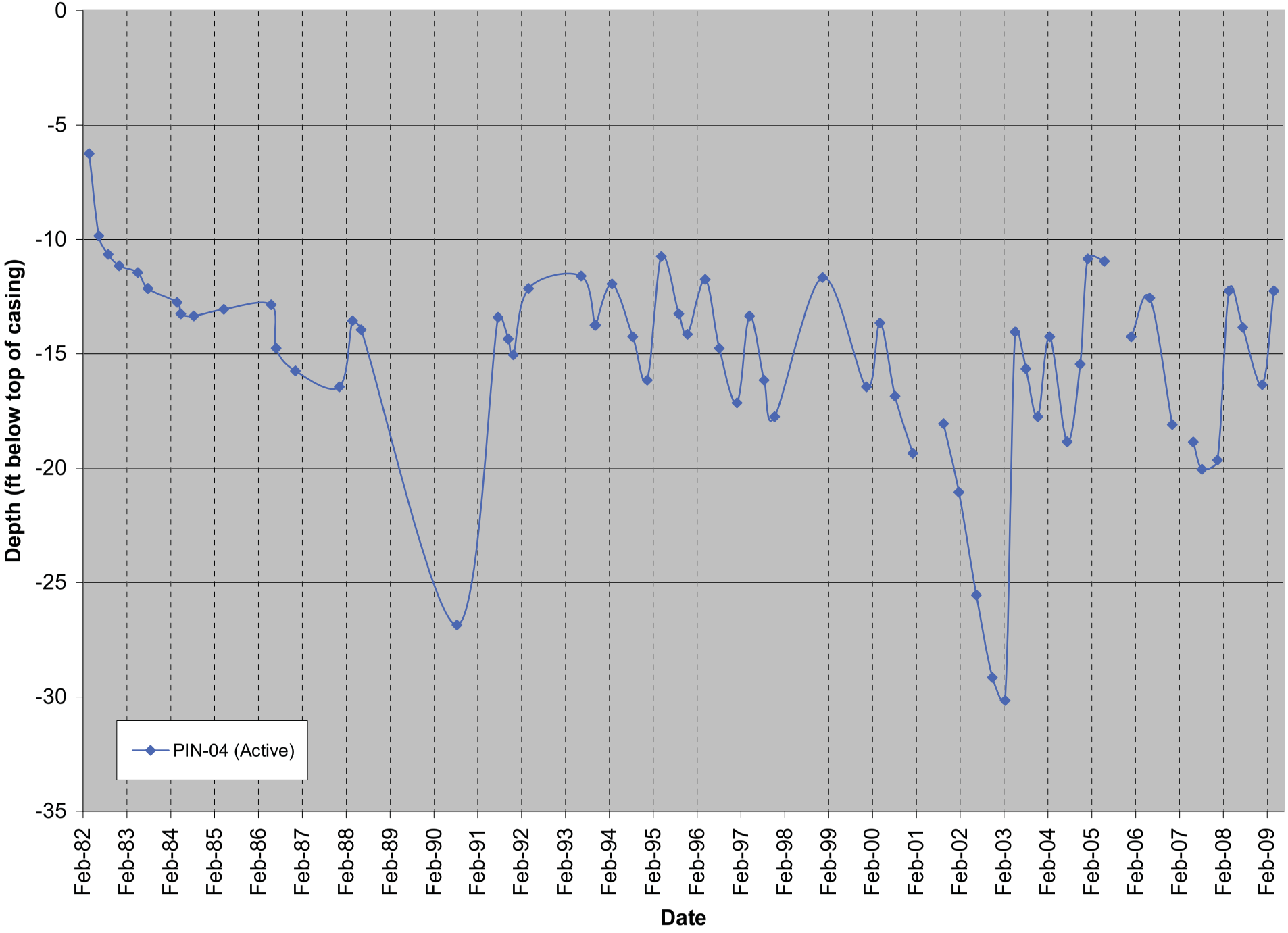
## Figure 14: Pine Valley Area 3 Well Hydrographs



## Figure 15: Pine Valley Area 4 Well Hydrographs



## Figure 16: Pine Valley Area 5 Well Hydrographs



# Figure 17

## Groundwater Elevation Comparison

Spring 1998 to Summer/Fall 2004

- Communities
- Freeways
- Major Highways
- Roads
- Watershed Boundary
- Parcles ( >5ac )
- Rivers
- Ocean/Lakes

Groundwater Drawdown (Feet)

- 0 to -25
- -25 to -50
- -50 to -75
- -75 to -100
- -100 to -125
- -125 to -150
- -150 to -175
- -175 to -200
- -200 to -225
- -225 to -250
- -250 to -275
- -275 to -300

0 800 1,600

Feet

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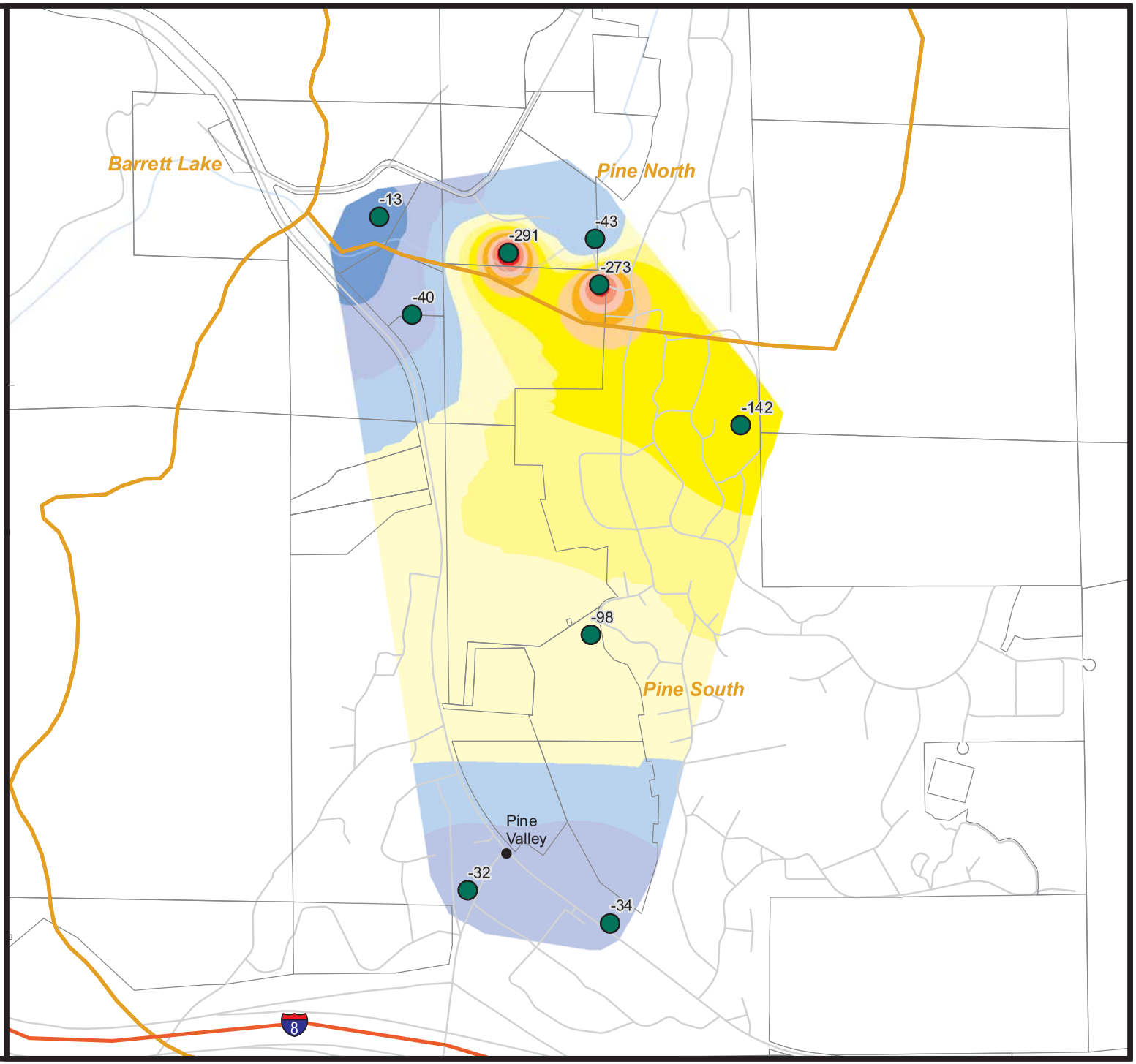
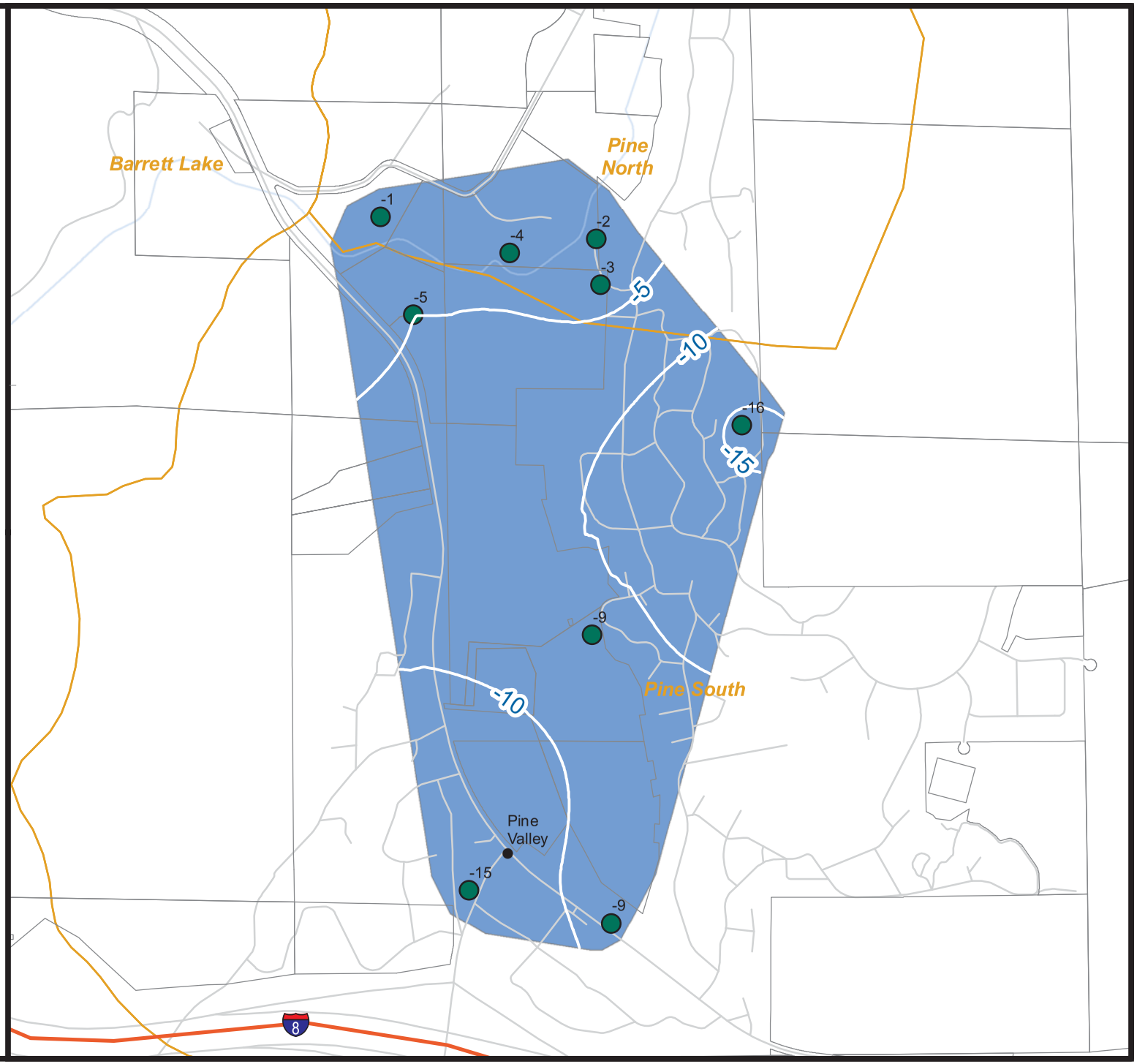


# Figure 18

## Groundwater Elevation Comparison

Spring 1998 to Spring 2005/2006




- Communities
- Freeways
- Major Highways
- Roads
- Watershed Boundary
- Parcles ( >5ac )
- Rivers
- Ocean/Lakes

Water Elevation Difference (Feet)

Groundwater Drawdown (Feet)

- 0 to -25

0 800 1,600

Feet

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# Figure 19

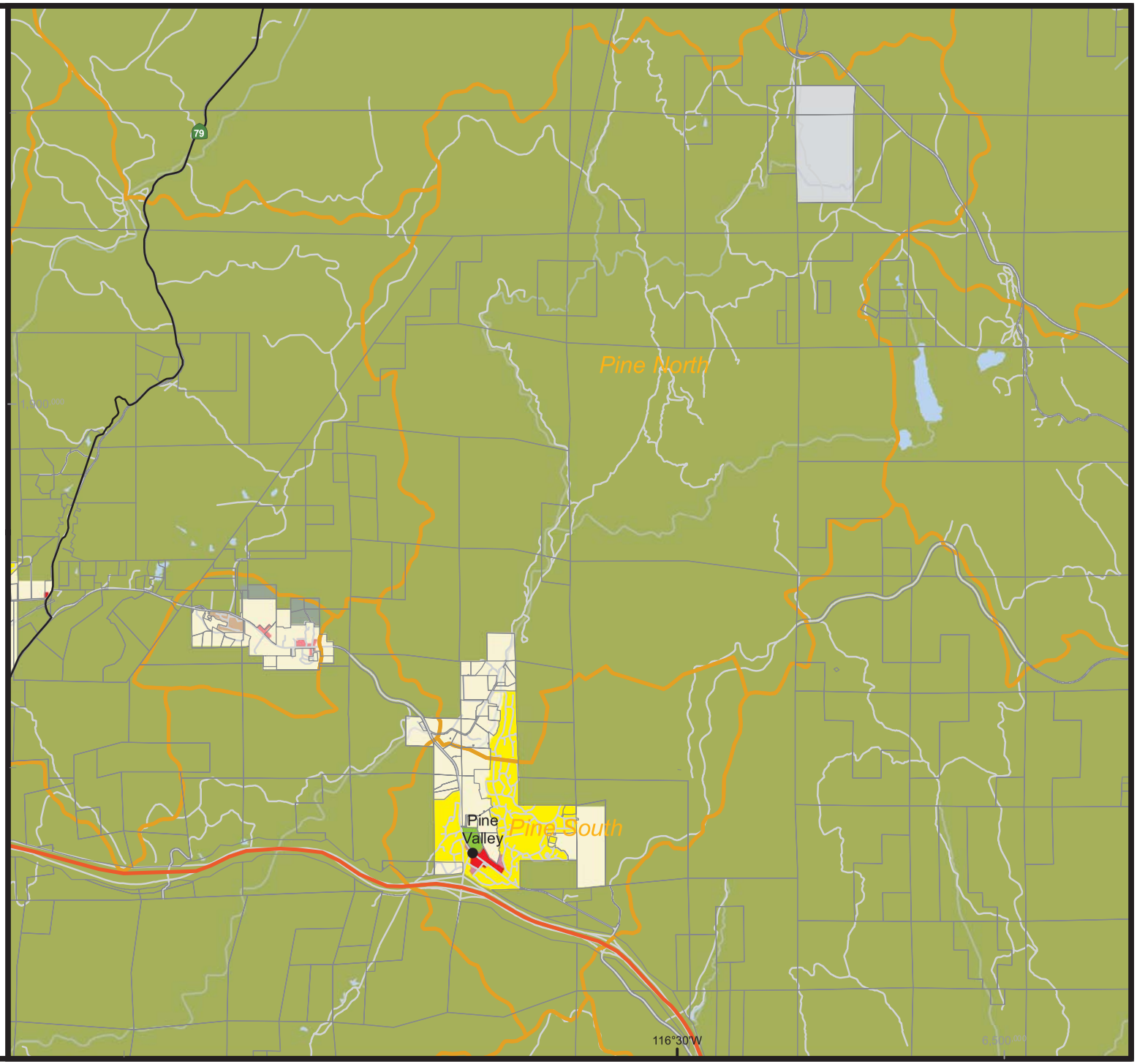
## Existing General Plan

- Communities
- Freeways
- Major Highways
- Roads
- Watershed Boundary
- Parcles ( >5ac )
- Rivers
- Ocean/Lakes

Existing General Plan

- Residential 1du/1,2,4 ac
- Residential 2du/ac
- Residential 4.3du/ac
- Office Professional
- Neighborhood Professional
- General Commercial
- Service Commercial
- Multiple Rural Use 1du/4,8,20ac
- Public/Semi-Public Land
- National Forest and State Park
- Indian Reservation

0 1 2
Miles

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# Figure 20

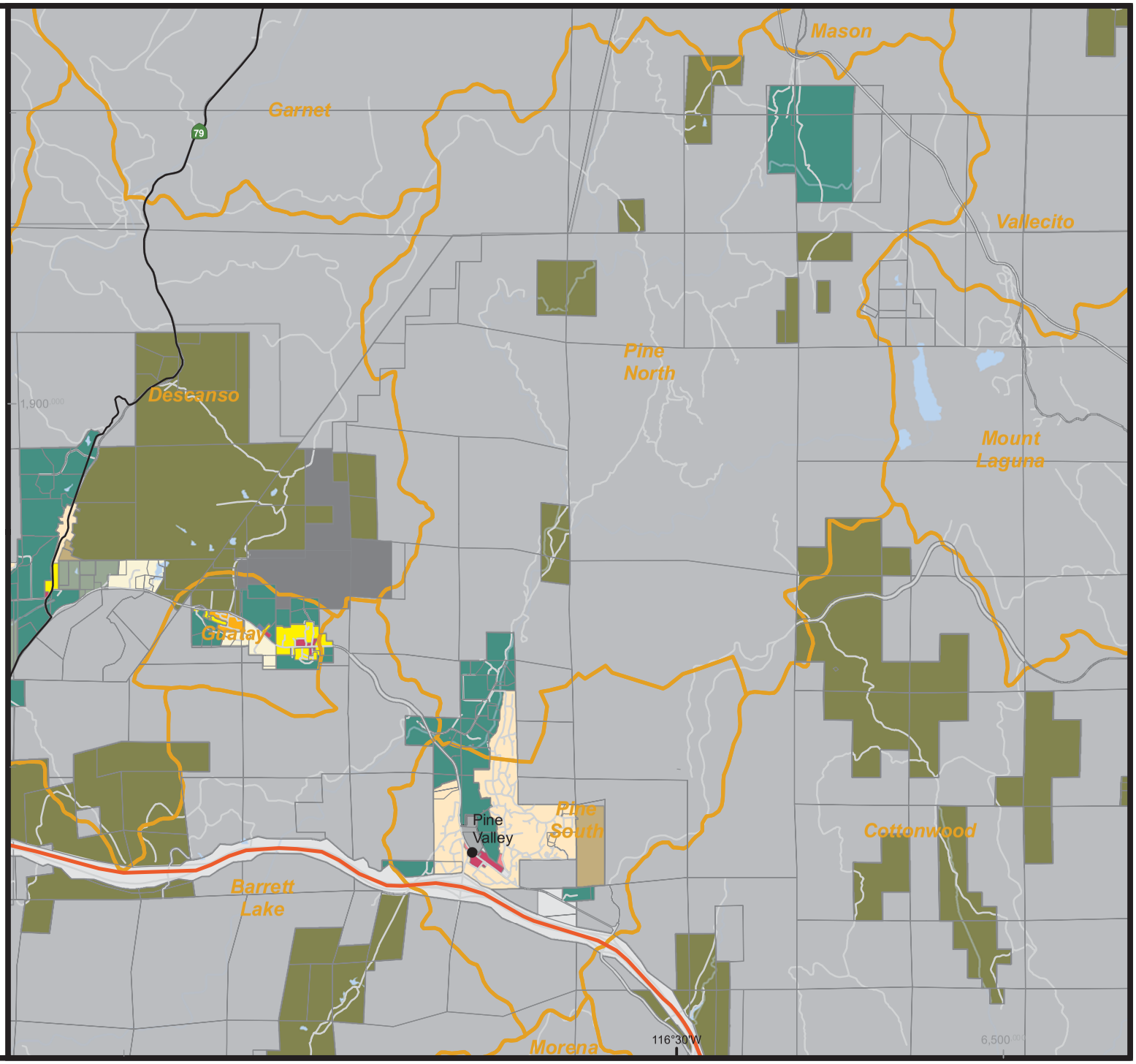
## Referral Map (July 2008)

- Communities
- Freeways
- Major Highways
- Roads
- Watershed Boundary
- Parcles ( >5ac )
- Rivers
- Ocean/Lakes

Draft Land Use August 2006

- Village Residential (VR-4.3)
- Village Residential (VR-2)
- Semi-rural Residential (SR-1)
- Semi-rural Residential (SR-2)
- Semi-rural Residential (SR-4)
- Semi-rural Residential (SR-10)
- Rural Lands (RL-40)
- Rural Lands (RL-40)
- Office Professional
- Rural Commercial
- Medium Impact Industrial
- Public/Semi-Public Lands
- National Forest & State Parks
- Open Space (Recreation)
- Open Space (Conservation)

0 1 2
Miles

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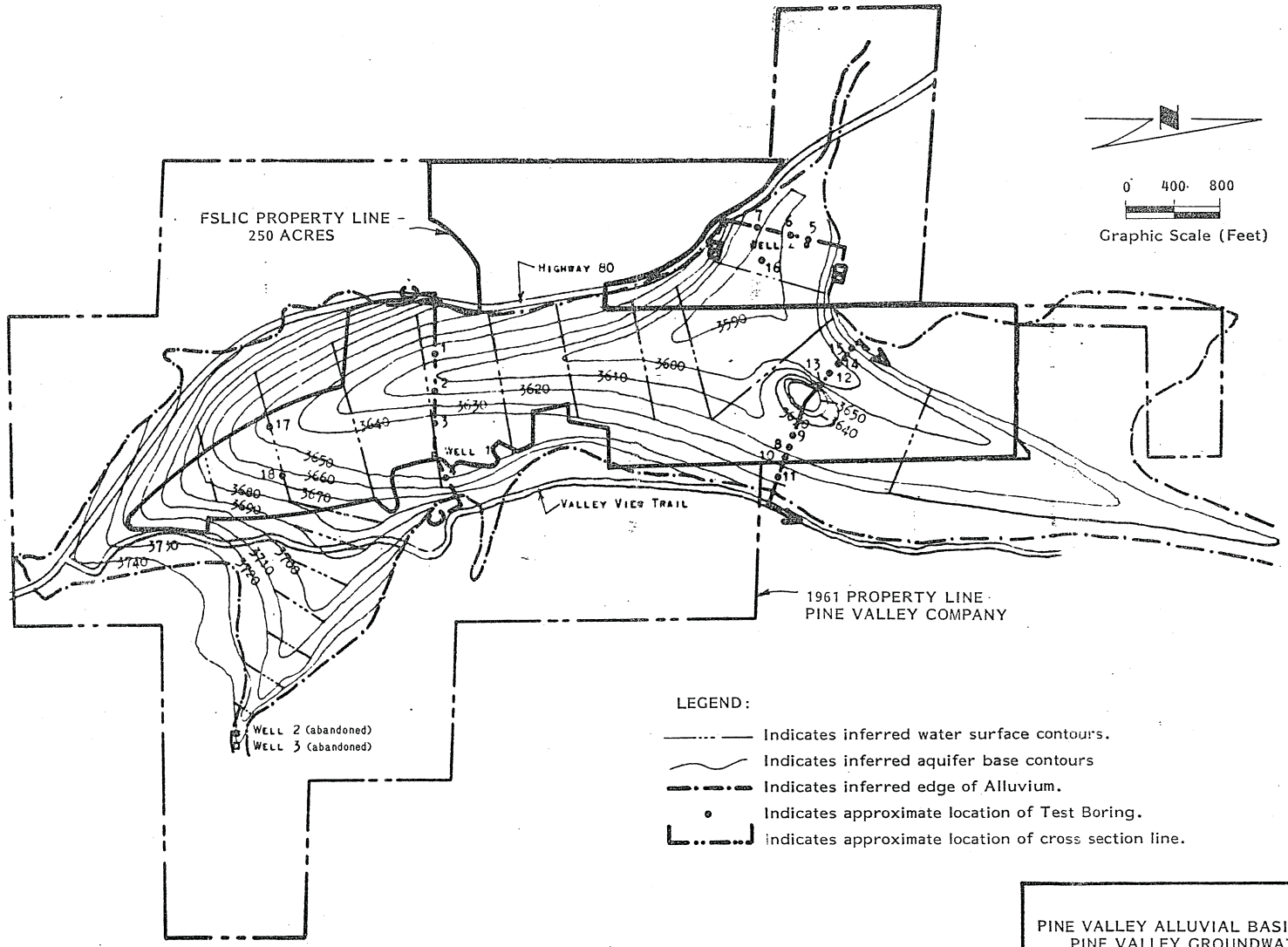
# *Attachment*

## *Select Data from Woodward, Clyde, Sherard, and Associates, 1961*




LEGEND:

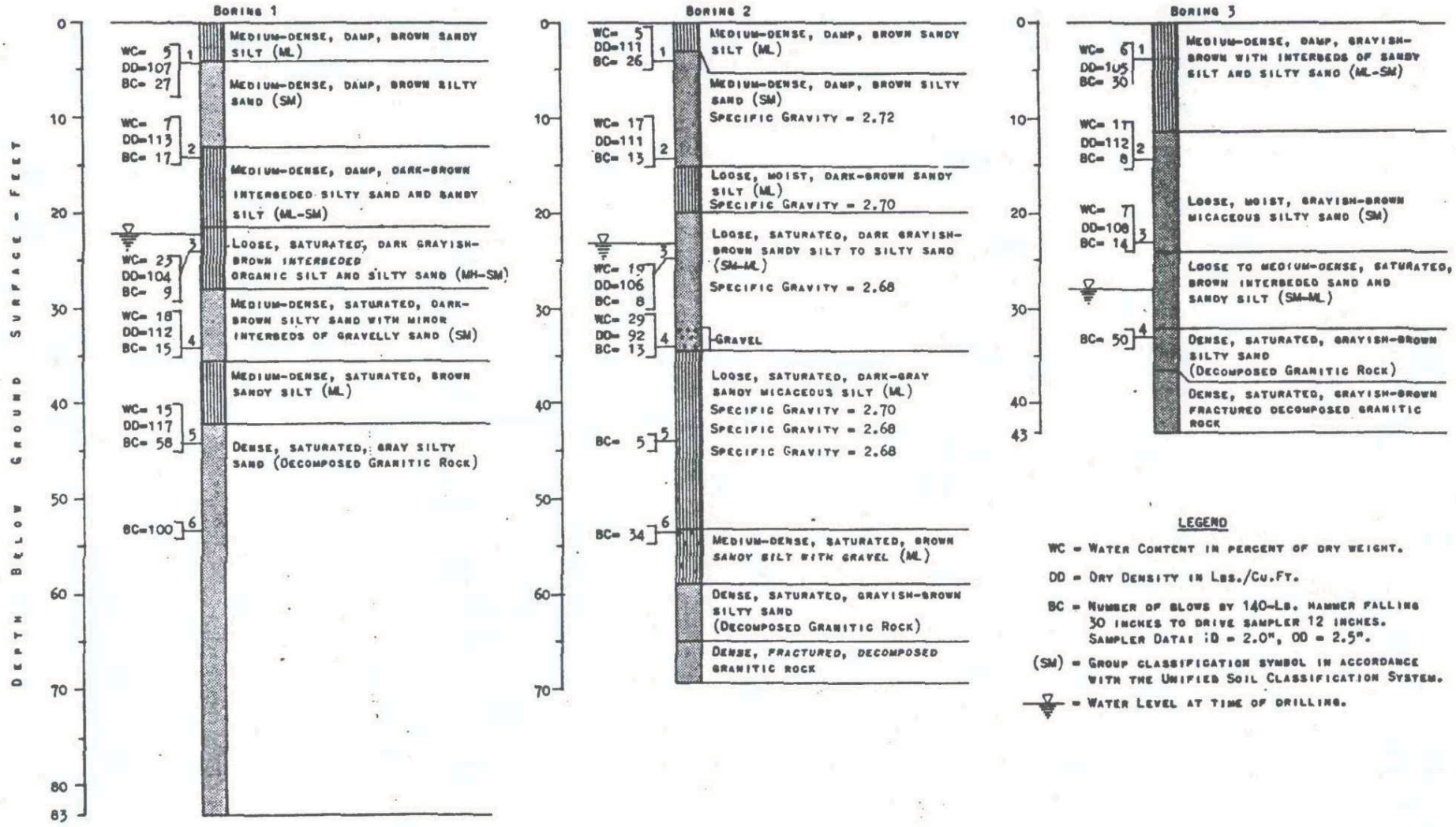
- Indicates inferred water surface contours.
- Indicates inferred aquifer base contours
- Indicates inferred edge of Alluvium.
- Indicates approximate location of Test Boring.
- Indicates approximate location of cross section line.

Source: Woodward, Clyde, Sherard and Associates, 1961, Job No. 61-245

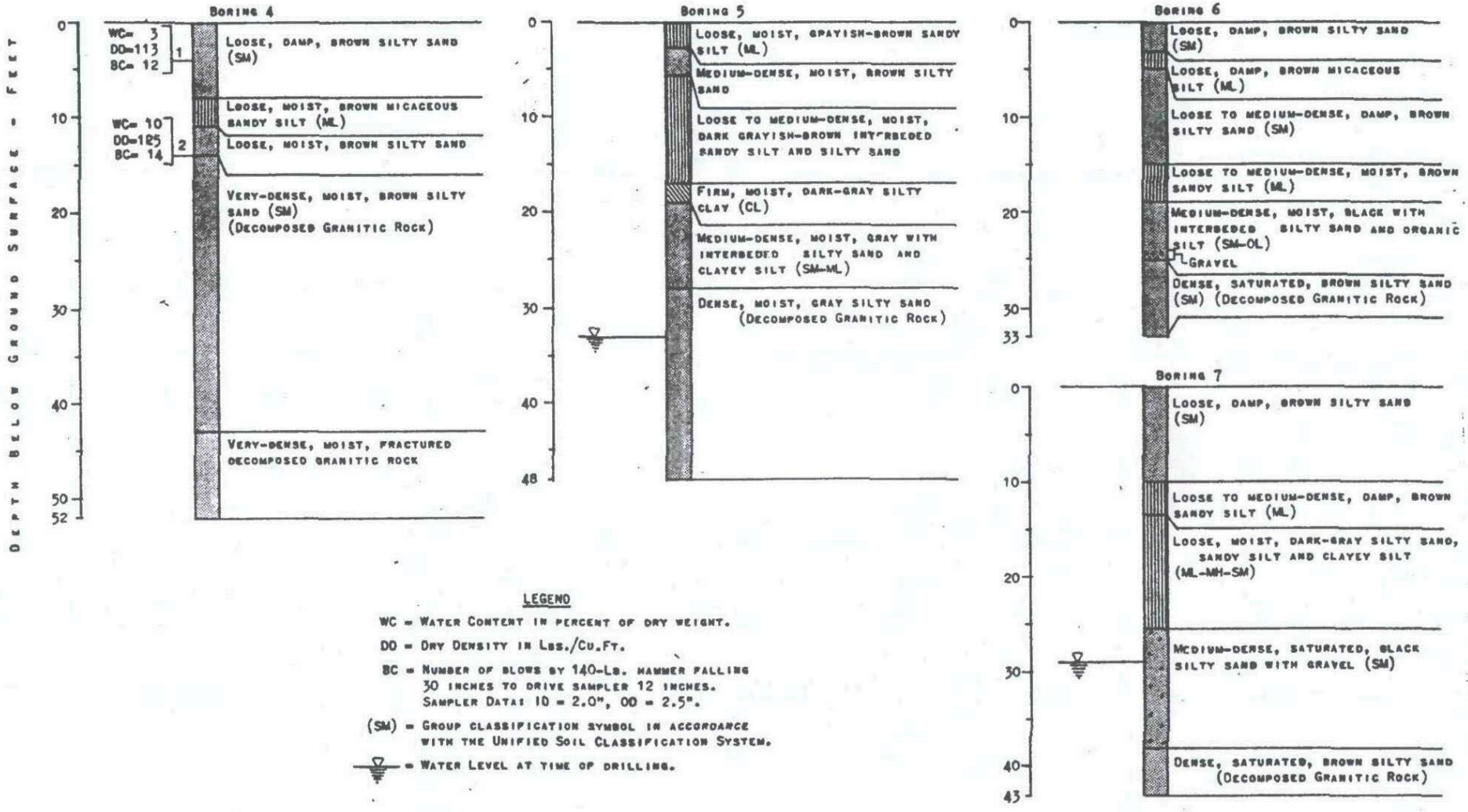
PINE VALLEY ALLUVIAL BASIN CONTOUR MAP
PINE VALLEY GROUNDWATER STUDY

| | | |
|---|---|---|
| DRAWN BY: ch | CHECKED BY: KJ | FIGURE NO: 4 |
| DATE: 3-22-85 | PROJECT NO: 55105K-0004 | |

WOODWARD-CLYDE CONSULTANTS




LOGS OF TEST BORINGS 1, 2 & 3
PINE VALLEY BASIN
JOB NO. 61-245




LEGEND

WC = WATER CONTENT IN PERCENT OF DRY WEIGHT.

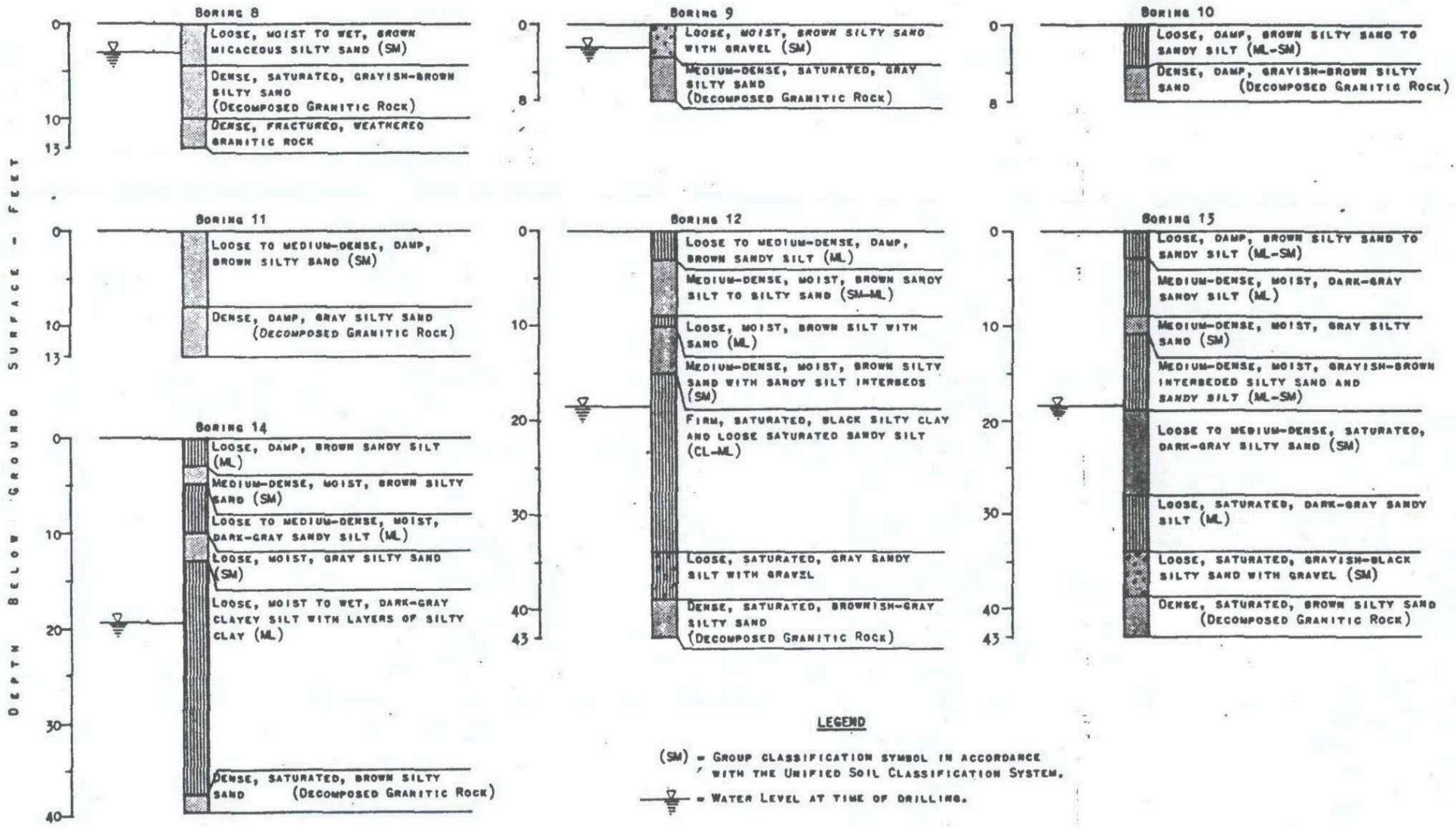
DD = DRY DENSITY IN LBS./CU.FT.

BC = NUMBER OF BLOWS BY 140-LB. HAMMER FALLING 30 INCHES TO DRIVE SAMPLER 12 INCHES. SAMPLER DATA: ID = 2.0", OD = 2.5".

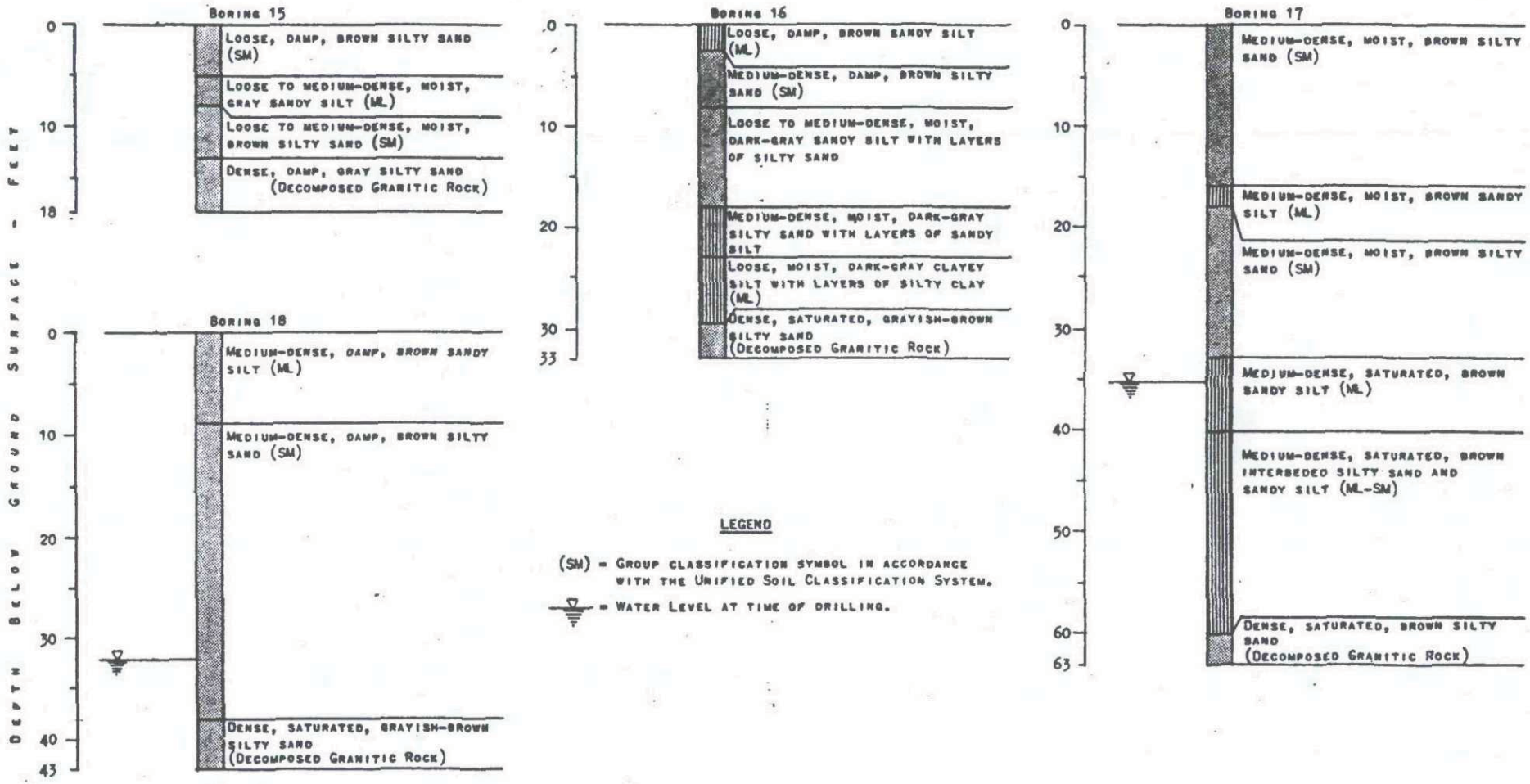
(SM) = GROUP CLASSIFICATION SYMBOL IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM.

▽ = WATER LEVEL AT TIME OF DRILLING.

LOGS OF TEST BORINGS 4, 5, 6 & 7
PINE VALLEY BASIN
JOB NO. 61-245

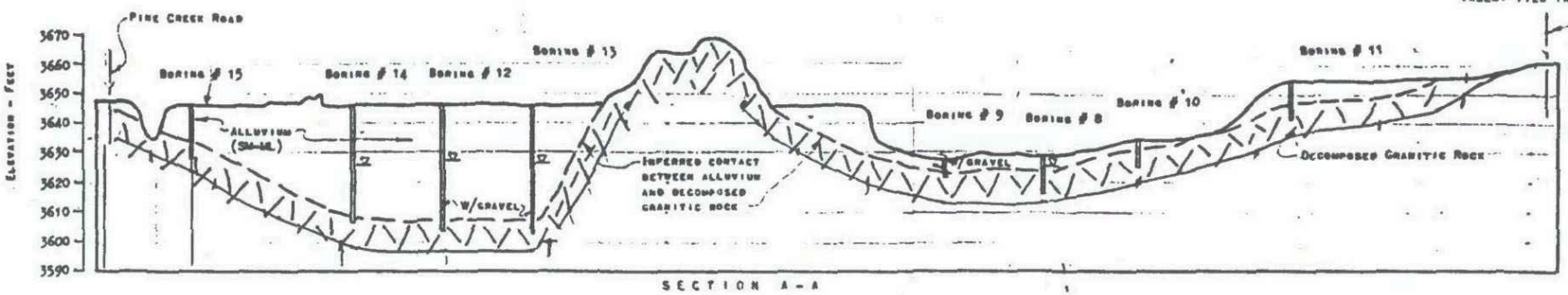



LOGS OF TEST BORINGS 8 THRU 14
PINE VALLEY BASIN
JOB NO. 61-245




LOGS OF TEST BORINGS 15 THRU 18
PINE VALLEY BASIN
JOB NO. 61-245

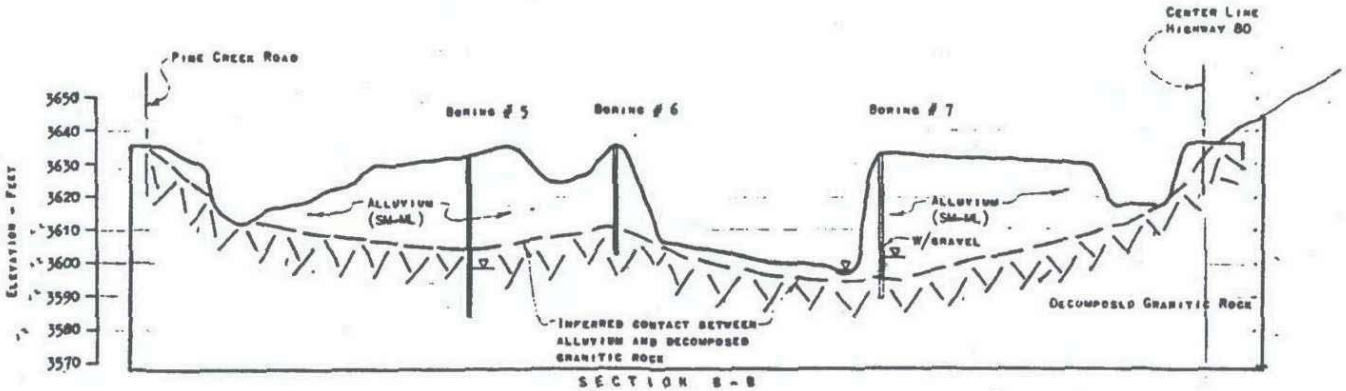
Fig. 7




SECTION A - A

Scale

Horizontal - 1"=100'
Vertical - 1"=30'




SECTION B - B

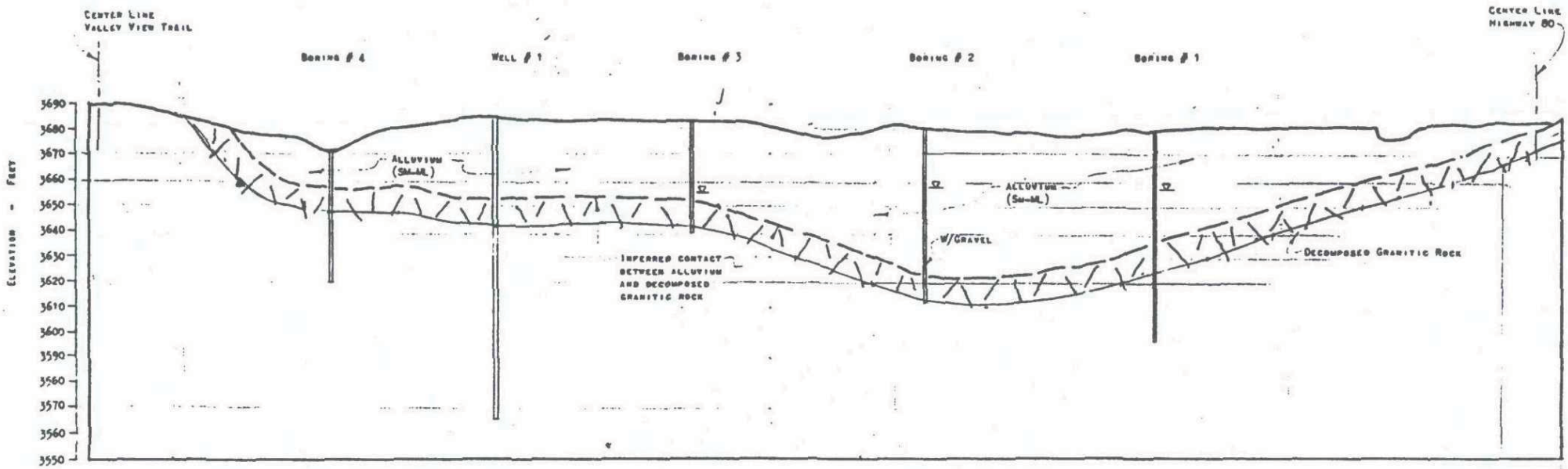
Scale

Horizontal - 1"=100'
Vertical - 1"=30'

0 30 60
Graphic Scale (Feet)

Cross Sections
Pine Valley Basin
Job No. 61-245

Fig.




SECTION C-C

Scale

Horizontal - 1"=100'
Vertical - 1"=30'

0 30 60
Graphic Scale (Feet)

Cross Section
Pine Valley Basin
Job No. 61-245