EXHIBIT "A"

SUPPLEMENTAL REPORT REGARDING PROPOSED ANTELOPE VALLEY AREA OF ADJUDICATION AND JURISDICTIONAL BOUNDARY FOR THE ANTELOPE VALLEY GROUNDWATER CASES

Supplemental Report Prepared on behalf of

Bolthouse Properties LLC and

Wm. Bolthouse Farms, Inc.

For the

Antelope Valley Groundwater Cases
Santa Clara Case No. 1-05-CV-049053

October 9, 2006

Prepared by

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Project No. 8029.001.0

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October 9, 2006
Project No. 8029.001.0-Task 8

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Subject: Submittal of Report Entitled Supplemental Report Regarding Proposed Antelope Valley Area of Adjudication and Jurisdictional Boundary for the Antelope Valley Groundwater Cases prepared on behalf of Bolthouse Properties LLC and Wm. Bolthouse Farms, Inc. for the Antelope Valley Groundwater Cases Santa Clara Case No. 1-05-CV-049053

Dear Mr. Zimmer:

In response to your request, Geomatrix Consultants, Inc. (Geomatrix), is pleased to submit our Supplemental Report Regarding Proposed Antelope Valley Area of Adjudication and Jurisdictional Boundary, prepared at your direction as a supplement to our June 28, 2006, report entitled Proposed Antelope Valley Area of Adjudication and Jurisdictional Boundary. Based on our studies, we are recommending a revised definition of the Area of Adjudication and Jurisdictional Boundary for the court to use in pursuing the Antelope Valley Groundwater Cases.

I trust that the enclosed report will meet your needs. It has been our pleasure to provide these consulting services to you. If you have any comments, or if we can be of additional service, please call.

Sincerely yours,
GEOMATRIX CONSULTANTS, INC.

N. Thomas Sheahan, PG, CEG, CHG, PGP, CPG
Vice President and Principal Hydrogeologist

NTS/s

Enclosure: **Supplemental Report Regarding Proposed Antelope Valley Area of Adjudication and Jurisdictional Boundary for the Antelope Valley Groundwater Cases, dated October 9, 2006**

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October 9, 2006

1.0 INTRODUCTION

Geomatrix Consultants, Inc. (Geomatrix), previously submitted a report entitled Proposed Antelope Valley Area of Adjudication and Jurisdictional Boundary, dated June 28, 2006 (Geomatrix 2006a), for the Antelope Valley Groundwater Cases. This report supplements that previously-submitted report, considers additional factors, and proposes a revised Area of Adjudication and Jurisdictional Boundary for the Antelope Valley Groundwater Cases. Furthermore, this supplemental report addresses specific issues concerning the interrelationships of surface water and groundwater raised by the court in this matter and provides additional evidence requested by the court.

A recent decision was handed down by Hon. Jack Komar on the Motion by the United States for Judgment on the Pleadings (Komar Decision)[1]. The Komar Decision discusses the "groundwater basin" (basin)[2] and the Area of Adjudication, and concludes that additional evidence is needed concerning the interrelationships between surface water and groundwater in the Antelope Valley (Valley) and vicinity. The Komar Decision states:

> "In sum, evidence is needed regarding (1) the hydrology of the basin, including regarding surface water and groundwater, (2) the hydrology of the area outside the basin but within the watershed, and (3) the extent of the interrelationship between the two." (Komar Decision, p. 12, Lines 21-23.)
>
> "With this evidence, a determination may be made as to whether there are sufficiently interlocking or correlative rights between those who are already a part of this action, and those who the United States contends should be joined in the action, *e.g.*, those claiming rights in the surface streams and in the watershed as a whole." (Komar Decision, p. 12, Lines 23-27)
>
> "To the extent the hydrology supports an assumption that there may be interlocking or correlative rights regarding groundwater in the basin and other water, this action should be expanded as suggested by the United States." (Komar Decision, p. 12, Lines 27-28, and p. 13, Line 1)

This supplemental report provides additional information regarding the specific issues raised in the Komar Decision, considers the nature and extent of the "groundwater basin," addresses the interrelationships between surface water and groundwater, presents the bases for determining the Antelope Valley Area of Adjudication and the Jurisdictional Boundary for the Antelope Valley Groundwater Cases, and presents a map (included as Figure 10) showing the revised proposed Antelope Valley Area of Adjudication and the Jurisdictional Boundary that encloses that area. I incorporate by reference into this supplemental report the information presented in the previous Geomatrix report (Geomatrix, 2006a).

[1] Order after Hearing re Motion by the United States for Judgment on the Pleadings, Superior Court of California, County of Los Angeles, Judicial Council Coordination Proceeding No. 4408, Hon. Jack Komar, September 22, 2006.

In addition to the text of this supplemental report, I have included two Attachments. Both Attachments are identified and discussed within this supplemental report, and incorporated herein by reference.

- Attachment A, References, presents a list of references cited in this supplemental report.

- Attachment B, Figures, presents the figures referenced in this supplemental report. For consistency with my June 28, 2006, report (Geomatrix 2006a), which included seven figures, I have continued the figure numbering system from that report in this supplemental report. Thus, the figure numbers in this supplemental report begin with Figure No. 8.

To understand the various aspects of the Antelope Valley and the bases for our recommendations, it is important to have definitions of certain key terms and phrases. Where each of the key terms or phrases first appears in the text below, we have included a definition of that term either in the text or as a footnote. Definitions of terms presented in our June 28, 2006, report (Geomatrix, 2006a) are incorporated herein by this reference, and in some instances are further defined.

2.0 OBJECTIVES

One objective of this supplemental report is to provide additional information regarding (1) the hydrology and hydrogeology of the groundwater basin, including information regarding surface water and groundwater interactions, (2) the hydrology and hydrogeology of the area outside of the alluvial aquifer portion of the basin but within the watershed, and (3) the extent of the interrelationship between the two. A second objective is to further support and define the Antelope Valley Area of Adjudication. Consistent with that second objective, it is also an

[2] Note that the lateral and vertical extent, the boundary line, and the specific characteristics of the "groundwater basin" for the Antelope Valley area have not yet been established by the Court in the Antelope Valley Groundwater Cases.

objective of this supplemental report to define the Jurisdictional Boundary for the Antelope Valley Groundwater Cases.

3.0 GENERAL CONSIDERATIONS

<u>3.1 General Criteria for Area of Adjudication</u>

The Area of Adjudication must be as small as reasonably possible to minimize the number of parties and properties that must be brought before the court in this matter; however, the Area of Adjudication must be sufficiently large to include (1) all of the area that might ultimately be determined to be the “groundwater basin” in the Antelope Valley and (2) all of the water resources that either affect the groundwater or would be affected by pumping of groundwater.

The definition of the “Antelope Valley Groundwater Basin” has not yet been decided by the court, and is beyond the scope of this report; however, to define the Antelope Valley Area of Adjudication, it is important to have a general understanding of the nature, the lateral and vertical extent, and the surface area that overlies the yet-to-be-determined Antelope Valley Groundwater Basin.

To avoid confusion in selecting the Area of Adjudication, however, it is important to understand that the Antelope Valley Groundwater Basin to be defined later by the court, should not be arbitrarily constrained to be limited to just the alluvial aquifer system in the Antelope Valley, as has been suggested by others. The fractured bedrock aquifer system in the Valley is also an important source of groundwater and should also be included within the Antelope Valley Groundwater Basin. Furthermore, due to the interrelationships between the surface water in streams, ponds, lakes, and reservoirs within the watershed of the Antelope Valley, the Area of Adjudication must also include those areas where surface water bodies feed the groundwater system, and where groundwater feeds the surface water bodies.

3.2 Definition of "Groundwater Basin"

It is good to start this discussion with a definition of the term "groundwater basin." One of the better presentations of the definition of the term "groundwater basin" is included in the attorney's reference book *California Water Law and Policy*[3] (Slater, 2006). The paragraphs below are direct quotations from this reference.

> "The term 'ground-water basin' is loosely defined and may have different meanings in different contexts. It is generally accepted to imply an area 'containing a groundwater reservoir capable of furnishing a substantial supply.' For lack of a better definition, the term is used herein as a 'hydrologic unit containing one large aquifer or several connected and interrelated aquifers.'" (Slater, 2006, p. 11-11) (Emphasis added)
>
> "As a conceptual aid, aquifers can be visualized as natural underground storage units. As with their surface water counterparts, water flows out of the underground reservoir by gravity and, like surface reservoirs, the underground aquifer is replenished naturally or artificially by percolation or subsurface infiltration." (Slater, 2006, p. 11-13) (Emphasis Added)

This definition is based in part on, and consistent with, the definition of "groundwater basin" published by Dr. David Keith Todd, PE, in his textbook (three editions) entitled *Groundwater Hydrology*, widely acclaimed by professional hydrogeologists for over 25 years as the most definitive reference work on the subjects of hydrogeology and groundwater resources.[4] Four important aspects of this general definition are worth noting.

- First, a groundwater basin is actually not an area, but instead is a three-dimensional unit containing hydrogeologically connected aquifer materials of various material types (*e.g.*, the alluvial aquifer materials and fractured rock aquifer materials).

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[3] Slater, Scott S., 2006. *California Water Law and Policy*, Vols. 1 & 2, Matthew Bender & Company, Inc., a member of the LexisNexis Group, Publication 83013, Release 11, June 2006 (Slater, 2006).
[4] Todd, D.K., 2005, 1980, 1959. *Groundwater Hydrology*. John Wiley & Sons, Inc., First Ed. 1959, Second Ed. 1980, Third Ed. 2005.

- Second, a groundwater basin may consist of multiple groundwater-related formations or aquifer systems (*e.g.*, alluvial aquifers and fractured-rock aquifers).[5]

- Third, there is no requirement that the formations within a groundwater basin be fully saturated, because they must allow for recharge of water by both natural and artificial means.

- Fourth, there is no requirement that the groundwater basin be hydrogeologically separated from adjacent groundwater basins.

This definition, although general, is sufficient for use in defining the full extent of the Antelope Valley Groundwater Basin, is widely accepted in the water-resources industry, and suitable for use in this matter.

Because the term "ground-water basin" may have different meanings in different contexts, one must be very cautious in selecting, as the definition for a current purpose, any previous definition of "groundwater basin," especially a definition for a specific, limited, or different purpose. As one example example, for convenience in developing digital computer models, persons performing modeling studies may limit their defined "groundwater basin" to only a select few subbasins, rather than an entire "groundwater basin." Other studies, for reasons of convenience or simplicity, may focus only on one type of aquifer material, such as unconsolidated alluvial aquifers, rather than to deal with the more correct but more complex situation of hydrogeologic interaction among multiple types of aquifers (*e.g.*, fractured-rock aquifers and alluvial aquifers) within the same "groundwater basin." As an example of a limited definition focusing only on one type of aquifer material, the California Department of Water Resources chose to limit its definition of "groundwater basin" in its Bulletin 118, Update 2003, to only the unconsolidated alluvial materials. The limited DWR definition is presented below.

[5] Note that the State of California, Department of Water Resources (DWR), Bulletin 118, Update 2003 (DWR 118-2003) defines groundwater basins to be only the alluvial aquifer systems, but this limited definition is for the specific purposes of that document, and not intended to be controlling in situations such as groundwater adjudication proceedings in court.

> "A groundwater basin is defined as an <u>alluvial</u> aquifer or a stacked series of <u>alluvial</u> aquifers with reasonably well-defined boundaries in a lateral direction and a definable bottom." (DWR 118-2003, P. 88) (Emphasis added)

One reason that DWR chose to use such a limited definition of "groundwater basin" in this document appears to be the simplicity of selecting boundaries using certain available maps.

> "Specifically the identification of the groundwater basins was initially based on the presence and areal extent of unconsolidated <u>alluvial</u> sediments identified on 1:250,000 scale, geologic maps published by the California Department of Conservation, Division of Mines and Geology." (DWR 118-2003, Appendix G)

Another reason appears to be that DWR chose to be consistent with the limited definition used in the previous versions of its Bulletin 118.

> Areas of groundwater production from consolidated rocks were not defined in previous versions of Bulletin 118 and are not included in this update." (DWR 118-2003, p. 92)

Notwithstanding its use of only a limited definition for "groundwater basin," DWR makes clear that it is fully aware of the importance of considering consolidated rock aquifer systems in groundwater management in California. In Bulletin 118, Update 2003, DWR takes special care to point this out, as shown in the following quotations.

> Groundwater in California is also found outside of alluvial groundwater basins. Igneous extrusive (volcanic), igneous intrusive, metamorphic, and sedimentary rocks are all potential sources of groundwater. These rocks often supply enough water for domestic use, but in some cases <u>can also yield substantial quantities</u>." (DWR 118-2003, p. 90) (Emphasis added)

> "Groundwater in igneous intrusive, metamorphic, and consolidated sedimentary rocks occurs in fractures resulting from tectonism and expansion of the rock as overburden pressures are relieved. <u>Groundwater is extracted from fractured rock in many of the mountainous areas of the State, such as the Sierra Nevada, the Peninsular Range, and the Coast Ranges.</u>" (DWR 118-2003, p. 92) (Emphasis added)

> "<u>As population grows in areas underlain by these rocks, such as</u> the foothills of the Sierra Nevada and <u>southern California mountains, many new wells are being built in fractured rock</u>.

> However, groundwater data are often insufficient to accurately estimate the long term reliability of groundwater supplies in these areas. Additional investigation, data evaluation, and management will be needed to ensure future sustainable supplies. The Legislature recognized both the complexity of these areas and the need for management in SB 1938 (2002), which amended the Water Code to require groundwater management plans with specific components be adopted for agencies to be eligible for certain funding administered by DWR for construction of groundwater projects." (DWR 118-2003, p. 92) (Emphasis added)

For purposes of the Antelope Valley Groundwater Cases, it is important for the court to not arbitrarily limit its definition of the Antelope Valley Groundwater Basin to just the alluvial aquifer system, but to allow consideration of the other aquifer systems in the Valley, also.

Keeping the broader definition of "groundwater basin" in mind, it is next appropriate to consider the geologic formations (aquifers) that should be considered for inclusion within the Antelope Valley Groundwater Basin. Information on the two major Antelope Valley aquifer systems is presented in the following section.

4.0 GROUNDWATER FORMATIONS IN THE ANTELOPE VALLEY

4.1 Alluvial Aquifer System

The largest portion of the Antelope Valley is underlain by unconsolidated alluvial deposits of Quaternary age, consisting of clay, silt, sand, and gravel. Figure 8 shows the areal extent of the Antelope Valley Alluvial Aquifer system, as defined by DWR. Coarser-grained portions of the alluvium that are saturated with groundwater provide the principal aquifers for development of groundwater by wells in the Antelope Valley; however, the unsaturated, upper portion of the alluvium serves as the zone of potential storage of water to be recharged by natural or artificial means to the Antelope Valley. Thus, the groundwater basin must include the full thickness of the Antelope Valley Alluvium, whether currently saturated or not.

4.2 Fractured Bedrock Aquifer System

Consolidated, fractured bedrock makes up the San Gabriel Mountains and the Tehachapi Mountains along the southwestern and northwestern boundaries, respectively, of the Antelope Valley. On Figure 8, fractured bedrock is present nearly everywhere within the Antelope Valley watershed boundary outside of the boundary of the alluvium. Fractured bedrock also underlies the alluvium throughout the Valley within the watershed boundary, and there are occasional occurrences of the bedrock protruding through the alluvium within the central portion of the Valley (Figure 8). The consolidated bedrock is principally composed of fractured granitic rocks, but includes meta-sediments such as limestone and dolomite with occasional intrusive volcanic rocks.

5.0 SURFACE-WATER/GROUNDWATER INTERRELATIONSHIPS

5.1 Precipitation and Recharge

Precipitation is the principal source of water for natural recharge of the groundwater systems in the Antelope Valley. Although annual average precipitation in the central and eastern portions of the Antelope Valley is relatively small, there is a significant amount of precipitation that occurs in the mountainous areas within the watershed along the southwestern and northwestern boundaries of the Antelope Valley, within the San Gabriel Mountains and the Tehachapi Mountains, respectively. Winter precipitation occurs in both the San Gabriel and Tehachapi Mountains; summer precipitation, resulting from monsoonal storms, occurs in the Tehachapi Mountains along the northwestern border of the Valley.

5.2 Surface-Water/Groundwater Interactions

The interaction between surface water and groundwater is well known and commonly accepted in the profession of hydrogeology. The following statement by the California Department of

Water Resources in its recent Bulletin 118, Update 2003 (DWR 118-2003), acknowledges the importance of this aspect.

> "This bulletin [DWR 118-2003] focuses on groundwater resources, but in reality groundwater and surface water are inextricably linked in the hydrologic cycle. As an example, groundwater may be recharged by spring runoff in streams, but later in the year the base flow of a stream may be provided by groundwater. So, although the land surface is a convenient division for categorizing water resources, it is a somewhat arbitrary one. <u>It is essential that water managers recognize and account for the relationship between groundwater and surface water in their planning and operations</u>." (DWR 118-2003, p. 20) (Emphasis added)

> "Groundwater and surface water bodies are connected physically in the hydrologic cycle. For example, at some locations or at certain times of the year, water will infiltrate the bed of a stream to recharge groundwater. At other times or places, groundwater may discharge, contributing to the base flow of a stream. <u>Changes in either the surface water or groundwater system will affect the other, so effective management requires consideration of both resources</u>." (DWR 118-2003, p. 81) (Emphasis added)

Part of the precipitation along the mountain fronts is collected in streams that flow to the lower portions of the Valley. Water from these streams infiltrates into the subsurface contributing recharge to the groundwater in the vicinity. Part of the precipitation along the fronts of these two mountain ranges infiltrates directly into the fractured bedrock, saturating the bedrock, and becoming groundwater available for discharge by springs and for development by water wells drilled into the bedrock. Bedrock springs occur in areas where the bedrock is sufficiently fractured to produce a significant secondary permeability and where there is sufficient rainfall to saturate the fractured bedrock. Figure 8 shows the locations of springs within the Antelope Valley watershed, as mapped by the U.S. Geological Survey (USGS)[6]. Most of these springs occur in areas underlain by fractured bedrock within the watershed.

Discharge of groundwater from the fractured bedrock as springs contributes to stream flows in the vicinity. Exfiltration of groundwater into streams from the saturated subsurface formations (alluvium and fractured bedrock) underlying the streams also contributes water to streams, increasing stream flows. Diversion and consumption of surface water from the streams reduces the amount of water in the streams that is available for groundwater recharge, and results in reduced amounts of groundwater available for use. Conversely, extraction of groundwater

[6] Spring locations are derived from the current USGS 7.5-Minute Quadrangle maps and other USGS maps of the Antelope Valley.

from fractured bedrock or other formations feeding the streams, such as by groundwater wells or spring-water-collection facilities, results in a reduction in the amount of surface water available for diversion from the streams and the amount of surface water that is available to infiltrate into the groundwater system elsewhere in the Valley. As a result, extraction of groundwater can directly affect stream flows and diversion of surface water from streams can directly affect the amount of groundwater available for use.

5.3 Importance of Surface-Water to the Groundwater System

The mountain fronts along the San Gabriel Mountains and the Tehachapi Mountains, which form the southwestern and northwestern boundaries of the Antelope Valley, respectively, are the areas where the greatest amount of inflow of water into the Antelope Valley watershed area occurs. Precipitation in the mountain ranges provides the greatest source of water for groundwater recharge. Some of this water is in the form of surface water, in streams, ponds, lakes, and reservoirs.

Little Rock Creek Valley is in the foothills of the San Gabriel Mountains south of the San Andreas Fault Zone, and is traversed by Little Rock Creek. This Creek collects precipitation falling in the San Gabriel Mountains and spring discharges from the fractured bedrock located near the headwaters of the creek, and carries this water principally as stream flow in a generally north-northwest direction into the Antelope Valley. A major surface water reservoir, Little Rock Reservoir, has been constructed within this Valley, and there are several other smaller pond structures which capture surface water flowing down Little Rock Creek. Surface water from this creek contributes recharge to the alluvial aquifer system of the Antelope Valley and may also contribute recharge to the fractured bedrock aquifer system where Little Rock Creek crosses the San Andreas Fault Zone. Diversions of surface water from this creek for other consumptive uses would reduce the amount of water available for recharge to the groundwater in the lower portions of the Valley. Extraction of groundwater from the fractured-rock aquifer system, especially near the headwaters of this creek, would reduce the amount of surface water available for direct use from this creek, and would reduce the amount of surface water available for recharge to the alluvial aquifer system lower in the Valley.

Leona Valley follows the alignment of the San Andreas Fault Zone, along Amargosa Creek. Lake Hughes, Lake Elizabeth, and Muntz Lakes are surface water bodies within the Leona Valley. The Leona Valley is situated along the foothills of the San Gabriel Mountains, and collects much of the precipitation that occurs along this stretch of the mountain front. This precipitation contributes to the stream flows in this area, contributes water to the ponds and lakes, and is the source of the groundwater stored in the alluvial aquifer system and the fractured bedrock aquifer system in the Leona Valley.[7] Therefore, groundwater in Leona Valley can flow into the main alluvial aquifer system in the main portion of the Antelope Valley. Diversions of surface water from the streams and lakes in the Leona Valley for other consumptive uses would reduce the amount of water available for recharge to the groundwater in the lower portions of the main portion of the Antelope Valley. Extraction of groundwater from the fractured-rock aquifer system in the Leona Valley would reduce the amount of surface water available for direct use from Amargosa creek, and would therefore reduce the amount of surface water available for recharge to the alluvial aquifer system lower in the main portion of the Valley.

In the foothills along the Tehachapi Mountains, which form the northwestern boundary of the Antelope Valley, there is significant precipitation and runoff of surface water that contributes to the groundwater resources of the Antelope Valley. There are numerous streams that flow generally in a southeastward direction down the mountain slope into the Antelope Valley. All of these mountain streams carry the precipitation from the Tehachapi Mountains down to the alluvial deposits in the lower portion of the Antelope Valley, recharging groundwater in the Valley. Oak Creek Valley parallels the alignment of the northeast-southwest-trending foothills of the Tehachapi Mountains and the Garlock Fault Zone. Oak Creek, which is located in this valley, captures a significant amount of surface runoff from the mountain front and carries this water in a northeasterly direction into the main Antelope Valley watershed. The creek then turns and continues flowing in a southerly direction towards the community of Willow Springs, and recharges the alluvial aquifer system in the Willow Springs vicinity. Just as is the case for

[7] Leona Valley is filled with alluvium and is underlain by intensively-fractured bedrock. Amargosa Creek is a surface water stream that flows from Leona Valley into the Antelope Valley and contributes surface water to the main portion of the Valley. The alluvium in Leona Valley is contiguous with and hydraulically connected to the

Little Rock Creek and Leona Valleys, discussed above, diversions of surface water from these creeks for other consumptive uses would reduce the amount of water available for recharge to the groundwater in the lower portions of the Valley. Extraction of groundwater from the fractured-rock aquifer system near the headwaters of these creeks would reduce the amounts of surface water available for direct use from these creeks, and would reduce the amounts of surface water available for recharge to the alluvial aquifer system lower in the Valley.

In the previously-submitted report (Geomatrix 2006a), I did not consider the surface water in the area along the northern portion of the Antelope Valley, east of the Willow Springs area, to warrant extending the Area of Adjudication north of the northern extent of the Antelope Valley Alluvium. Based on additional work conducted by consultants for the United States, it appears that there are areas along this northern portion of the Valley where intermittent streams occur that provide contribution by recharge to the groundwater system of the Antelope Valley.[8] Following review of this additional information and the map included in the consultants' reports (referred to in those reports as "Attachment A"), I have modified my conclusion concerning this area. If the water that is captured by these intermittent streams along the northern portion of the Valley, water which flows through the area just north of the northern extent of the Antelope Valley Alluvium between the Willow Springs area in the west and the area near the San Bernardino County line to the east, were not accounted for in the Area of Adjudication and were to be diverted for local or other consumptive use without restriction before recharging the Antelope Valley groundwater system, there could be a significant reduction in the amount of water available for the remainder of the water users in the Antelope Valley.

The consultants for the United States have constructed a modified watershed boundary line in this area, referred to as the "Boundary of the Antelope Valley Watershed Contributory to the Antelope Valley Groundwater Basin" ("Green Line") on the map in Attachment A. As a result of my supplemental review, I have concluded that the "Green Line" from Attachment A is an

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alluvium in the main portion of the Antelope Valley. Similarly, the fractured bedrock aquifer system in the Leona Valley is hydraulically connected to the alluvium in the main Antelope Valley.

[8] http://www.scefiling.org/cases/docket/docket.jsp?caseId=19: 06/29/06, 243, DECLARATION OF RIC A. WILLIAMS, ATTACHMENT A; and 07/07/06, 248, NOTICE OF FILING AMENDED RECOMMENDATION FOR THE BOUNDARY OF THE AREA OF ADJUDICATION.

appropriate boundary for the Area of Adjudication along this northern portion of the Antelope Valley.

Based on the above, I conclude that precipitation and surface water captured in streams along the mountain fronts and higher-elevation areas within the watershed around the perimeter of the Antelope Valley is the primary source of natural recharge to the Antelope Valley. If the surface water in ponds or streams is captured or diverted for consumptive use before it has an opportunity to contribute recharge to the groundwater aquifers, there could be a significant reduction in the amount of natural recharge available to the Valley. Similarly, extraction of groundwater from the aquifer systems feeding the surface water bodies could significantly reduce the surface water available for diversion and use. Therefore, all of the surface water and groundwater in these areas must be properly accounted for in resolving the Antelope Valley water-rights matters.

5.4 Areal Extent of Fractured Bedrock Aquifer

Because the presence of springs is direct evidence of saturated fractured bedrock, the presence and areal extent of saturated, fractured bedrock within the Antelope Valley watershed can be demonstrated by identifying the density of natural springs that occur in the bedrock areas. Nearly all of the USGS-identified springs occur in the fractured bedrock areas along the mountain fronts bordering the southwestern and northwestern boundaries of the Antelope Valley (Figure 8).

The density of fractured bedrock springs is greatest along the traces of the major faults in the area, the San Andreas Fault along the San Gabriel Mountains and the Garlock Fault along the Tehachapi Mountains (see Figure 8).[9] This density distribution is consistent with that expected due to the degree of fracturing caused by movement along the faults and the heavier

[9] A total of about 194 springs are mapped within the Antelope Valley watershed. The springs generally occur in the bedrock areas along the San Gabriel and Tehachapi Mountain fronts (Figure 8). There are about 131 springs, mostly in the fractured bedrock, along the 77-mile length of foothills of the San Gabriel Mountains (about 1.5 springs per mile). Of these, 48 springs occur in the 22-mile zone along the Leona Valley (2.2 springs per mile) and 50 springs occur in the 14-mile segment nearest the confluence of the San Gabriel and Garlock Faults (3.6 springs per mile). There are about 61 springs, mostly in the bedrock, along the 32-mile length of foothills of the

precipitation that occurs along these mountain ranges. As expected, the density of springs is greatest in the vicinity of the intersection of these two faults, near the western corner of the Antelope Valley where the combined stresses of both faults have produced the greatest degree of fracturing.

5.5 Importance of the Fractured Bedrock Aquifer System

The saturated fractured bedrock areas along the mountain fronts bordering the southwestern and northwestern boundaries of the Antelope Valley are saturated with groundwater, support numerous spring discharges, and therefore, are capable of supplying significant quantities of groundwater to wells drilled into the fractured bedrock. Spring discharges also supply significant quantities of water to streams in the vicinity. Figure 9 shows locations of both springs and wells in the Antelope Valley and vicinity.

Although most of the wells in the Antelope Valley are located over the deeper, saturated alluvial aquifer system in the central portion of the Valley, a significant number of wells are located along the edges of the Valley where the alluvium is either thin or unsaturated, located directly over the fractured bedrock, or located in smaller tributary valleys such as the Leona Valley (Figure 9). Wells located over thin sections of unsaturated alluvium penetrate the alluvium, extend into the fractured bedrock, and draw water directly and principally from the fractured bedrock aquifer system, not the alluvial aquifers.

As noted above, extraction of groundwater can directly affect stream flows and diversion of surface water from streams can directly affect the amount of groundwater that recharges the aquifer systems and becomes available for use as groundwater. Consequently, the saturated, fractured bedrock areas where springs are identified constitute a significant aquifer system within the Antelope Valley.

Tehachapi Mountains (1.9 springs per mile). Of these, 31 springs occur in the 13-mile segment nearest the confluence of the San Gabriel and Garlock Faults (2.4 springs per mile).

6.0 DEFINITION OF THE ANTELOPE VALLEY AREA OF ADJUDICATION

As noted above, a large portion of the Antelope Valley is underlain by the Antelope Valley Alluvium. The saturated portions of this formation provide the principal aquifers for development of groundwater by wells in the Antelope Valley. Also, the unsaturated, upper portion of the alluvium serves as the zone of potential storage of water to be recharged by natural or artificial means to the Antelope Valley. Thus, the definition of the Antelope Valley Area of Adjudication must include, as a minimum, the full thickness of the Antelope Valley Alluvium, both saturated and unsaturated.

Future recharge, by natural or artificial means, may saturate portions of the alluvial aquifer and fractured bedrock that are presently not saturated. Depending on the recharge locations and the amounts of recharge, it is possible that nearly the full thickness of the Antelope Valley Alluvium may become saturated in some areas due to recharge in the future. Therefore, the full area of the alluvium, at least that portion within the areas not already adjudicated,[10] must be included in the Antelope Valley Area of Adjudication.

Groundwater within the fractured bedrock is hydraulically connected to the alluvium and to the surface-water streams in the Antelope Valley. This fractured bedrock within the watershed boundary captures precipitation and stream flows by infiltration along the mountain fronts and transmits this groundwater laterally into the alluvial aquifer system. Groundwater can flow into the alluvium from both that portion of the saturated fractured bedrock that is laterally adjacent to the alluvium and from that portion of the saturated, fractured bedrock that is situated beneath the alluvium. Due to the hydraulic connection between the alluvium and the fractured bedrock, groundwater can also migrate vertically downward from the alluvium into the fractured bedrock underlying the alluvium, and laterally into the fractured bedrock adjacent to the alluvial deposits. Thus, the saturated fractured bedrock aquifer system is hydraulically connected to the alluvial aquifer system, and is a significant part of the Antelope Valley aquifer system.

[10] Along the eastern portion of the Antelope Valley is the boundary of the previously-adjudicated Mojave Basin Area. This boundary cuts through a portion of the Antelope Valley Alluvial Aquifer. That portion of the Antelope Valley Alluvial Aquifer included within the Mojave Basin Area may be appropriate to exclude from the Antelope Valley Area of Adjudication.

Groundwater flowing from the fractured bedrock as springs contributes to stream flows in the vicinity, and exfiltration of groundwater to the streams from the saturated fractured bedrock underlying the streams also contributes water to streams. Diversion of surface water from the streams reduces the amount of groundwater available by reducing the quantities of water that the streams can provide for groundwater recharge. On the other hand, extraction of fractured-bedrock groundwater feeding the streams reduces the stream flows and the amount of surface water available for diversion from the streams. Thus, the Area of Adjudication must include the areas of saturated fractured bedrock within the watershed of the Valley.

The Area of Adjudication, therefore, must include the Antelope Valley Alluvium, the saturated, fractured bedrock within the Antelope Valley watershed, and the areas where streams and other surface water bodies occur within the watershed of the Valley. Figure 9 shows the Area of Adjudication proposed for use in the Antelope Valley Groundwater cases. As described partially in Geomatrix (2006a) and in this supplemental report, this area is no bigger than necessary, but is sufficiently large to enclose the full area of what may be defined by the court as the Antelope Valley Groundwater Basin, and includes all water resources that contribute to the groundwater system and have interrelationships with the groundwater system.

7.0 DEFINITION OF JURISDICTIONAL BOUNDARY

The Jurisdictional Boundary of the Antelope Valley Area of Adjudication needs to be defined using commonly-applied land-surveying techniques. In Figure 10, I have superimposed the Township-Range-Section (TRS) survey information over the Antelope Valley Area of Adjudication for this purpose because the section lines provide a means to exactly define this boundary. The Jurisdictional Boundary, therefore, can be defined using commonly-applied land-surveying techniques to define the Boundary as a sequence of straight lines following the TRS section lines immediately outside of, and enclosing, the full Area of Adjudication. I have extended the TRS system to the west to cover the entire Area of Adjudication. I have applied this convenient and precise means for defining the Jurisdictional Boundary, and have shown the Proposed Jurisdictional Boundary on Figure 10, in addition to the Area of Adjudication and the

TRS system. I propose that this line be selected as the Jurisdictional Boundary for the Antelope Valley Area of Adjudication.

8.0 SUMMARY, DEFINITION OF THE ANTELOPE VALLEY AREA OF ADJUDICATION AND JURISDICTIONAL BOUNDARY

In summary, the Antelope Valley Area of Adjudication must be defined as the combination of (1) the full area of the Antelope Valley Alluvium within the areas not already adjudicated, including the areas of bedrock outcrops through the alluvium in the central portion of the Valley, (2) the saturated fractured bedrock within the watershed along the San Gabriel and Tehachapi Mountains bounding the Valley, and (3) those areas containing surface water bodies (streams, ponds, lakes, reservoirs) which are hydraulically connected to the groundwater system.

Precipitation and surface water captured in streams along the mountain fronts and higher-elevation areas around the perimeter of the Antelope Valley are the primary sources of natural recharge to the Antelope Valley. If the surface water in ponds or streams is captured or diverted for consumptive use before it has an opportunity to contribute recharge to the groundwater aquifers, there could be a significant reduction in the amount of natural recharge available to the Valley. Conversely, pumping of groundwater from the aquifer system feeding the surface water bodies could cause a significant reduction in the amount of surface water available for diversion and use. Therefore, all of the surface water streams and ponds, in addition to the groundwater aquifers, in these areas must be properly accounted for in resolving the Antelope Valley water-rights matters, and must be included within the Area of Adjudication.

Figure 10 shows the boundary of the Proposed Area of Adjudication needed for the Antelope Valley Groundwater Cases. This boundary is similar to the boundary presented in the previously-submitted report by Geomatrix (2006a), but is modified to include the areas of surface water streams along the northern portion of the Valley that feed water into the Valley.

This area includes all of the Antelope Valley Alluvial Aquifer within the areas not already adjudicated, includes the bedrock outcrops within the Antelope Valley Alluvium, and includes the saturated fractured bedrock areas within the watershed along the San Gabriel and Tehachapi Mountains bounding the Valley on the southwestern and northwestern sides, respectively. The Jurisdictional Boundary of the Area of Adjudication is also shown on Figure 10. Based on this supplemental information, therefore, it is proposed that the Boundary of the Area of Adjudication be selected as the boundary shown on Figure 10 of this report. Similarly, it is proposed that the Jurisdictional Boundary of the Area of Adjudication be selected as the Jurisdictional Boundary shown on Figure 10 of this report.

9.0 CLOSURE

Geomatrix is pleased to have been given the opportunity to prepare this supplemental report and to provide our recommendations concerning the Antelope Valley Area of Adjudication and the Jurisdictional Boundary for the Antelope Valley Groundwater Cases. We trust that the information contained herein is adequate for your use. If there are any questions, or if we can be of additional service, please call.

Respectfully submitted,

GEOMATRIX CONSULTANTS, INC.

N. Thomas Sheahan, PG, CEG, CHG, PGP, CPG

Vice President and Principal Hydrogeologist

ATTACHMENT A,

REFERENCES

California Department of Water Resources, 2003. California's Groundwater, Bulletin 118, Update 2003, October (DWR, 118-2003).

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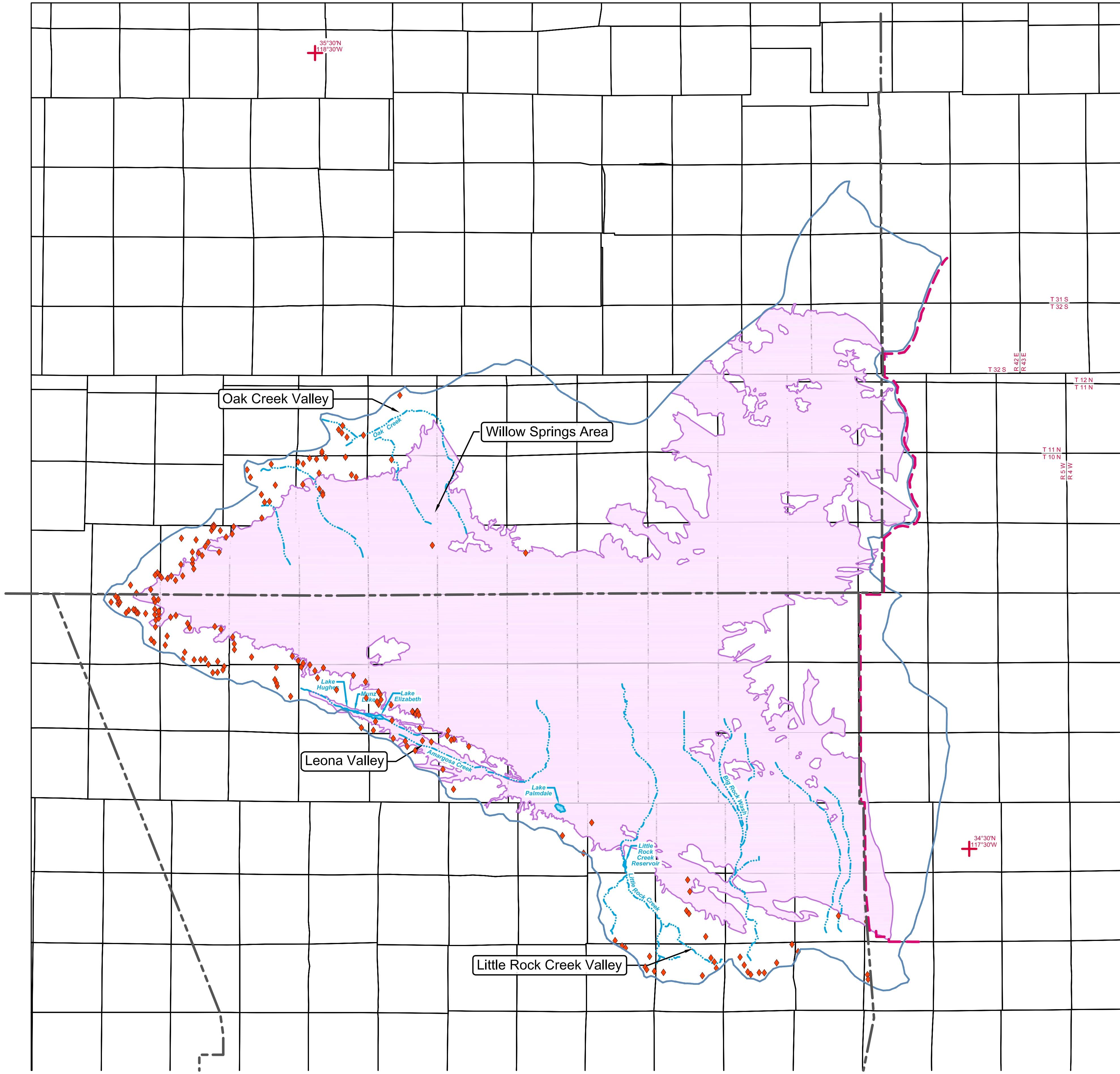
ATTACHMENT B

FIGURES



Explanation

- Watershed boundary
- Mojave Basin Area boundary
- County line
- Antelope Valley Alluvium
- Creek or stream
- Lake or reservoir
- Spring shown on USGS 7.5 minute quadrangles and/or basemap
- Township and range

Note:

1. The alluvial valley files were obtained from the Department of Water Resources at [www.groundwater.water.ca.gov/bulletin 118/basin_maps/index.cfm] in a UTM 10, NAD27 projection. The shape files have been reprojected into California State Plane Coordinate System, Zone 5, NAD83 projection. The Antelope Valley Alluvium boundary was isolated into a separate shape file.

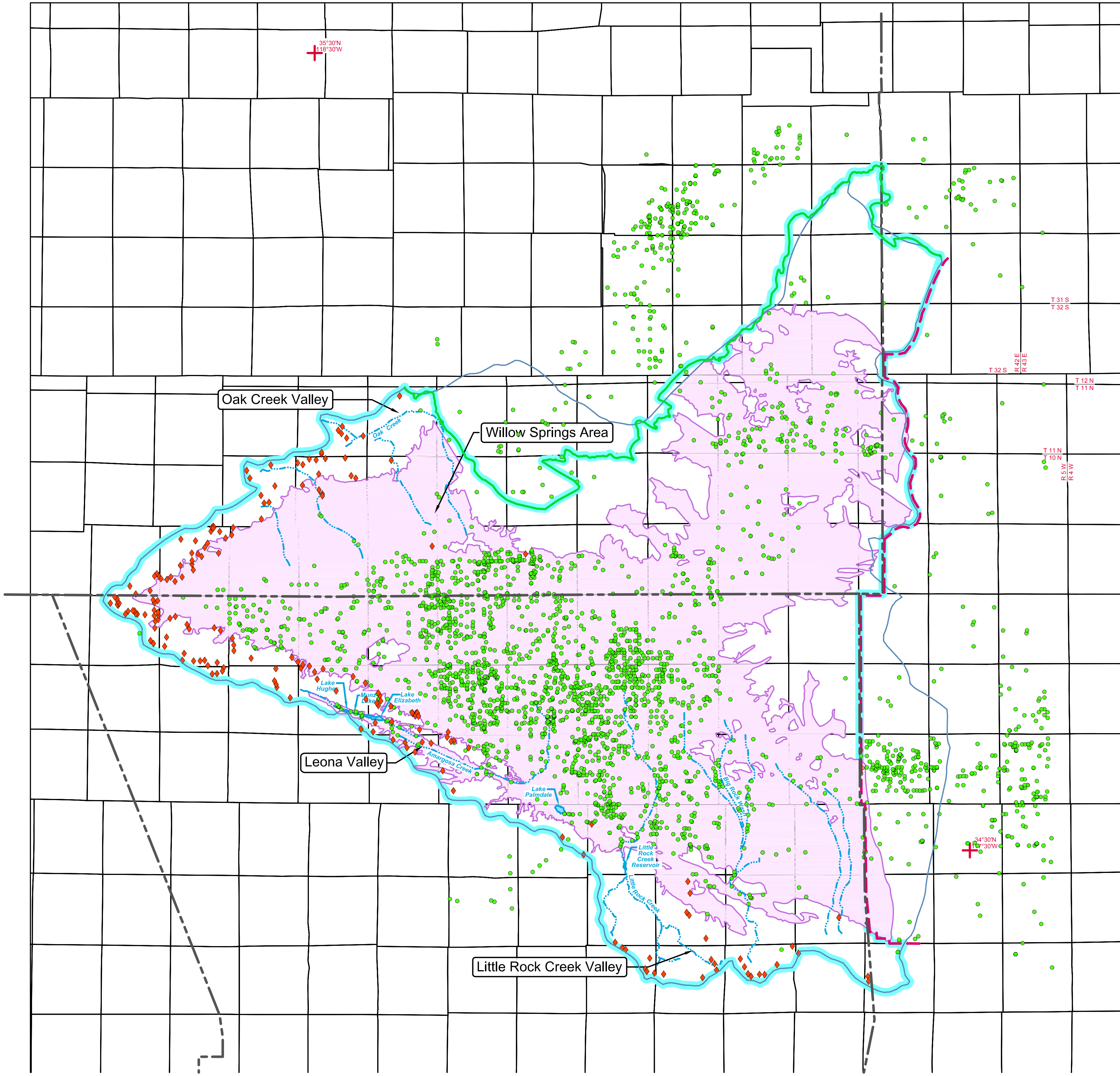
0 3 6
Approximate scale in feet

SPRINGS WITHIN THE ANTELOPE VALLEY AREA OF ADJUDICATION

Antelope Valley Adjudication
Antelope Valley, California

By: jrw	Date: 10/9/06	Project No. 8029.001
Geomatrix		Figure 8

Filepath: W:\projects\008029.001.0 (Bolthouse Settlement)\Graphics\FIGS 2-4_6-9_newWatershed.dwg
Plot Time: Oct 09, 2006 - 12:26pm, Plotted By: jwalker



Explanation

- Boundary of the Antelope Valley Watershed contributory to the Antelope Valley groundwater basin
- Area of Adjudication boundary
- Watershed boundary
- Mojave Basin Area boundary
- County line
- Antelope Valley Alluvium
- Creek or stream
- Lake or reservoir
- Spring shown on USGS 7.5 minute quadrangles and/or basemap
- Water well
- Township and range

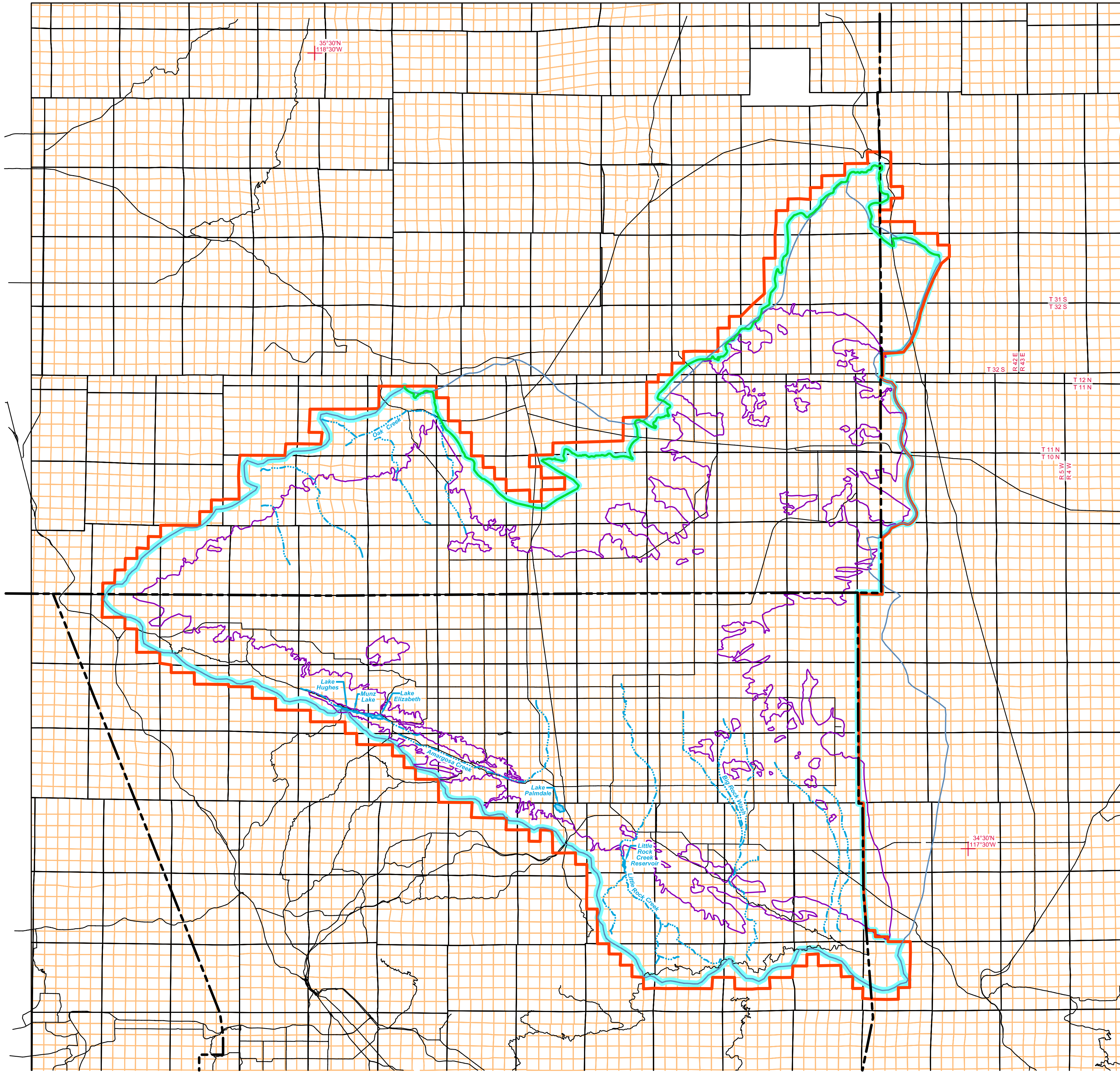
Notes:

1. The alluvial valley files were obtained from the Department of Water Resources at [www.groundwater.water.ca.gov/bulletin 118/basin_maps/index.cfm] in a UTM 10, NAD27 projection. The shape files have been reprojected into California State Plane Coordinate System, Zone 5, NAD83 projection. The Antelope Valley Alluvium boundary was isolated into a separate shape file.
2. The boundary of the Antelope Valley Watershed contributory to the Antelope Valley groundwater basin prepared by United States consultants, from http://www.scefiling.org/cases/docket /docket.jsp?caseId=19: 06/29/06, 243, DECLARATION OF RIC A. WILLIAMS, ATTACHMENT A; and 07/07/06, 248, NOTICE OF FILING AMENDED RECOMMENDATION FOR THE BOUNDARY OF THE AREA OF ADJUDICATION.

SPRINGS AND WELLS IN ANTELOPE VALLEY AND VICINITY

Antelope Valley Adjudication
Antelope Valley, California

By: jrw	Date: 10/9/06	Project No. 8029.001
Geomatrix		Figure 9



Explanation

- Jurisdictional Boundary of Area of Adjudication boundary
- Boundary of the Antelope Valley Watershed contributory to the Antelope Valley groundwater basin
- Area of Adjudication boundary
- Watershed boundary
- Antelope Valley Alluvium boundary
- County line
- State and U.S. highways
- Creek or stream
- Lake or reservoir
- Township and range
- Section

Notes:

1. The alluvial valley files were obtained from the Department of Water Resources at [www.groundwater.water.ca.gov/bulletin 118/basin_maps/index.cfm] in a UTM 10, NAD27 projection. The shape files have been reprojected into California State Plane Coordinate System, Zone 5, NAD83 projection. The Antelope Valley Alluvium boundary was isolated into a separate shape file.
2. The boundary of the Antelope Valley Watershed contributory to the Antelope Valley groundwater basin prepared by United States consultants, from http://www.scefiling.org/cases/docket /docket.jsp?caseId=19: 06/29/06, 243, DECLARATION OF RIC A. WILLIAMS, ATTACHMENT A; and 07/07/06, 248, NOTICE OF FILING AMENDED RECOMMENDATION FOR THE BOUNDARY OF THE AREA OF ADJUDICATION.

PROPOSED AREA OF ADJUDICATION AND JURISDICTIONAL BOUNDARY

Antelope Valley Adjudication
Antelope Valley, California

By: jrw	Date: 10/9/06	Project No. 8029.001
Geomatrix		Figure 10