County of Los Angeles

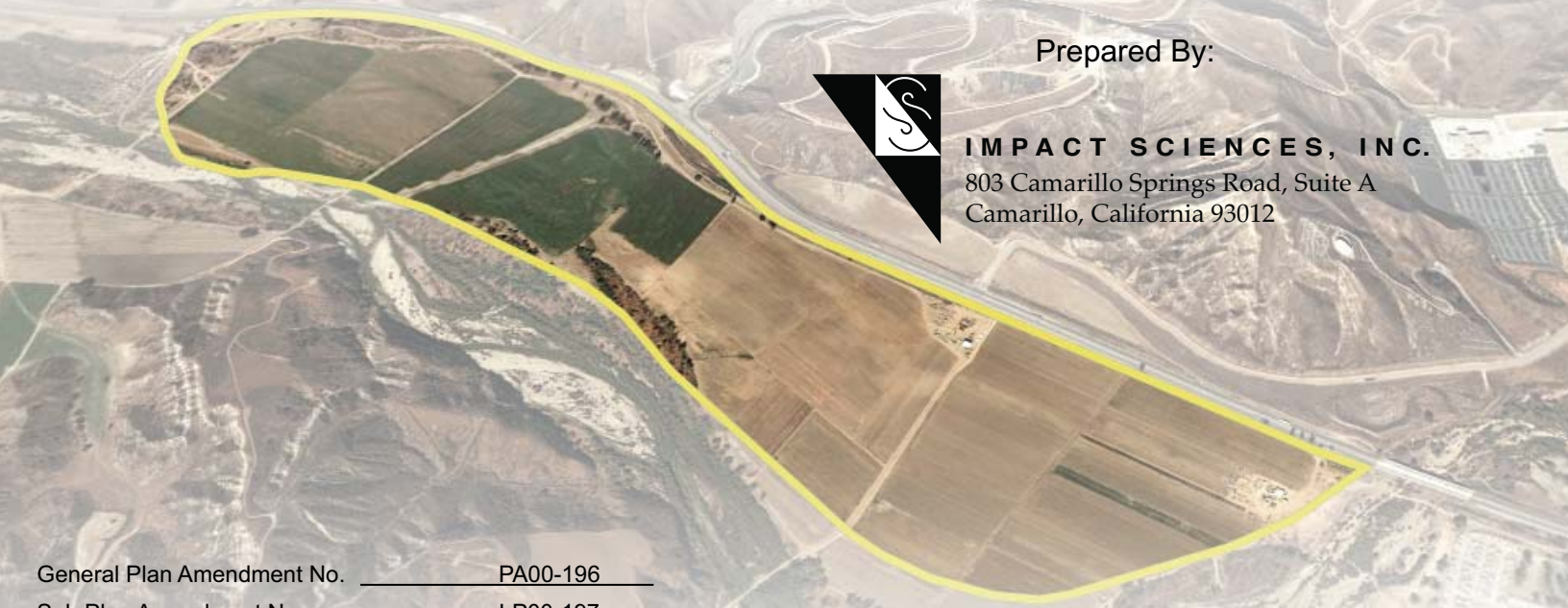
Draft Environmental Impact Report

SCH No. 2004021002

VOLUME VI PART 2
START - CLWA CAPITAL
IMPROVEMENTS 4.10N

Volume VI — Appendices
Appendix 4.10 (Continued)

LANDMARK VILLAGE



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General Plan Amendment No.	PA00-196
Sub Plan Amendment No.	LP00-197
Specific Plan Amendment No.	SP00-198
Vesting Tentative Tract Map No.	53108
SEA Conditional Use Permit No.	RCUP200500112
Oak Tree Permit No.	OTP00-196
Off-Site Materials Transport Approval No.	CUP00-196
Conditional Use Permit (Off-Site Grading)	CUP00-196

NEWHALL RANCH
Newhall Ranch Company

NOVEMBER 2006

DRAFT
ENVIRONMENTAL IMPACT REPORT

for
LANDMARK VILLAGE

SCH No. 2004021002

Volume VI - Appendices
Appendix 4.10 (Continued)

Prepared for:

Los Angeles County
Department of Regional Planning
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November 2006

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Castaic Lake Water Agency

Data Document

Providing Economic Justification for

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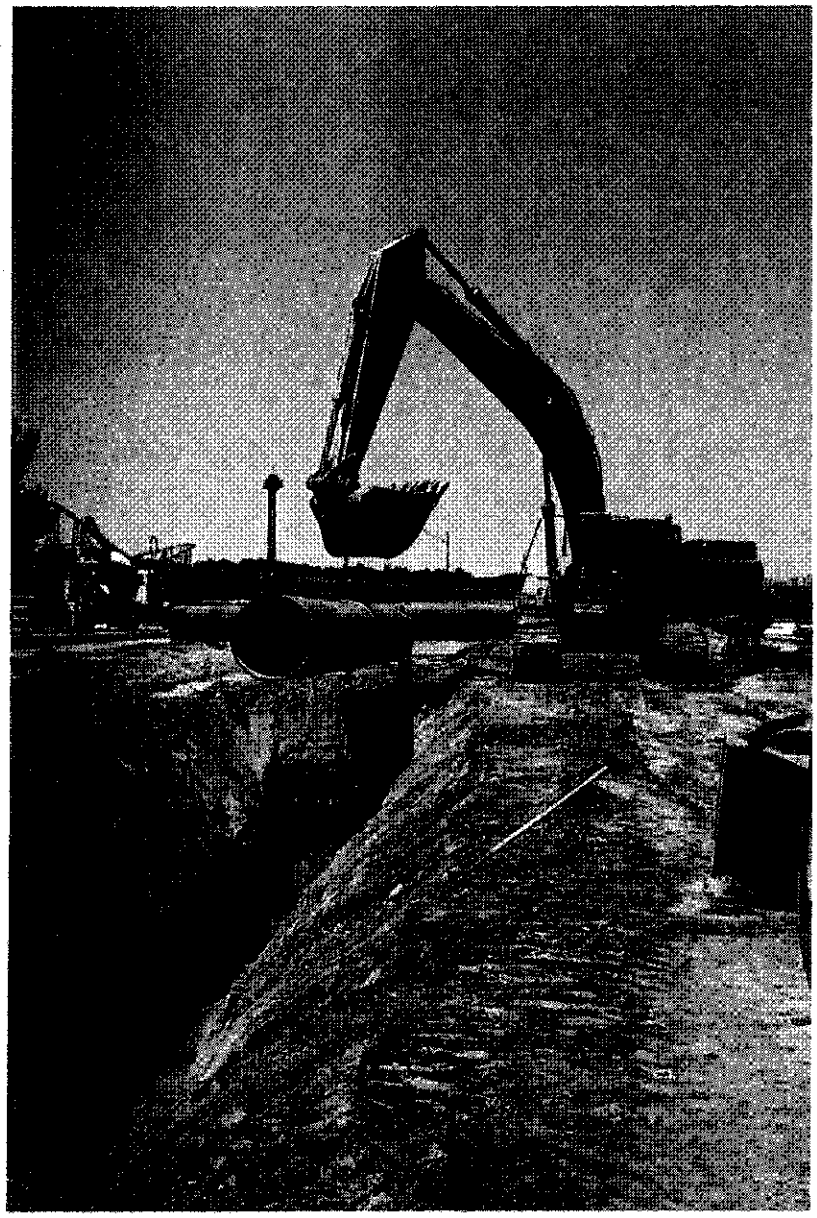

April 19, 2003

Castaic Lake Water Agency
Memorandum

April 18, 2003

To: Board of Directors

From: Laurie Foster
Finance Officer

Subject: 2003 Data Document

Enclosed for your review is the Castaic Lake Water Agency Data Document Providing Justification for Proposed Facility Capacity Fees dated April 19, 2003. Please bring this document to the April 30, 2003 Public Hearing forming water service areas for Castaic Lake Water Agency 2003/04 and taking all necessary actions to set and fund the Agency's annual capital budget.

LAF

Enclosure

Cc (w/out enclosure): Dan Masnada, Russ Behrens

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Castaic Lake Water Agency

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Providing Economic Justification for

Proposed Facility Capacity Fees

April 2003

Report Purpose

This report provides the data concerning the estimated cost of facilities to supply water for new development, and the proposed method and basis for allocating the costs among those lands on which new development occurs, as required by Section 26.1 (c) (3) of the Castaic Water District Law. The following discussion addresses the Castaic Lake Water Agency's proposed Fiscal Year 2003/04 Facility Capacity Fee program in the context of estimated long-term costs of the Capital Improvement Program (CIP) activities of the Agency.

The CIP is a plan [within the meaning of §26.1 of the CLWA act] for the following purposes:

(1) To obtain additional facilities, works, property, improvements, and supplies of water.

(2) To increase or enlarge, as may be appropriate, its existing capacity and facilities for obtaining, importing, transporting, and delivering additional quantities of water to retail water distributors within the agency which are in need of additional water supplies.

(3) To finance or reimburse the agency for advancing the cost of acquiring facilities, works, property, improvements, and supplies of water and to allocate that cost among lands within water service areas of the agency which, by reason of new development or new construction thereon, will need new water service and will be benefited by making the additional supplies of agency water available for purchase by the retail water distributors that will supply those lands with water.

Agency water made available through CIP activities will be sold to retail water distributors who in turn, will serve Agency water to lands on which new water-utilizing development may occur as and when approved by municipal and County planning agencies. Neither the CIP nor the adoption of Facility Capacity Fees commits the Agency to proceed with any project identified in the CIP. The purpose of the CIP is to identify and estimate the cost of

projects which would be able to produce additional water supplies needed in the event new development is approved and constructed. The ultimate decision to proceed with any water supply, storage, treatment, or transmission project will depend upon growth patterns, development approvals given by city and county planning authorities, cost, and the feasibility and environmental impacts of each project. The Facility Capacity Fees contemplated herein will produce revenue only if new development actually occurs, and will not provide funding for water supply projects if no development occurs.

This report also presents background information concerning the proposed methods and basis for allocating the estimated long-term cost of Agency CIP activities to those lands which have been designated by planning agencies to accommodate new development. In addition, the report updates previous data document reports by recognizing the water demand of development which has occurred within the Agency since the adoption of the last Facility Capacity Fees.

This report is consistent with the recently submitted Urban Water Management Plan dated December 2000 which was prepared as required by State law. The Urban Water Management Plan reviews water demand and source of supply over near and long-term periods.

The Agency's water planning documents such as the Draft Integrated Water Resources Plan, Phase I dated February 8, 1998, and the Urban Water Management Plan are used as a source for the development of the Agency's CIP.

This report sets forth economic justification for the creation of revised facility capacity fee rates to fund new development's fair share of the proposed CIP activities identified and recommended by the Agency's Engineer.

Background

The proposed Facility Capacity Fee is structured to provide an identified equitable means of funding future Agency CIP activities between existing users and future development which creates new water demand. The Agency's enabling act, (West's Water Code-Appendix, Chapter 103), describes the manner in which the Agency's annual capital budget, including Facility Capacity Fees, shall be established, continued, and/or funded each year.

When the Facility Capacity Fee Program was first developed, the Agency recognized that only by reviewing and revising the data document analysis of the fee annually, would it flexibly and fairly account for and explain changing assumptions and conditions. Therefore, the program included an annual review to ensure that any difference between what had been forecast and what was actually occurring, was accounted for in later revisions and that there were accurate tracking mechanisms of the monies collected and expended in furtherance of the Agency CIP activities.

Legislation

The continuing concern regarding water supplies for new development has resulted in legislation in the form of Senate Bill No. 221 and SB 610. The legislation requires planning and permitting agencies to obtain from local water providers written verification that adequate water supplies for proposed projects are available. Since this is new legislation, the exact nature of the written verification is still uncertain. The CIP reflects a variety of projects from which the Agency can select appropriate alternatives to ensure that an adequate water supply can be made available for whatever development is approved by the city and county planning authorities.

State Water Project Reliability

The State Department of Water Resources recently published a draft report describing the State Water Project's ability to deliver the water that is requested by the State Contractors. The State is capable of providing on the average 75% of the requested amount. However, project deliveries have dropped as low as 19% in the driest years. Further, the aforementioned legislation requires assurance of water delivery under varying drought conditions. With this in mind, the Agency's Engineer has developed the CIP to provide sufficient supply, storage, and banking facilities to accommodate the worse case situation.

Projected Water Demand

The cornerstone of the Agency's CIP is to identify projects which could provide an adequate water supply under any number of future demand scenarios. The selection of appropriate projects will depend upon actual growth patterns. The CIP includes projects which would be able to accommodate the maximum anticipated water demand, as well as lesser demands which may occur. The development of the demand projections includes the following:

1. Ultimate demand based on current land use designations
2. Timing of future demand increases

3. Location of future demand increases
4. Effect of water conservation efforts to mitigate increase in demand
5. Potential use of recycled water as an additional source of water

The Agency maintains a database of every parcel within its service area. Information regarding the parcel's land use designation, projected water demand if the parcel remains vacant, and potential water use if developed, is annually updated. As the Agency service area has matured, growth patterns have changed in response to market demand and land availability. The CIP in turn has been updated to take these changes into consideration.

The Agency's computer-generated model uses information obtained from Los Angeles and Ventura County assessor records, and utilizes land use information as identified by the County assessors. For obvious reasons, the data lags actual conditions and thus the model does not reflect up-to-the-minute conditions. The model also includes estimated construction costs for various water supply, storage, treatment, and distribution projects and thus is capable of producing close approximations of actual costs. Since the process is repeated annually, it reflects current information. See Appendix A-1 for projected water demand by WSA.

Economic Climate

The last three years we have seen an economic downturn in the general economy. However, the demand for housing has resulted in a relatively stable housing market in the Santa Clarita Valley. This can be attributed to an acute demand for housing and relatively low mortgage rates. The State Department of Finance and the Southern California Association of Governments predict continued strong growth for Southern California.

The demand for housing can be demonstrated by a comparison of the median price of a detached house in the first quarter of 1999 ($289,945) to the third quarter of 2002 ($388,704). The price of an attached home in the fourth quarter of 1998 was $166,950 compared to a price of $279,990 in the third quarter of 2002.

CIP Scheduling

In accordance with standard industry practice, the Agency's CIP activities require a relatively long planning horizon. Also standard is the assumption that cycles of "boom and bust" will occur. Thus, the plan must be flexible enough to accommodate adjustments in the scheduling of projects. The Agency has an adopted policy of conservatism. **That is, the Agency will only build or acquire what it needs in such a manner as to insure that the**

Agency's water supply and facilities needs are continuously met subject to an adequate margin of safety. The policy mitigates the Agency's exposure to building facilities prematurely and having to operate underutilized facilities inefficiently. This further protects the existing user from funding the operation of facilities needed for future growth.

Policies

The Agency has two primary policies that are used as a guide in the preparation of the CIP and Facility Capacity Fees.

Fairness Policy

This policy simply states that the benefiting user pays according to the actual cost of the service. Certain facilities are required for existing as well as future users, and there are other facilities that are required only by new users. For example, changes in higher water quality standards are a benefit to existing users. Thus, the cost of providing the higher water quality is appropriately paid by existing users. The need for additional treatment capacity, on the other hand, is growth induced and thus a responsibility of the new user.

The cost of facilities benefiting both existing and future users is allocated between such uses based upon the proportional benefit. The proportional benefit is determined by taking the total capacity of the facility in terms of the number of acre-feet of annual demand it is designated to serve and allocating a share of the cost to current users reflecting the total annual demand in acre-feet of the current users who benefit from the facility. For instance, if a reservoir provides storage which is necessary to provide reliability for 5,000 acre-feet of annual demand, and the current users who will benefit from the reservoir represent 2,500 acre-feet of annual demand, then 50% of the cost of the reservoir would be allocated to current users and only 50% of the cost would be calculated into the Facility Capacity Fees for the area benefited by the reservoir reflecting the additional demand generated by future users.

Conservative Economic Policy

As previously discussed, the Agency will only build or acquire what it needs in such a manner as to insure that the Valley's water supply needs are continuously met. This policy is particularly important in the water utility industry as it is difficult to build in small increments to match growth needs on a yearly basis. On the other hand, building too soon and too

large results in excessive capital and operating costs with an insufficient number of customers to pay for the service.

Water Plan

The foundation for the Agency's proposed CIP is land use and other statistical data conforming to applicable land uses. The Agency's consultants have developed and the Agency benefits from a computerized model that catalogs all of the available land within the Agency. The model captures each parcel's existing and authorized land uses, as maintained by the Assessor and planning agencies. Potential water demands (if the lands are developed or more intensively developed) are computed using extrapolations from existing consumption data. This information enables the Agency to determine, with reasonable accuracy, the amount of water required to meet the projected needs of the Santa Clarita Valley.

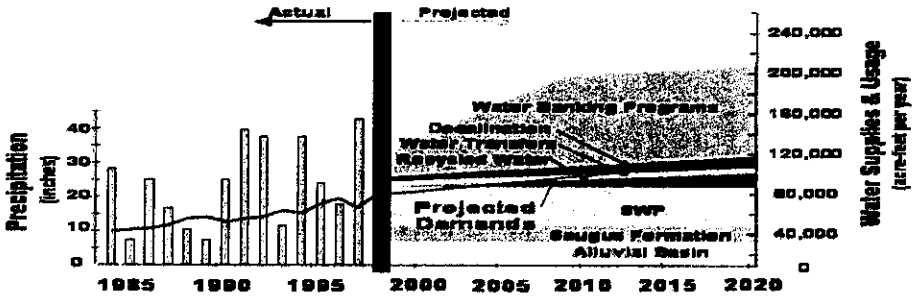
Using information obtained from the local retail purveyors, the database also contains information concerning where and when the water demand could materialize, based upon their best estimates of development. The County of Los Angeles Department of Regional Planning also supplies a report on proposed development from its development monitoring system.

Water Demand Model

This report has examined the approved land uses throughout the entire Castaic Lake Water Agency service area and the associated water demands. In this regard, a range of water demands was developed using a range of densities for specific general plan land use classifications. For the purpose of this report in determining Facility Capacity Fees, the decision was made to continue the previous practice of using the mid-range value of densities and historic water consumption.

The Draft IWRP water demand model calculated the projected future demand for the currently designated allowable land uses within the Castaic Lake Water Agency service area at approximately 175,000 acre-feet of water without conservation savings. The updated water demand for this report, with conservation, is 169,000 acre-feet. The total demand has changed slightly as a result of land use changes. However, as land is developed portions are dedicated to such uses as streets and parking lots that do not generate a water demand. Conversely, some land is developed for uses which result in a higher water use than

projected. As a result the demand at build-out is still projected to be within the ranges developed in the Draft IWRP.



As noted in the above figure, the projected water demand for 2020 is slightly more than 100,000 acre-feet, which exceeds the current reliable supply. The Agency's CIP includes additional water acquisition, recycled water, as well as water banking and storage projects to meet the future demands. These additional sources may be pursued as demand becomes more certain.

Projected Sales of Facility Capacity Fees

The financing of the Agency's Capital program is based primarily on the revenue derived from the Facilities Capacity Fees. The financial community does not consider this revenue source as stable and, as a result, is reluctant to issue a high credit rating, which, in turn, makes it difficult to secure reasonably priced bond insurance.

In 1991 the Agency issued its first bonds to begin construction of capital facilities. In order to demonstrate that the Facility Capacity Fees were a credit worthy security for the bonds, it was necessary to demonstrate exceptional conservatism in the Agency's projection of sales.

Further, the Agency had no track record of annual sales of capacity to demonstrate the reliability of strength of the building market in the Santa Clarita Valley. The Agency developed forecasts based on County general plans and development activity by the local purveyors. This, in turn, was translated into a series of scenarios projecting possible income under various economic conditions.

Based upon historical connection data and housing sales, it was determined that Facility Capacity Fee sales would be based on a reduced number from the forecasted water demand

(see Appendix A-2). This was necessary based on the financial community's concern with a variable revenue stream that was further complicated by the fact that certain development can occur that is not subject to the building permit process, thus escaping payment of the Facility Capacity Fees. In addition, landowners can develop their land using groundwater and not take any Agency water. These developments create a demand for water but they are not accountable to the Agency.

As shown in Appendix B, annual sales of capacity have been highly variably since the program was implemented. Based on the Agency's history of sales, the maintenance of cash reserves has enabled the Agency to sell a total of three bond issues all backed with insurance and a sound credit rating.

Water Conservation

The Agency has signed a memorandum of understanding with other urban water suppliers, public advocacy organizations and other interested parties. The California Urban Water Conservation Council has the responsibility for monitoring the implementation of the MOU. A major effort of this coalition is the implementation of Best Management Practices as a means of achieving water conservation goals.

There are 14 Best Management Practices. The Agency is currently involved in a pilot study for the implementation of these practices. It is anticipated that the conservation effort will reduce the water demand by approximately 10% or more.

The agency has an extensive program for the education of grade school children concerning water, its source, use and care. The Agency's conservation garden demonstrates the use of drought tolerant plants and ground covers that can be attractive while using minimum amounts of water.

Capital Improvement Program

The Agency's proposed CIP activities have been developed to fulfill the Agency's stated mission, which is to provide reliable, quality water at a reasonable cost to the Santa Clarita Valley. Thus, the proposed CIP is structured to include facilities for the treatment, storage, and transmission of water as well as the acquisition of additional water supplies. Since the State Water Project is not complete and water deliveries are variable, the proposed CIP

contains certain elements to increase reliability through a combination of additional water supplies, water banking, storage and conjunctive use.

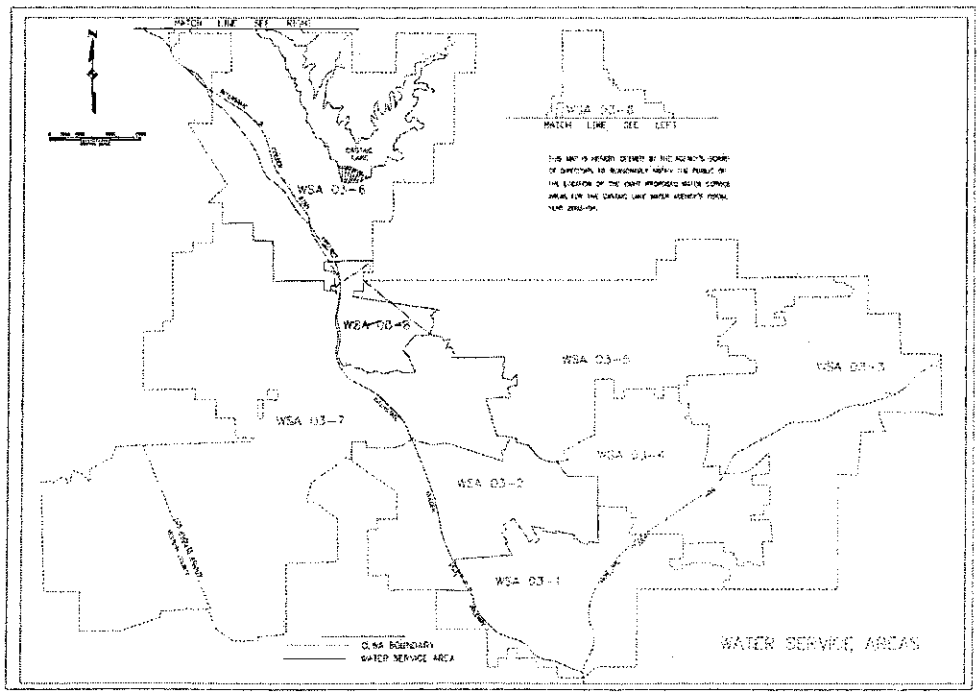
Water Service Areas

In keeping with Agency policy that the benefiting user pays, it was determined that the distribution of cost would be fairly apportioned by dividing the Agency's service area into logical hydraulic water service areas (WSAs). This enables the engineers to plan and distribute costs on a cost of service basis.

The Agency Engineer has determined that 26 specific Sub-WSAs and eight water service areas (see map below and Appendix C for an enlarged map) constitute the most practical building blocks for establishing water needs and, in turn, Agency capital facilities. Additionally, these Sub-WSAs are used in determining the areas of benefit for each capital project. These Sub-WSAs are then grouped into logical configurations to form a smaller number of WSAs and to conform to Agency policy in providing planned transmission facilities to each proposed WSA.

Multiple alternative configurations have been considered and evaluated. As a result of this evaluation, eight WSAs were established for the Agency's Capital Facility Program for Fiscal Year 1991/92. This configuration has been used every year since then, and it is proposed that the eight existing WSAs be maintained for FY 2003/04.

Water Service Areas



Water Demand by WSA

The Agency's computerized database provides water demand based on the aforementioned Sub-WSAs. The data is then analyzed to determine the Agency facilities needed for each Sub-WSA, taking into consideration the availability of local groundwater and water conservation. The net water demand is then translated into specific facilities, sizes, phasing, and cost.

Distribution of Benefits

After facility requirements are determined, costs are allocated to WSAs and then to existing or future users based on the projected benefits to be derived from the project. Each of the individual projects within the CIP are evaluated to determine from where within the Agency the project provides benefits (i.e., WSA) and who benefits from the project (existing or future users). Based on the determination of the distribution of benefits, the costs for the project are distributed accordingly. Specific details of this procedure are provided in the following section (Existing and Future User Benefits) and Appendix D.

Program Financing

Since the facilities have to be in place before development can take place, capital projects are typically debt-financed. The cost of financing is an additional cost of the program and is included as part of the project cost. In addition, portions of projects benefit existing users as well as future users. Thus, it is necessary to distribute the debt in the same manner as projects benefit (i.e., existing and future).

Agency Revenues

The Agency's authorized revenue sources are as follows:

1. Water rates
2. Facility Capacity Fees
3. Ad valorem taxes for authorized debt service
   a. State Water Project
4. Portion of 1% basic property tax levy
5. Water Standby Charges
6. Interest on investments

Existing Users Funding

Existing users could fund their portion of the Agency program through the following:

1. Portion of 1% property tax (current practice)
2. Water rates (currently not in effect)
3. Parcel charges (currently not in effect)
4. Ad valorem taxes for State Water Project (current practice)

Future Users Funding

1. Facility Capacity Fees (current practice)
2. Interest on Investments (current practice)
3. Parcel Charges (currently not in effect)
4. Portion of 1% property tax (current practice)
5. Ad valorem taxes for the State Water Project (current practice)

Existing and Future User Benefits

The allocation between existing and future users is developed based on benefits received from each facility described as follows and in Appendix D.

The existing water treatment facilities (Rio Vista and Earl Schmidt) require upgrading to meet new drinking water treatment standards issued by the State of California and United States Environmental Protection Agency. These improvements are allocated to existing users.

Emergency storage improvements included in the capital improvement plan benefit existing and future users by providing protection against short term loss of imported water supplies. Planned new storage facilities accommodate the needs of existing and future users, and costs are shared between them. This storage is provided at water treatment plant sites and along pipeline routes.

New potable water supply projects are allocated to future users and include additional potable water supplies (such as State Water Project water).

Recycled water distribution projects are allocated between existing and future users as each benefit. The development of recycled water improves the Agency's overall water supply

reliability although it will be distributed in those areas where it is most cost effective and efficient to do so.

There are two types of State Project Water reliability enhancement projects, water supply banking and Saugus aquifer wells. These projects firm up the reliability of the State Water Project water by providing an alternative supply during periods of reduced State Water Project deliveries. These projects are allocated to existing and future users.

Pipeline and pump station projects are required to convey State Water Project water to new users and all costs are allocated to future users.

Several projects (listed as System Appurtenances projects) provide improvements needed to accommodate delivery of State Water Project water and are allocated to future users.

Water treatment expansion projects are required to accommodate future users and are allocated to future users.

A description of each project included in the Draft Capital Improvement Plan (CIP) and allocation between existing and future users is provided in Appendix D. Appendix D-1 is provides a summary of the entire Draft CIP and distribution of estimated project costs among water supply, supply banking, pipeline, pump stations, storage and water treatment. Appendix D-2 provides a summary of cost allocations between existing and future users. Appendix D-3 is the projected construction schedule.

Standard Unit of Benefit

In order to distribute benefits, it is necessary to establish a "unit of benefit" that can be applied as a standard of measure. The Agency's unit measure is an **acre foot of water per year.** There is a direct nexus between the demand for an acre foot of water and the capital facilities required to supply that acre foot of water.

For example, the unit of measure for water supplies is acre feet per year. Storage is measured in acre feet and transmission is measured in acre-feet per year. Water demand is also measured in acre-feet per year. Historical consumption records for the Santa Clarita Valley indicate that the water demand for a single family dwelling ranges from 0.5 acre-feet per year to as high as 0.8 acre-feet per year based on the dwelling size and location.

Water Needs by Water Service Area

Water demands within the Agency's service area are met by both groundwater produced by retail purveyors and imported water provided by the Agency. This year recycled water will also become a source of non-potable supply to meet current and future non-potable demands. The sizing of the proposed Agency facilities is based on the demand for Agency potable and non-potable water. The additional potable and non-potable water needed to satisfy the demand was projected using a computerized water demand model as well as production records from the Agency and the four local purveyors.

Supplemental Water Needs

The Agency is now able to provide recycled water as a non-potable supply, thus augmenting the water supply to the service area. The additional water needed to satisfy the demand (referred to as supplemental water demand) was projected using a computerized water demand model as well as production records from the Agency and the four local retail purveyors.

The Agency's water demand model provides a forecast of total demand in the future for each Sub-WSA. The supplemental water demand for each Sub-WSA was determined by mathematically balancing the estimated future water demand by taking into account the configuration of the Agency and purveyor distribution systems and the potential use of recycled water. By using this mathematical approach, the optimum blend of local groundwater and supplemental water is achieved. Details of the mathematical model are set forth in Appendix E.

Water and Facility Cost Allocations

The "optimum blend" provides the hydraulic data required to size Agency water supply and treatment facilities. Projects derived from this technical process are labeled "Agency-wide" projects. The hydraulic data are used to size the transmission lines. Accordingly, these projects are labeled "WSA-specific" projects. An estimate of project cost is calculated, and the project is scheduled based on projected water demand. As a matter of Agency policy, "Agency-wide" projects include the cost of acquisition of additional water supply, water treatment facilities, and storage. "Agency-wide" projects are considered to have equal benefit regardless of geographic location within the service area.

Thus, the component of the facility capacity fee for the cost per acre foot of this portion of the CIP is the same for all WSAs regardless of location within the Agency's service area. The costs are then allocated to existing and future users. The portion which is determined to be attributable to future users becomes the "base" number for the calculation of the Facility Capacity Fee. The "base" number represents the costs of acquiring, treating, and storing an acre foot of water anywhere within the Agency service area.

As a matter of policy, "WSA-specific" projects include the cost of Agency Transmission facilities. These costs are allocated to the WSAs based on the relative benefits of a transmission project to a specific WSA. Accordingly, each WSA's share of the proposed pipeline's cost was calculated in proportion to each WSA's share of the capacity based on supplemental water demand. The resulting capital cost to convey an acre foot of water varies accordingly from WSA to WSA. The future users' benefits from the Agency's CIP was obtained (after excluding the existing users' benefits) by combining each WSA's share of the Agency-wide projects and the WSA-specific projects.

Facility Capacity Fee Calculation Methodology

As discussed earlier, each WSA's estimated water demand is expressed in acre feet per year, and is based upon combining land use codes with actual water usage from the purveyors.

Using the CIP costs and incremental water demands, the financial computer models are analyzed and mathematically calculate the cost per acre foot per WSA for "WSA-specific" transmission, and cost per acre foot for "Agency-wide" storage, banking, and treatment.

The Agency's financial model calculates these costs using a number of assumptions, including estimated future water demand (acre feet), construction inflation, general inflation, cost of borrowed money, interest earnings, and increase in assessed value. (See Appendices E and F) for a detailed explanation of the model and its method of calculation and assumptions.) Most important, the financial model also utilizes the cash flow approach to determine when funds would have to be borrowed. For the FY 2003/04 Facility Capacity Fee calculation, the financial model is based on the most recent CIP requirements and the updated forecast for water demand. The Agency generally conducts an annual review and update of the CIP as well as the Facility Capacity Fee schedule. As the area develops, there will be a shift in demand from WSA to WSA based on a number of factors such as changes in anticipated development, type of developments, etc.

The annual update provides an opportunity to revise the capital needs and resulting costs in response to actual conditions. The location, size, and timing of facilities are done in accordance with District Policy. Facilities are to be available five years ahead of need. This policy precludes the construction of facilities far in advance of need, thus eliminating the cost of maintaining underutilized facilities. Further, it precludes growth inducement since the facilities are only constructed to meet the needs of authorized development. In summary, the financial model was designed to incorporate all parameters concerning the CIP, estimated water demands, and assumptions that impact the Facility Capacity Fee.

Fiscal Year 2003/04 Facility Capacity Fees

The proposed CIP in FY 2003/04 dollars is estimated at about $455 million (Appendix D). The specific amount of expenditure of capital funds will be authorized by the Board of Directors after consideration is given to a variety of physical factors and the needs of the purveyors. The proposed Facility Capacity Fees by water service area for FY 03-04 are as noted:

WSA	Charge Per Acre Foot	
	FY 1999/2000	FY 2003/04
99-1	$ 9,056	$ 8,771
99-2	$ 9,142	$ 9,336
99-3	$ 9,451	$ 12,833
99-4	$ 8,498	$ 11,479
99-5	$ 8,772	$ 9,900
99-6	$ 7,984	$ 8,213
99-7	$ 8,554	$ 9,446
99-8	$ 8,889	$ 8,856

Some of the fees are increasing and others are decreasing. The change is due to a number of factors, including the distribution of past debt and estimated imported water demands by the WSAs. The CIP likewise changed in that the acquisition of the Santa Clarita Water Company (SCWC) reduced capital needs while the re-evaluation of the State Water Project's

reliability resulted in the need to acquire more water and increase groundwater banking programs.

Apportionment of Costs and Benefits

The current CIP models were developed using a variety of sources of revenue including Facility Capacity Fees, portion of 1% property taxes, interest earnings and other miscellaneous income. Multiple models were analyzed in order to establish a proforma that would match the appropriate revenue sources with expenditures, thus complying with law and achieving the equities required by the fairness doctrine adopted by the Board of Directors.

Because of the detailed and comprehensive cash flow modeling, the appropriate WSA Facility Capacity Fees were developed to match their proportionate share of the CIP facilities attributable to growth. **That portion of the CIP that is attributable to benefits to the existing users is funded through revenue other than from Facility Capacity Fees.**

The State Water Project costs (fixed and variable) have been paid through existing voter approved ad valorem taxes for all properties within the agency's service area. The undeveloped property assessed value is $846,968,711 (5% of total assessed value) and developed property assessed value is $16,352,999,197 (95% of total assessed value) as of August 2002.

Planning Horizon

The Agency's long-range capital program consists of major water supply projects needed to supply the proposed development authorized by the appropriate planning agencies. The plan takes into consideration the following factors:

1. It includes facilities which include water acquisition, treatment, storage, and transmission pipelines
2. It utilizes cost data and timing for input into the Facility Capacity Fee model
3. It involves a time-phased program to accommodate the projected need five years in advance

The traditional approach used by the water industry is to plan infrastructure alternatives as far into the future as practical and update it as often as annually to ensure the plan will reasonably take into account changed circumstances as they occur. The Agency's CIP program is designed in a manner that allows the Agency to modify specific projects in response to changed conditions and at the same time maintain the fiscal integrity of the program. The timing and location of actual water demand has changed over the past 17-plus years and the CIP program as well as the charges have responded to these changes.

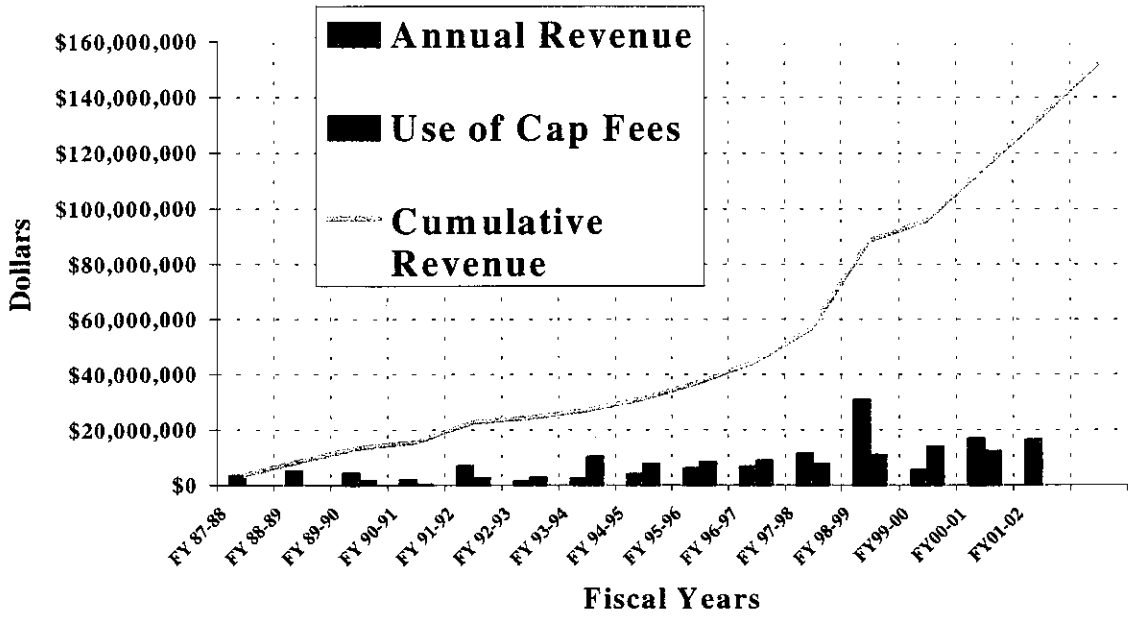
The legislature has recognized the need for long-range water planning in California as exemplified in the requirement for water agencies to provide an Urban Water Management Plan every five years. This plan takes into consideration water demands under various hydrological cycles for at least 20 or more years. Further, the legislature recently passed SB 221 and SB 610, which place greater emphasis on long-term water planning because it mandates that water purveyors provide assurance of water supplies 20 or more years into the future.

Water Supply Planning and Development in California requires very long planning horizons. For this reason the Agency has adopted a 50-year planning horizon for its planning model.

CIP Financing

Since the majority of the Agency's Capital programs are required for future needs, it was determined that the program would be debt-financed. This excludes the existing rate payer from funding growth related costs. Existing users only pay for the benefits they derive from the agency's CIP. This is in keeping with the Agency Policy of "Benefiting User Pays." In addition, water supply facilities last many generations and it would place an undue burden on existing users if the CIP were to be funded on a pay as you go basis. Debt financing allows each generation to pay for what it uses. This is also in keeping with the Agency Policy of "Benefiting User Pays." This can be best demonstrated by the history of Facility Capacity Fee Revenues.

Summary of Facility Capacity Fee Revenue



Facility Capacity Fees collected in one fiscal year may not be expended until future fiscal years. Likewise, in some years, there will not be sufficient Facility Capacity Fees collected to cover the cost of the CIP or other such expenses (such as payments on existing Agency Certificates of Participation). The financial model incorporates the impact of these timing conditions. In addition, reserve funds have been set aside to ensure the economic viability of the CIP and to provide security for the repayment of Certificates of Participation issued by the Agency to fund its CIP as described in this Data Document and in prior year Agency data documents.

Capital Replacement

The cost of system maintenance and replacement, as well as upgrades to comply with water quality regulations, is a responsibility of the existing user and as such is not funded from Facility Capacity Fees.

Summary

The foregoing program is intended to comply with the Board-adopted policies of conservatism and fairness. Conservatism will be achieved through the measured construction of those facilities necessary to maintain an advance supply of water to meet the needs of those developments authorized by the planning agencies.

Implementation of the Fairness Doctrine is accomplished through the use of a mixture of revenue sources that match the benefit to the cost. The proposed Facility Capacity Fee is calculated to fund that portion of the CIP attributable to growth-related facilities. That portion of the CIP attributable to existing users is funded by other sources.

Through the use of the aforementioned water resources, the optimization of the entire Santa Clarita Valley's water resources is achievable. Thus, the **Santa Clarita Valley is provided with reliable, quality water at a reasonable cost.**

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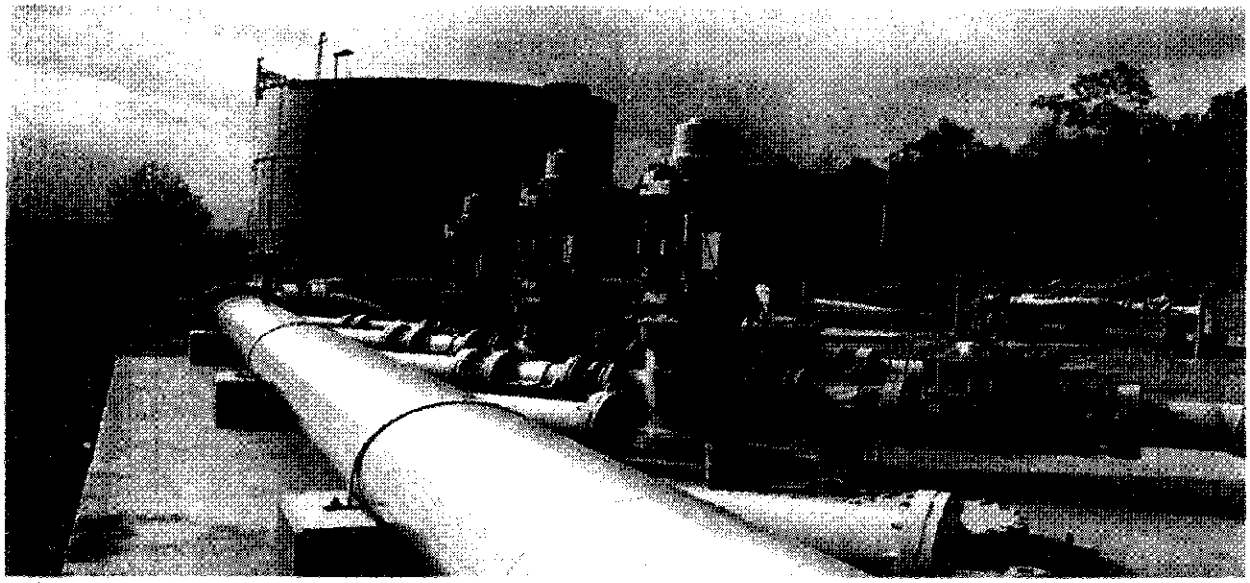
APPENDICES



Projected Annual Increase In Water Demand in Acre-Feet

WSA	1	2	3	4	5	6	7	8	Totals
2004	331	191	597	268	425	185	1,086	14	3,096
2005	334	151	530	237	400	192	988	14	2,847
2006	345	130	492	219	381	202	931	22	2,722
2007	271	8	157	56	135	166	372	19	1,184
2008	244	7	80	27	110	164	304	20	955
2009	241	33	31	4	101	165	293	20	888
2010	215	26	24	31	76	168	236	21	797
2011	189	9	93	33	55	172	203	21	775
2012	312	16	118	97	262	246	240	28	1,320
2013	300	10	257	45	253	288	573	30	1,756
2014	286	9	243	112	239	285	541	32	1,747
2015	276	12	238	109	229	283	525	34	1,706
2016	265	17	232	106	226	278	506	37	1,666
2017	257	10	234	105	219	274	497	43	1,638
2018	249	10	234	105	219	269	491	43	1,621
2019	244	12	237	106	220	264	491	43	1,618
2020	280	12	317	146	284	285	632	46	2,003
2021	298	67	361	168	303	295	708	48	2,247
2022	304	78	382	179	320	298	743	48	2,351
2023	307	112	395	185	339	298	763	49	2,446
2024	307	137	403	189	349	296	775	49	2,506
2025	307	144	410	192	350	294	784	49	2,530
2026	306	184	415	195	356	292	792	49	2,589
2027	305	174	420	198	352	289	798	44	2,580
2028	304	155	424	200	355	286	805	17	2,547
2029	304	139	429	203	358	284	811	18	2,546
2030	304	147	434	205	317	281	818	18	2,524
2031	304	154	439	157	318	279	826	19	2,497
2032	304	162	344	163	334	277	659	20	2,263
2033	301	169	339	169	339	275	679	21	2,292
2034	302	176	351	175	346	274	698	22	2,344
2035	304	183	364	180	345	273	718	23	2,390
2036	307	190	376	186	340	272	738	24	2,433
2037	336	220	433	214	386	292	840	28	2,749
2038	298	229	449	221	398	294	868	29	2,787
2039	296	229	449	212	396	289	865	29	2,765
2040	261	229	448	212	363	285	805	29	2,631
2041	261	229	448	212	363	280	805	29	2,626
2042	261	229	447	212	363	276	805	29	2,621
2043	261	229	446	212	363	272	805	29	2,616
2044	261	229	446	212	363	200	805	29	2,544
2045	261	229	445	212	363	200	805	29	2,543
2046	261	229	445	212	363	200	805	29	2,543
2047	261	229	444	212	363	200	805	29	2,542
2048	261	229	436	212	363	200	805	29	2,534
2049	261	229	436	212	363	200	805	29	2,534
2050	174	153	201	141	242	133	537	19	1,599
Total	13,221	6,153	16,377	7,662	14,309	11,774	32,192	1,406	103,059

Projected Annual Sales in Acre-Feet

	1	2	3	4	5	6	7	8	Totals
2004	182	105	328	147	234	102	597	8	1,703
2005	184	83	292	130	220	106	544	8	1,566
2006	190	71	271	121	209	111	512	12	1,497
2007	149	4	86	31	74	91	205	11	651
2008	134	4	44	15	61	90	167	11	525
2009	133	18	17	2	56	91	161	11	489
2010	118	14	13	17	42	93	130	11	439
2011	104	5	51	18	30	94	112	12	426
2012	171	9	65	53	144	135	132	16	726
2013	165	5	142	25	139	159	315	17	966
2014	157	5	134	61	131	157	297	18	961
2015	152	7	131	60	126	156	289	19	939
2016	146	9	128	58	124	153	278	20	916
2017	141	6	129	58	120	151	273	24	901
2018	137	6	129	58	121	148	270	24	891
2019	134	7	130	59	121	145	270	24	890
2020	154	7	175	81	156	156	348	25	1,101
2021	164	37	199	93	166	162	390	26	1,236
2022	167	43	210	98	176	164	409	27	1,293
2023	169	61	217	102	186	164	419	27	1,345
2024	169	75	222	104	192	163	426	27	1,378
2025	169	79	225	106	192	162	431	27	1,392
2026	168	101	228	107	196	161	435	27	1,424
2027	168	96	231	109	194	159	439	24	1,419
2028	167	85	233	110	195	158	443	9	1,401
2029	167	77	236	111	197	156	446	10	1,400
2030	167	81	239	113	174	155	450	10	1,388
2031	167	85	241	87	175	153	454	11	1,373
2032	167	89	189	90	184	152	362	11	1,245
2033	165	93	186	93	187	151	373	12	1,260
2034	166	97	193	96	190	151	384	12	1,289
2035	167	100	200	99	190	150	395	13	1,315
2036	169	104	207	102	187	150	406	13	1,338
2037	185	121	238	118	212	160	462	15	1,512
2038	164	126	247	122	219	162	478	16	1,533
2039	163	126	247	116	218	159	476	16	1,521
2040	144	126	246	116	199	157	443	16	1,447
2041	144	126	246	116	199	154	443	16	1,444
2042	144	126	246	116	199	152	443	16	1,442
2043	144	126	246	116	199	150	443	16	1,439
2044	144	126	245	116	199	110	443	16	1,399
2045	144	126	245	116	199	110	443	16	1,399
2046	144	126	245	116	199	110	443	16	1,398
2047	144	126	244	116	199	110	443	16	1,398
2048	144	126	240	116	199	110	443	16	1,394
2049	144	126	240	116	199	110	443	16	1,394
2050	96	84	111	78	133	73	295	11	880
Total	7,271	3,383	9,006	4,212	7,867	6,472	17,702	769	56,682

Castaic Lake Water Agency
Historic Water Facilities Fee Sales (Acre Feet)

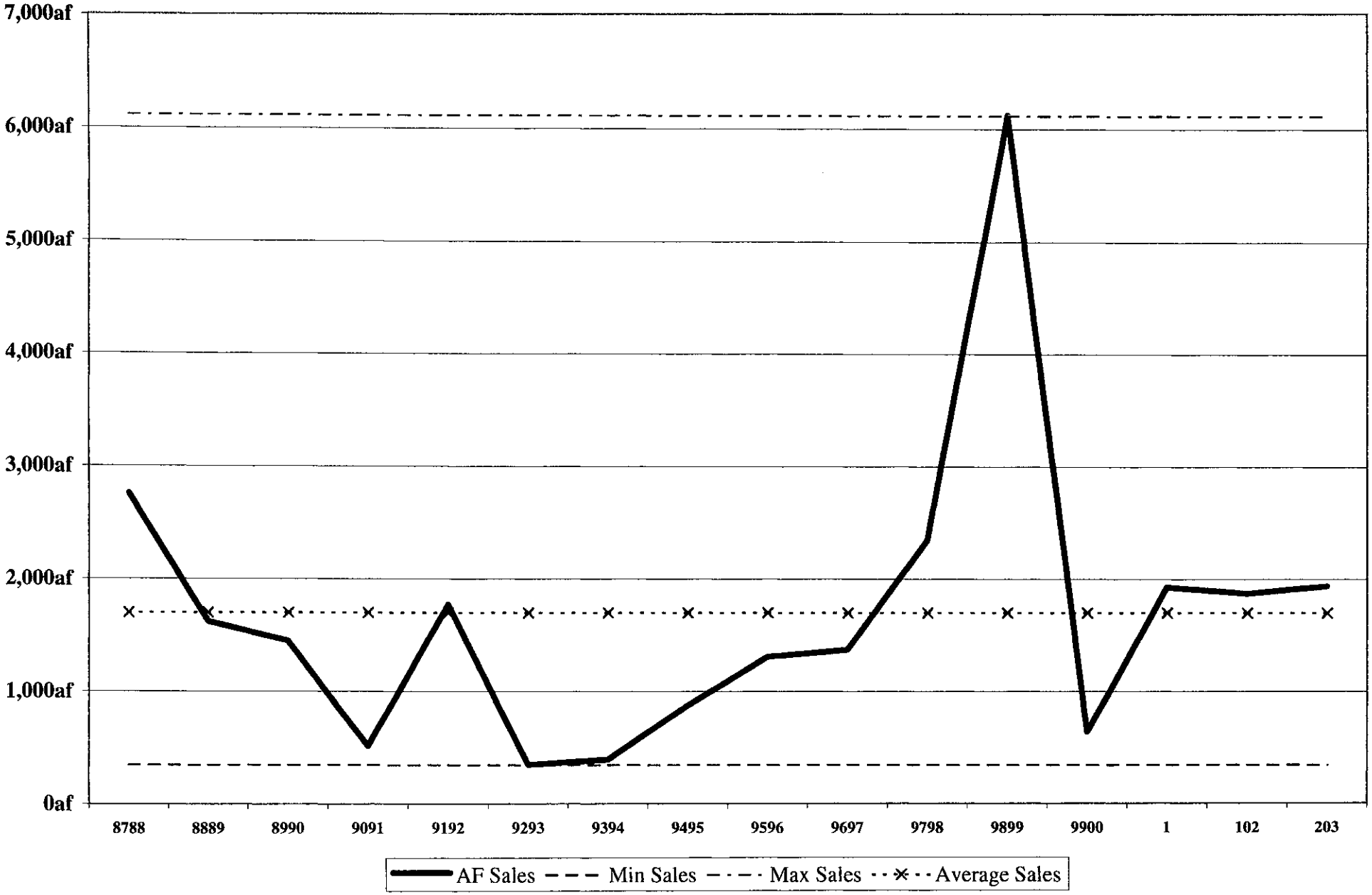


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Table D
Castaic Lake Water Agency
FY 03/04 Capital Improvement Project Allocations

Project	Description
Water Supply Projects Projects 1 through 13 Recycled Water – Phase IB through Phase XI, Recycled water ASR project and associated environmental studies.	Cost of design and construction of the Reclaimed Water System phases as developed in the Draft Master Plan Update. Existing users pay share of project based on their share (65,490 AF – 38.75%) of the 2050 demand (168,950 AF) of the agency. Future users pay 61.24%. Projects increase system reliability. Project cost shared by all sub-WSAs.
Project 14 Additional Water Supply Purchase (40,000 AF)	Cost of acquiring additional water supply to increase level of contractual State Water Project contracts (or other water supply). Additional supply required due to recently identified reliability of current SWP contracts. Future users pay all costs and shared by all sub-WSAs.
Water Supply Banking Projects Projects 15 through 20 Water Supply Banking I, II, III and IV: Suagus Wells 1, 2, 3, and 4	Existing users pay a share of the project costs based on their share of imported water demand (36,839 AF – 36.29%) of the 2050 demand (101,520 AF). Future users allocated 63.71%. Project cost is shared by all sub-WSAs.
Pipeline/PS/Storage Projects Project 21 Honby Extension and Storage II.	Cost of design and construction of the pipeline, reservoir, and pump station. Existing users pay a share of the cost of the storage facilities based on their share of demand. Future users pay the cost of pipeline, pump station, and their share of the storage facilities. First phase of project. Storage facilities cost shared by all sub-WSAs. Pipeline and pump station cost shared by sub-WSAs 88-23, 25, 26, 33, and 36.
Project 22 Lateral Extension (Pitchess)	Cost of design and construction of pipeline from the Castaic Conduit west to the west side of Interstate 5. New pipeline to serve future users. Future users pay all project costs. Pipeline cost is shared by sub-WSAs 88-2 and 15.
Project 23 Lateral Ext. & Storage	Cost of design and construction of the Lateral Extension & Storage Project. The pipeline begins at the Newhall Parallel at the Santa Clara River and travels west into the mountains west of interstate 5. This project includes a reservoir near its terminus. Existing users pay a share of the cost of the storage facilities based on their share of demand. Future users pay cost of pipeline and their share of the storage facilities. Storage facilities cost is shared by all sub-WSAs. Pipeline

Project	Description
	cost is paid by sub-WSA 88-12 and 15.
Project 24 Honby and Newhall Parallel II (Honby Parallel)	Cost of design and construction of the Honby Parallel from RVWTP to Sand Canyon Road. Project includes pipeline, reservoir, and pump station. Existing users pay a share of the cost of the storage facilities based on their share of demand. Future users pay the cost of pipeline, pump station, and their share of the storage facilities. Storage facilities cost shared by all sub-WSAs. Pipeline and pump station costs shared by sub-WSAs 88-23, 25, 26, 33 and 36.
Project 25 Honby & Newhall Parallel III (Newhall Parallel 2)	Cost of design and construction of the pipeline. Future users pay all costs. Pipeline cost shared by sub-WSAs 88-23, 25, 26, 33, and 36.
Project 26 System Appurtenances I (CC)	Cost associated with relocation of the Castaic Conduit. Project enhances capacity of treatment system. Future users pay the entire cost. Project cost shared by all sub-WSAs.
Project 27 System Appurtenances II (MWD Cap.)	Cost associated with capacity in MWD system to deliver SWP to CLWA. Future users pay the entire cost. Project cost shared by all sub-WSAs.
Project 28 Additional Water Supply IX (SWP peaking)	Cost associated with delivery systems to deliver SWP to CLWA. Future users pay the entire cost. Project cost shared by all sub-WSAs.
Water Treatment Projects Project 29 ESFP Ozone/Contact Clarifiers/Wash-water Treatment	Cost of design and construction of Earl Schmidt Water Treatment Plant water quality upgrades needed to meet Clean Water Act. Project cost is allocated to existing users.
Project 30 Earl Schmidt Expansion 56 MGD – 1 (Treatment)	Cost of design and construction for the expansion of ESFP from 25 to 56 MGD. Future users pay the entire cost of expansion. Project cost is shared by all sub-WSAs.
Project 31 Earl Schmidt Exp. 56 MGD II (Intake Pump)	Future users will pay the entire cost for pump station improvements required to expand ESFP from 25 to 56 MGD. Total project cost is shared by all sub-WSAs.
Project 32 Earl Schmidt Storage Improvements 56 MGD III (storage)	Cost of design and construction of improvements to storage facilities at the ESFP. Existing users pay a share of the cost of the storage facilities based on their share of imported water demand (36,839 AF existing users and 101,520 AF for all

Project	Description
	users 2050). Project cost is shared by all sub-WSAs.
Project 33 Rio Vista Exp. 60 MGD (Treatment)	Cost of design and construction of expansion of RVWTP from 30 MGD to 60 MGD. Future users pay entire cost of the treatment plant expansion. Project cost is shared by all sub-WSAs.
Project 34 Rio Vista Exp. 90 MGD (Treatment)	Cost of design and construction of expansion of RVWTP from 60 MGD to 90 MGD. Future users pay the entire cost of treatment plant expansion. Project cost shared by all sub-WSAs
Project 35 Rio Vista Exp. 90 MGD (Storage)	Cost of design and construction of additional storage capacity at the RVWTP. Existing users pay for a share of the cost of the storage facilities based on their share of imported demand (36,839 AF existing users and 101,520 AF for all users in 2050). Project cost is shared by all sub-WSAs.
Project 36 Rio Vista Exp. 120 MGD (Treatment)	Cost of design and construction of expansion of RVWTP from 90 MGD to 120 MGD. Future users pay the entire cost of treatment plant expansion. Project cost shared by all sub-WSAs.
Project 37 Rio Vista Exp. 130 MGD (Treatment)	Cost of design and construction of expansion of RVWTP from 120 MGD to 130 MGD. Future users pay the entire cost of treatment plant expansion. Project cost shared by all sub-WSAs.
Projects 38, 39 and 40 Water Quality Improvements I, II and III	Cost of Improvements to the existing water treatment plants to meet changes in the State Drinking Water Act. Existing users pay entire costs.

	Project	Total Cost	Treatment/Storage/Supply		Pipeline	
	Water Supply Projects		Percent	Cost	Percent	Cost
1	Recycled Water - Phase IB	$4,547,000	100.00%	$4,547,000	0.00%	$0
2	Recycled Water - Phase II	$10,618,000	100.00%	$10,618,000	0.00%	$0
3	Recycled Water - Phase III	$9,072,000	100.00%	$9,072,000	0.00%	$0
4	Recycled Water - Phase IV	$12,809,000	100.00%	$12,809,000	0.00%	$0
5	Recycled Water - Phase V	$1,746,000	100.00%	$1,746,000	0.00%	$0
6	Recycled Water - Phase VI	$4,718,000	100.00%	$4,718,000	0.00%	$0
7	Recycled Water - Phase VII	$9,268,000	100.00%	$9,268,000	0.00%	$0
8	Recycled Water - Phase VIII	$5,453,000	100.00%	$5,453,000	0.00%	$0
9	Recycled Water - Phase IX	$1,804,000	100.00%	$1,804,000	0.00%	$0
10	Recycled Water - Phase X	$1,783,000	100.00%	$1,783,000	0.00%	$0
11	Recycled Water - Phase XI	$762,000	100.00%	$762,000	0.00%	$0
12	Recycled Water - ASR	$8,337,000	100.00%	$8,337,000	0.00%	$0
13	Recycled Water Environmental Studies	$515,000	100.00%	$515,000	0.00%	$0
14	Additional Supply Purchase (40,000 AFY)	$60,000,000	100.00%	$60,000,000	0.00%	$0
	Subtotal	**$131,432,000**		**$131,432,000**		**$0**
	Water Supply Banking Projects					
15	Water Supply Banking I	$17,366,000	100.00%	$17,366,000	0.00%	$0
16	Water Supply Banking II	$17,366,000	100.00%	$17,366,000	0.00%	$0
17	Water Supply Banking III	$17,366,000	100.00%	$17,366,000	0.00%	$0
18	Water Supply Banking IV	$17,366,000	100.00%	$17,366,000	0.00%	$0
19	Saugus Aquifer Wells 1 and 2	$2,745,000	100.00%	$2,745,000	0.00%	$0
20	Saugus Aquifer Wells 3 and 4	$2,745,000	100.00%	$2,745,000	0.00%	$0
	Subtotal	**$74,954,000**		**$74,954,000**		**$0**
	Pipeline/PS/Storage Projects					
21	Honby Extension & Storage II	$15,366,000	20.70%	$3,388,000	79.30%	$12,978,000
22	Lateral Extension (Pitchess)	$2,138,000	0.00%	$0	100.00%	$2,138,000
23	Lateral Extension & Storage II	$12,269,000	37.96%	$4,657,000	62.04%	$7,612,000
24	Honby & Newhall Parallel II (Honby Parallel)	$24,462,000	29.84%	$7,300,000	70.16%	$17,162,000
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	$2,719,000	0.00%	$0	100.00%	$2,719,000
26	System Appurtenances I (CC)	$6,559,000	0.00%	$0	100.00%	$6,559,000
27	System Appurtenances II (MWD Cap.)	$6,898,000	0.00%	$0	100.00%	$6,898,000
28	Additional Water Supply IX (SWP Peaking)	$5,490,000	0.00%	$0	100.00%	$5,490,000
	Subtotal	**$76,901,000**		**$15,345,000**		**$61,556,000**
	Water Treatment Projects					
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	$9,762,000	100.00%	$9,762,000	0.00%	$0
30	ESFP Exp. 56 MGD I (Treatment)	$9,084,000	100.00%	$9,084,000	0.00%	$0
31	ESFP Exp. 56 MGD II (Intake Pump)	$4,944,000	100.00%	$4,944,000	0.00%	$0
32	ESFP Exp. 56 MGD III (Storage)	$19,842,000	100.00%	$19,842,000	0.00%	$0
33	Rio Vista Exp. 60 MGD	$23,683,000	100.00%	$23,683,000	0.00%	$0
34	Rio Vista Exp. 90 MGD (Treatment)	$30,699,000	100.00%	$30,699,000	0.00%	$0
35	Rio Vista Exp. 90 MGD (Storage)	$9,173,000	100.00%	$9,173,000	0.00%	$0
36	Rio Vista Exp. 120 MGD	$22,438,000	100.00%	$22,438,000	0.00%	$0
37	Rio Vista Exp. 130 MGD	$11,500,000	100.00%	$11,500,000	0.00%	$0
38	Water Quality Improvements I	$8,365,000	100.00%	$8,365,000	0.00%	$0
39	Water Quality Improvements II	$11,309,000	100.00%	$11,309,000	0.00%	$0
40	Water Quality Improvements III	$11,309,000	100.00%	$11,309,000	0.00%	$0
	Subtotal	**$172,108,000**		**$172,108,000**		**$0**
	Total Capital Improvement Program Cost	**$455,395,000**	**86.48%**	**$393,839,000**	**13.52%**	**$61,556,000**

Castaic Lake Water Agency
FY03-04 Capital Improvement Program
Existing vs Future Cost Allocation

			Existing Users Share of Costs		Future Users Share of Costs	
	Project	Project Cost (2003 $)	Percent	Cost (2003)	Percent	Cost
	Water Supply Projects					
1	Recycled Water - Phase IB	$4,547,000	38.76%	$1,763,000	61.24%	$2,784,000
2	Recycled Water - Phase II	$10,618,000	38.76%	$4,116,000	61.24%	$6,502,000
3	Recycled Water - Phase III	$9,072,000	38.76%	$3,517,000	61.24%	$5,555,000
4	Recycled Water - Phase IV	$12,809,000	38.76%	$4,965,000	61.24%	$7,844,000
5	Recycled Water - Phase V	$1,746,000	38.76%	$677,000	61.24%	$1,069,000
6	Recycled Water - Phase VI	$4,718,000	38.76%	$1,829,000	61.24%	$2,889,000
7	Recycled Water - Phase VII	$9,268,000	38.76%	$3,593,000	61.24%	$5,675,000
8	Recycled Water - Phase VIII	$5,453,000	38.76%	$2,114,000	61.24%	$3,339,000
9	Recycled Water - Phase IX	$1,804,000	38.76%	$699,000	61.24%	$1,105,000
10	Recycled Water - Phase X	$1,783,000	38.76%	$691,000	61.24%	$1,092,000
11	Recycled Water - Phase XI	$762,000	38.76%	$295,000	61.24%	$467,000
12	Recycled Water - ASR	$8,337,000	38.76%	$3,232,000	61.24%	$5,105,000
13	Recycled Water Environmental Studies	$515,000	38.76%	$200,000	61.24%	$315,000
14	Additional Supply Purchase (40,000 AFY)	$60,000,000	0.00%	$0	100.00%	$60,000,000
	Subtotal	**$131,432,000**	**21.07%**	**$27,691,000**	**78.93%**	**$103,741,000**
	Water Supply Banking Projects					
15	Water Supply Banking I	$17,366,000	36.29%	$6,302,000	63.71%	$11,064,000
16	Water Supply Banking II	$17,366,000	36.29%	$6,302,000	63.71%	$11,064,000
17	Water Supply Banking III	$17,366,000	36.29%	$6,302,000	63.71%	$11,064,000
18	Water Supply Banking IV	$17,366,000	36.29%	$6,302,000	63.71%	$11,064,000
19	Saugus Aquifer Wells 1 and 2	$2,745,000	36.29%	$996,000	63.71%	$1,749,000
20	Saugus Aquifer Wells 3 and 4	$2,745,000	36.29%	$996,000	63.71%	$1,749,000
	Subtotal	**$74,954,000**	**36.29%**	**$27,200,000**	**63.71%**	**$47,754,000**
	Pipeline/PS/Storage Projects					
21	Honby Extension & Storage II	$16,366,000	7.51%	$1,229,000	92.49%	$15,137,000
22	Lateral Extension (Pitchess)	$2,136,000	0.00%	$0	100.00%	$2,136,000
23	Lateral Extension & Storage II	$12,269,000	13.77%	$1,690,000	86.23%	$10,579,000
24	Honby & Newhall Parallel II (Honby Parallel)	$24,462,000	10.83%	$2,649,000	89.17%	$21,813,000
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	$2,719,000	0.00%	$0	100.00%	$2,719,000
26	System Appurtenances I (CC)	$6,559,000	0.00%	$0	100.00%	$6,559,000
27	System Appurtenances II (MWD Cap.)	$6,898,000	0.00%	$0	100.00%	$6,898,000
28	Additional Water Supply IX (SWP Peaking)	$5,490,000	0.00%	$0	100.00%	$5,490,000
	Subtotal	**$76,901,000**	**7.24%**	**$5,568,000**	**92.76%**	**$71,333,000**
	Water Treatment Projects					
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	$9,762,000	100.00%	$9,762,000	0.00%	$0
30	ESFP Exp. 56 MGD I (Treatment)	$9,084,000	0.00%	$0	100.00%	$9,084,000
31	ESFP Exp. 56 MGD II (Intake Pump)	$4,944,000	0.00%	$0	100.00%	$4,944,000
32	ESFP Exp. 56 MGD III (Storage)	$19,842,000	36.29%	$7,200,000	63.71%	$12,642,000
33	Rio Vista Exp. 60 MGD	$23,683,000	0.00%	$0	100.00%	$23,683,000
34	Rio Vista Exp. 90 MGD (Treatment)	$30,699,000	0.00%	$0	100.00%	$30,699,000
35	Rio Vista Exp. 90 MGD (Storage)	$9,173,000	36.29%	$3,329,000	63.71%	$5,844,000
36	Rio Vista Exp. 120 MGD	$22,438,000	0.00%	$0	100.00%	$22,438,000
37	Rio Vista Exp. 130 MGD	$11,500,000	0.00%	$0	100.00%	$11,500,000
38	Water Quality Improvements I	$8,365,000	100.00%	$8,365,000	0.00%	$0
39	Water Quality Improvements II	$11,309,000	100.00%	$11,309,000	0.00%	$0
40	Water Quality Improvements III	$11,309,000	100.00%	$11,309,000	0.00%	$0
	Subtotal	**$172,108,000**	**29.79%**	**$51,274,000**	**70.21%**	**$120,834,000**
	Total Capital Improvement Program Cost	**$455,395,000**	**24.54%**	**$111,733,000**	**75.46%**	**$343,662,000**
	Existing Total Water Demand - 2003 (AFY)	65,491				
	Future Total Water Demand - 2050 (AFY)	168,950				
	Share Existing (total)	38.76%				
	Share Future (total)	61.24%				
	Existing Imported Demand (AFY)	36,839				
	Future Imported Demand (AFY)	101,520				
	Share Existing (imported)	36.29%				
	Share Future (imported)	63.71%				
	Water Banking Allocation					
	Existing Users Requirements (AFY	36,839				
	Future Users Requirements (AFY	101,520				
	Existing Users allocation	36.29%				
	Future Users allocation	63.71%				

Castaic Lake Water Agency
FY03-04 Capital Improvement Program
Program Schedule

	Project	Project Type	Growth Portion	Total Cost	Growth Portion of Cost	Fiscal Year Required	2004	2005	2006	2007	2008	2009
	Water Supply Projects											
1	Recycled Water - Phase IB	Water Supply	61.24%	$4,547,000	$2,784,000	2004	$2,784,000					
2	Recycled Water - Phase II	Water Supply	61.24%	$10,618,000	$6,502,000	2006	$1,950,600	$1,950,600	$2,600,800			
3	Recycled Water - Phase III	Water Supply	61.24%	$9,072,000	$5,555,000	2007		$1,666,500	$1,666,500	$2,222,000		
4	Recycled Water - Phase IV	Water Supply	61.24%	$12,809,000	$7,844,000	2008			$2,353,200	$2,353,200	$3,137,600	
5	Recycled Water - Phase V	Water Supply	61.24%	$1,746,000	$1,069,000	2009				$320,700	$320,700	$427,600
6	Recycled Water - Phase VI	Water Supply	61.24%	$4,718,000	$2,889,000	2010					$866,700	$866,700
7	Recycled Water - Phase VII	Water Supply	61.24%	$9,268,000	$5,675,000	2011						$1,702,500
8	Recycled Water - Phase VIII	Water Supply	61.24%	$5,453,000	$3,339,000	2012						
9	Recycled Water - Phase IX	Water Supply	61.24%	$1,804,000	$1,105,000	2013						
10	Recycled Water - Phase X	Water Supply	61.24%	$1,783,000	$1,092,000	2014						
11	Recycled Water - Phase XI	Water Supply	61.24%	$762,000	$467,000	2014						
12	Recycled Water - ASR	Water Supply	61.24%	$8,337,000	$5,105,000	2005	$2,297,250	$2,807,750				
13	Recycled Water Environmental Studies	Water Supply	61.24%	$515,000	$315,000	2004	$315,000					
14	Additional Supply Purchase (40,000 AFY)	Water Supply	100.00%	$60,000,000	$60,000,000	2032						
	Subtotal			**$131,432,000**	**$103,741,000**		**$7,346,850**	**$6,424,950**	**$6,620,500**	**$4,896,900**	**$4,326,000**	**$2,996,800**
	Water Supply Banking Projects											
15	Water Supply Banking I	Water Supply	63.71%	$17,366,000	$11,064,000	2004	$11,064,000					
16	Water Supply Banking II	Water Supply	63.71%	$17,366,000	$11,064,000	2014						
17	Water Supply Banking III	Water Supply	63.71%	$17,366,000	$11,064,000	2022						
18	Water Supply Banking IV	Water Supply	63.71%	$17,366,000	$11,064,000	2028						
19	Saugus Aquifer Wells 1 and 2	Water Supply	63.71%	$2,745,000	$1,749,000	2004	$1,749,000					
20	Saugus Aquifer Wells 3 and 4	Water Supply	63.71%	$2,745,000	$1,749,000	2004	$1,749,000					
	Subtotal			**$74,954,000**	**$47,754,000**		**$14,562,000**	**$0**	**$0**	**$0**	**$0**	**$0**
	Pipeline/PS/Storage Projects											
21	Honby Extension & Storage II	Pipeline/PS/Storage	92.49%	$16,366,000	$15,137,000	2005	$7,568,500	$7,568,500				
22	Lateral Extension (Pitchess)	Pipeline	100.00%	$2,138,000	$2,138,000	2004	$2,138,000					
23	Lateral Extension & Storage II	Pipeline/Storage	86.23%	$12,269,000	$10,579,000	2005	$3,173,700	$7,405,300				
24	Honby & Newhall Parallel II (Honby Parallel)	Pipeline/PS/Storage	89.17%	$24,462,000	$21,813,000	2017						
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	Pipeline	100.00%	$2,719,000	$2,719,000	2005	$815,700	$1,903,300				
26	System Appurtenances I (CC)	Pipeline	100.00%	$6,559,000	$6,559,000	2005	$1,967,700	$4,591,300				
27	System Appurtenances II (MWD Cap.)	Pipeline	100.00%	$6,898,000	$6,898,000	2035						
28	Additional Water Supply IX (SWP Peaking)	Pipeline	100.00%	$5,490,000	$5,490,000	2010						
	Subtotal			**$76,901,000**	**$71,333,000**		**$15,663,600**	**$21,468,400**	**$0**	**$0**	**$0**	**$0**
	Water Treatment Projects											
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	Water Treatment	0.00%	$9,762,000	$0	2006	$0	$0	$0			
30	ESFP Exp. 56 MGD I (Treatment)	Water Treatment	100.00%	$9,084,000	$9,084,000	2006	$2,725,200	$2,725,200	$3,633,600			
31	ESFP Exp. 56 MGD II (Intake Pump)	Water Treatment	100.00%	$4,944,000	$4,944,000	2006	$1,483,200	$1,483,200	$1,977,600			
32	ESFP Exp. 56 MGD III (Storage)	Water Treatment	63.71%	$19,842,000	$12,642,000	2006	$3,792,600	$3,792,600	$5,056,800			
33	Rio Vista Exp. 60 MGD	Water Treatment	100.00%	$23,683,000	$23,683,000	2010					$4,736,600	$7,104,900
34	Rio Vista Exp. 90 MGD (Treatment)	Water Treatment	100.00%	$30,699,000	$30,699,000	2026						
35	Rio Vista Exp. 90 MGD (Storage)	Water Treatment	63.71%	$9,173,000	$5,844,000	2026						
36	Rio Vista Exp. 120 MGD	Water Treatment	100.00%	$22,438,000	$22,438,000	2040						
37	Rio Vista Exp. 130 MGD	Water Treatment	100.00%	$11,500,000	$11,500,000	2048						
38	Water Quality Improvements I	Water Treatment	0.00%	$8,365,000	$0	2009				$0	$0	$0
39	Water Quality Improvements II	Water Treatment	0.00%	$11,309,000	$0	2010					$0	$0
40	Water Quality Improvements III	Water Treatment	0.00%	$11,309,000	$0	2015						
	Subtotal			**$172,106,000**	**$120,834,000**		**$8,001,000**	**$8,001,000**	**$10,668,000**	**$0**	**$4,736,600**	**$7,104,900**
	Total Capital Improvement Program Cost			**$455,395,000**	**$343,662,000**		**$45,573,450**	**$35,894,250**	**$17,288,500**	**$4,896,900**	**$9,061,600**	**$10,101,700**

Castaic Lake Water Agency
FY03-04 Capital Improvement Program
Program Schedule

	Project	Project Type	Growth Portion	Total Cost	Growth Portion of Cost	Fiscal Year Required	2010	2011	2012	2013	2014	2015
	Water Supply Projects											
1	Recycled Water - Phase IB	Water Supply	61.24%	$4,547,000	$2,784,000	2004						
2	Recycled Water - Phase II	Water Supply	61.24%	$10,618,000	$6,502,000	2006						
3	Recycled Water - Phase III	Water Supply	61.24%	$9,072,000	$5,555,000	2007						
4	Recycled Water - Phase IV	Water Supply	61.24%	$12,809,000	$7,844,000	2008						
5	Recycled Water - Phase V	Water Supply	61.24%	$1,746,000	$1,069,000	2009						
6	Recycled Water - Phase VI	Water Supply	61.24%	$4,718,000	$2,889,000	2010	$1,155,600					
7	Recycled Water - Phase VII	Water Supply	61.24%	$9,268,000	$5,675,000	2011	$1,702,500	$2,270,000				
8	Recycled Water - Phase VIII	Water Supply	61.24%	$5,453,000	$3,339,000	2012	$1,001,700	$1,001,700	$1,335,600			
9	Recycled Water - Phase IX	Water Supply	61.24%	$1,804,000	$1,105,000	2013		$331,500	$331,500	$442,000		
10	Recycled Water - Phase X	Water Supply	61.24%	$1,783,000	$1,092,000	2014			$327,600	$327,600	$436,800	
11	Recycled Water - Phase XI	Water Supply	61.24%	$762,000	$467,000	2014			$140,100	$140,100	$186,800	
12	Recycled Water - ASR	Water Supply	61.24%	$8,337,000	$5,105,000	2005						
13	Recycled Water Environmental Studies	Water Supply	61.24%	$515,000	$315,000	2004						
14	Additional Supply Purchase (40,000 AFY)	Water Supply	100.00%	$60,000,000	$60,000,000	2032						
	Subtotal			**$131,432,000**	**$103,741,000**		**$3,859,800**	**$3,603,200**	**$2,134,800**	**$909,700**	**$623,600**	**$0**
	Water Supply Banking Projects											
15	Water Supply Banking I	Water Supply	63.71%	$17,366,000	$11,064,000	2004						
16	Water Supply Banking II	Water Supply	63.71%	$17,366,000	$11,064,000	2014					$11,064,000	
17	Water Supply Banking III	Water Supply	63.71%	$17,366,000	$11,064,000	2022						
18	Water Supply Banking IV	Water Supply	63.71%	$17,366,000	$11,064,000	2028						
19	Saugus Aquifer Wells 1 and 2	Water Supply	63.71%	$2,745,000	$1,749,000	2004						
20	Saugus Aquifer Wells 3 and 4	Water Supply	63.71%	$2,745,000	$1,749,000	2004						
	Subtotal			**$74,954,000**	**$47,754,000**		**$0**	**$0**	**$0**	**$0**	**$11,064,000**	**$0**
	Pipeline/PS/Storage Projects											
21	Honby Extension & Storage II	Pipeline/PS/Storage	92.49%	$16,366,000	$15,137,000	2005						
22	Lateral Extension (Pitchess)	Pipeline	100.00%	$2,138,000	$2,138,000	2004						
23	Lateral Extension & Storage II	Pipeline/Storage	86.23%	$12,269,000	$10,579,000	2005						
24	Honby & Newhall Parallel II (Honby Parallel)	Pipeline/PS/Storage	89.17%	$24,462,000	$21,813,000	2017						$4,362,600
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	Pipeline	100.00%	$2,719,000	$2,719,000	2005						
26	System Appurtenances I (CC)	Pipeline	100.00%	$6,559,000	$6,559,000	2005						
27	System Appurtenances II (MWD Cap.)	Pipeline	100.00%	$6,898,000	$6,898,000	2035						
28	Additional Water Supply IX (SWP Peaking)	Pipeline	100.00%	$5,490,000	$5,490,000	2010	$5,490,000					
	Subtotal			**$76,901,000**	**$71,333,000**		**$5,490,000**	**$0**	**$0**	**$0**	**$0**	**$4,362,600**
	Water Treatment Projects											
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	Water Treatment	0.00%	$9,762,000	$0	2006						
30	ESFP Exp. 56 MGD I (Treatment)	Water Treatment	100.00%	$9,084,000	$9,084,000	2006						
31	ESFP Exp. 56 MGD II (Intake Pump)	Water Treatment	100.00%	$4,944,000	$4,944,000	2006						
32	ESFP Exp. 56 MGD III (Storage)	Water Treatment	63.71%	$19,842,000	$12,642,000	2006						
33	Rio Vista Exp. 60 MGD	Water Treatment	100.00%	$23,683,000	$23,683,000	2010	$11,841,500					
34	Rio Vista Exp. 90 MGD (Treatment)	Water Treatment	100.00%	$30,699,000	$30,699,000	2026						
35	Rio Vista Exp. 90 MGD (Storage)	Water Treatment	63.71%	$9,173,000	$5,844,000	2026						
36	Rio Vista Exp. 120 MGD	Water Treatment	100.00%	$22,438,000	$22,438,000	2040						
37	Rio Vista Exp. 130 MGD	Water Treatment	100.00%	$11,500,000	$11,500,000	2048						
38	Water Quality Improvements I	Water Treatment	0.00%	$8,365,000	$0	2009						
39	Water Quality Improvements II	Water Treatment	0.00%	$11,309,000	$0	2010	$0					
40	Water Quality Improvements III	Water Treatment	0.00%	$11,309,000	$0	2015				$0	$0	$0
	Subtotal			**$172,108,000**	**$120,834,000**		**$11,841,500**	**$0**	**$0**	**$0**	**$0**	**$0**
	Total Capital Improvement Program Cost			**$455,395,000**	**$343,662,000**		**$21,191,300**	**$3,603,200**	**$2,134,800**	**$909,700**	**$11,687,600**	**$4,362,600**

Castaic Lake Water Agency
FY03-04 Capital Improvement Program
Program Schedule

	Project	Project Type	Growth Portion	Total Cost	Growth Portion of Cost	Fiscal Year Required	2016	2017	2018	2019	2020	2021	2022
	Water Supply Projects												
1	Recycled Water - Phase IB	Water Supply	61.24%	$4,547,000	$2,784,000	2004							
2	Recycled Water - Phase II	Water Supply	61.24%	$10,618,000	$6,502,000	2006							
3	Recycled Water - Phase III	Water Supply	61.24%	$9,072,000	$5,555,000	2007							
4	Recycled Water - Phase IV	Water Supply	61.24%	$12,809,000	$7,844,000	2008							
5	Recycled Water - Phase V	Water Supply	61.24%	$1,746,000	$1,069,000	2009							
6	Recycled Water - Phase VI	Water Supply	61.24%	$4,718,000	$2,889,000	2010							
7	Recycled Water - Phase VII	Water Supply	61.24%	$9,268,000	$5,675,000	2011							
8	Recycled Water - Phase VIII	Water Supply	61.24%	$5,453,000	$3,339,000	2012							
9	Recycled Water - Phase IX	Water Supply	61.24%	$1,804,000	$1,105,000	2013							
10	Recycled Water - Phase X	Water Supply	61.24%	$1,783,000	$1,092,000	2014							
11	Recycled Water - Phase Xi	Water Supply	61.24%	$762,000	$467,000	2014							
12	Recycled Water - ASR	Water Supply	61.24%	$8,337,000	$5,105,000	2005							
13	Recycled Water Environmental Studies	Water Supply	61.24%	$515,000	$315,000	2004							
14	Additional Supply Purchase (40,000 AFY)	Water Supply	100.00%	$60,000,000	$60,000,000	2032							
	Subtotal			**$131,432,000**	**$103,741,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Water Supply Banking Projects												
15	Water Supply Banking I	Water Supply	63.71%	$17,366,000	$11,064,000	2004							
16	Water Supply Banking II	Water Supply	63.71%	$17,366,000	$11,064,000	2014							
17	Water Supply Banking III	Water Supply	63.71%	$17,366,000	$11,064,000	2022							$11,064,000
18	Water Supply Banking IV	Water Supply	63.71%	$17,366,000	$11,064,000	2028							
19	Saugus Aquifer Wells 1 and 2	Water Supply	63.71%	$2,745,000	$1,749,000	2004							
20	Saugus Aquifer Wells 3 and 4	Water Supply	63.71%	$2,745,000	$1,749,000	2004							
	Subtotal			**$74,954,000**	**$47,754,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$11,064,000**
	Pipeline/PS/Storage Projects												
21	Honby Extension & Storage II	Pipeline/PS/Storage	92.49%	$16,366,000	$15,137,000	2005							
22	Lateral Extension (Pitchess)	Pipeline	100.00%	$2,138,000	$2,138,000	2004							
23	Lateral Extension & Storage II	Pipeline/Storage	86.23%	$12,269,000	$10,579,000	2005							
24	Honby & Newhall Parallel II (Honby Parallel)	Pipeline/PS/Storage	89.17%	$24,462,000	$21,813,000	2017	$6,543,900	$10,906,500					
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	Pipeline	100.00%	$2,719,000	$2,719,000	2005							
26	System Appurtenances I (CC)	Pipeline	100.00%	$6,559,000	$6,559,000	2005							
27	System Appurtenances II (MWD Cap.)	Pipeline	100.00%	$6,898,000	$6,898,000	2035							
28	Additional Water Supply IX (SWP Peaking)	Pipeline	100.00%	$5,490,000	$5,490,000	2010							
	Subtotal			**$76,901,000**	**$71,333,000**		**$6,543,900**	**$10,906,500**	**$0**	**$0**	**$0**	**$0**	**$0**
	Water Treatment Projects												
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	Water Treatment	0.00%	$9,762,000	$0	2006							
30	ESFP Exp. 56 MGD I (Treatment)	Water Treatment	100.00%	$9,084,000	$9,084,000	2006							
31	ESFP Exp. 56 MGD II (Intake Pump)	Water Treatment	100.00%	$4,944,000	$4,944,000	2006							
32	ESFP Exp. 56 MGD III (Storage)	Water Treatment	63.71%	$19,842,000	$12,642,000	2006							
33	Rio Vista Exp. 60 MGD	Water Treatment	100.00%	$23,683,000	$23,683,000	2010							
34	Rio Vista Exp. 90 MGD (Treatment)	Water Treatment	100.00%	$30,699,000	$30,699,000	2026							
35	Rio Vista Exp. 90 MGD (Storage)	Water Treatment	63.71%	$9,173,000	$5,844,000	2026							
36	Rio Vista Exp. 120 MGD	Water Treatment	100.00%	$22,438,000	$22,438,000	2040							
37	Rio Vista Exp. 130 MGD	Water Treatment	100.00%	$11,500,000	$11,500,000	2048							
38	Water Quality Improvements I	Water Treatment	0.00%	$8,365,000	$0	2009							
39	Water Quality Improvements II	Water Treatment	0.00%	$11,309,000	$0	2010							
40	Water Quality Improvements III	Water Treatment	0.00%	$11,309,000	$0	2015							
	Subtotal			**$172,108,000**	**$120,834,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Total Capital Improvement Program Cost			**$455,395,000**	**$343,662,000**		**$6,543,900**	**$10,906,500**	**$0**	**$0**	**$0**	**$0**	**$11,064,000**

Castaic Lake Water Agency
FY03-04 Capital Improvement Program
Program Schedule

	Project	Project Type	Growth Portion	Total Cost	Growth Portion of Cost	Fiscal Year Required	2023	2024	2025	2026	2027	2028
	Water Supply Projects											
1	Recycled Water - Phase IB	Water Supply	61.24%	$4,547,000	$2,784,000	2004						
2	Recycled Water - Phase II	Water Supply	61.24%	$10,618,000	$6,502,000	2006						
3	Recycled Water - Phase III	Water Supply	61.24%	$9,072,000	$5,555,000	2007						
4	Recycled Water - Phase IV	Water Supply	61.24%	$12,809,000	$7,844,000	2008						
5	Recycled Water - Phase V	Water Supply	61.24%	$1,746,000	$1,069,000	2009						
6	Recycled Water - Phase VI	Water Supply	61.24%	$4,718,000	$2,889,000	2010						
7	Recycled Water - Phase VII	Water Supply	61.24%	$9,268,000	$5,675,000	2011						
8	Recycled Water - Phase VIII	Water Supply	61.24%	$5,453,000	$3,339,000	2012						
9	Recycled Water - Phase IX	Water Supply	61.24%	$1,804,000	$1,105,000	2013						
10	Recycled Water - Phase X	Water Supply	61.24%	$1,783,000	$1,092,000	2014						
11	Recycled Water - Phase XI	Water Supply	61.24%	$762,000	$467,000	2014						
12	Recycled Water - ASR	Water Supply	61.24%	$8,337,000	$5,105,000	2005						
13	Recycled Water Environmental Studies	Water Supply	61.24%	$515,000	$315,000	2004						
14	Additional Supply Purchase (40,000 AFY)	Water Supply	100.00%	$60,000,000	$60,000,000	2032						
	Subtotal			**$131,432,000**	**$103,741,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Water Supply Banking Projects											
15	Water Supply Banking I	Water Supply	63.71%	$17,366,000	$11,064,000	2004						
16	Water Supply Banking II	Water Supply	63.71%	$17,366,000	$11,064,000	2014						
17	Water Supply Banking III	Water Supply	63.71%	$17,366,000	$11,064,000	2022						
18	Water Supply Banking IV	Water Supply	63.71%	$17,366,000	$11,064,000	2028						$11,064,000
19	Saugus Aquifer Wells 1 and 2	Water Supply	63.71%	$2,745,000	$1,749,000	2004						
20	Saugus Aquifer Wells 3 and 4	Water Supply	63.71%	$2,745,000	$1,749,000	2004						
	Subtotal			**$74,964,000**	**$47,754,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$11,064,000**
	Pipeline/PS/Storage Projects											
21	Honby Extension & Storage II	Pipeline/PS/Storage	92.49%	$16,366,000	$15,137,000	2005						
22	Lateral Extension (Pitchess)	Pipeline	100.00%	$2,138,000	$2,138,000	2004						
23	Lateral Extension & Storage II	Pipeline/Storage	86.23%	$12,269,000	$10,579,000	2005						
24	Honby & Newhall Parallel II (Honby Parallel)	Pipeline/PS/Storage	89.17%	$24,462,000	$21,813,000	2017						
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	Pipeline	100.00%	$2,719,000	$2,719,000	2005						
26	System Appurtenances I (CC)	Pipeline	100.00%	$6,559,000	$6,559,000	2005						
27	System Appurtenances II (MWD Cap.)	Pipeline	100.00%	$6,898,000	$6,898,000	2035						
28	Additional Water Supply IX (SWP Peaking)	Pipeline	100.00%	$5,490,000	$5,490,000	2010						
	Subtotal			**$76,901,000**	**$71,333,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Water Treatment Projects											
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	Water Treatment	0.00%	$9,762,000	$0	2006						
30	ESFP Exp. 56 MGD I (Treatment)	Water Treatment	100.00%	$9,084,000	$9,084,000	2006						
31	ESFP Exp. 56 MGD II (Intake Pump)	Water Treatment	100.00%	$4,944,000	$4,944,000	2006						
32	ESFP Exp. 56 MGD III (Storage)	Water Treatment	63.71%	$19,842,000	$12,642,000	2006						
33	Rio Vista Exp. 60 MGD	Water Treatment	100.00%	$23,683,000	$23,683,000	2010						
34	Rio Vista Exp. 90 MGD (Treatment)	Water Treatment	100.00%	$30,699,000	$30,699,000	2026		$6,139,800	$9,209,700	$15,349,500		
35	Rio Vista Exp. 90 MGD (Storage)	Water Treatment	63.71%	$9,173,000	$5,844,000	2026		$1,168,800	$1,753,200	$2,922,000		
36	Rio Vista Exp. 120 MGD	Water Treatment	100.00%	$22,438,000	$22,438,000	2040						
37	Rio Vista Exp. 130 MGD	Water Treatment	100.00%	$11,500,000	$11,500,000	2048						
38	Water Quality Improvements I	Water Treatment	0.00%	$8,365,000	$0	2009						
39	Water Quality Improvements II	Water Treatment	0.00%	$11,309,000	$0	2010						
40	Water Quality Improvements III	Water Treatment	0.00%	$11,309,000	$0	2015						
	Subtotal			**$172,108,000**	**$120,834,000**		**$0**	**$7,308,600**	**$10,962,900**	**$18,271,500**	**$0**	**$0**
	Total Capital Improvement Program Cost			**$455,396,000**	**$343,662,000**		**$0**	**$7,308,600**	**$10,962,900**	**$18,271,500**	**$0**	**$11,064,000**

Castaic Lake Water Agency
FY03-04 Capital Improvement Program
Program Schedule

	Project	Project Type	Growth Portion	Total Cost	Growth Portion of Cost	Fiscal Year Required	2029	2030	2031	2032	2033	2034
	Water Supply Projects											
1	Recycled Water - Phase IB	Water Supply	61.24%	$4,547,000	$2,784,000	2004						
2	Recycled Water - Phase II	Water Supply	61.24%	$10,618,000	$6,502,000	2006						
3	Recycled Water - Phase III	Water Supply	61.24%	$9,072,000	$5,555,000	2007						
4	Recycled Water - Phase IV	Water Supply	61.24%	$12,809,000	$7,844,000	2008						
5	Recycled Water - Phase V	Water Supply	61.24%	$1,746,000	$1,069,000	2009						
6	Recycled Water - Phase VI	Water Supply	61.24%	$4,718,000	$2,889,000	2010						
7	Recycled Water - Phase VII	Water Supply	61.24%	$9,268,000	$5,675,000	2011						
8	Recycled Water - Phase VIII	Water Supply	61.24%	$5,453,000	$3,339,000	2012						
9	Recycled Water - Phase IX	Water Supply	61.24%	$1,804,000	$1,105,000	2013						
10	Recycled Water - Phase X	Water Supply	61.24%	$1,783,000	$1,092,000	2014						
11	Recycled Water - Phase XI	Water Supply	61.24%	$762,000	$467,000	2014						
12	Recycled Water - ASR	Water Supply	61.24%	$8,337,000	$5,105,000	2005						
13	Recycled Water Environmental Studies	Water Supply	61.24%	$515,000	$315,000	2004						
14	Additional Supply Purchase (40,000 AFY)	Water Supply	100.00%	$60,000,000	$60,000,000	2032				$60,000,000		
	Subtotal			**$131,432,000**	**$103,741,000**		**$0**	**$0**	**$0**	**$60,000,000**	**$0**	**$0**
	Water Supply Banking Projects											
15	Water Supply Banking I	Water Supply	63.71%	$17,366,000	$11,064,000	2004						
16	Water Supply Banking II	Water Supply	63.71%	$17,366,000	$11,064,000	2014						
17	Water Supply Banking III	Water Supply	63.71%	$17,366,000	$11,064,000	2022						
18	Water Supply Banking IV	Water Supply	63.71%	$17,366,000	$11,064,000	2028						
19	Saugus Aquifer Wells 1 and 2	Water Supply	63.71%	$2,745,000	$1,749,000	2004						
20	Saugus Aquifer Wells 3 and 4	Water Supply	63.71%	$2,745,000	$1,749,000	2004						
	Subtotal			**$74,954,000**	**$47,754,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Pipeline/PS/Storage Projects											
21	Honby Extension & Storage II	Pipeline/PS/Storage	92.49%	$16,366,000	$15,137,000	2005						
22	Lateral Extension (Pitchess)	Pipeline	100.00%	$2,138,000	$2,138,000	2004						
23	Lateral Extension & Storage II	Pipeline/Storage	86.23%	$12,269,000	$10,579,000	2005						
24	Honby & Newhall Parallel II (Honby Parallel)	Pipeline/PS/Storage	89.17%	$24,462,000	$21,813,000	2017						
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	Pipeline	100.00%	$2,719,000	$2,719,000	2005						
26	System Appurtenances I (CC)	Pipeline	100.00%	$6,559,000	$6,559,000	2005						
27	System Appurtenances II (MWD Cap.)	Pipeline	100.00%	$6,898,000	$6,898,000	2035						
28	Additional Water Supply IX (SWP Peaking)	Pipeline	100.00%	$5,490,000	$5,490,000	2010						
	Subtotal			**$76,901,000**	**$71,333,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Water Treatment Projects											
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	Water Treatment	0.00%	$9,762,000	$0	2006						
30	ESFP Exp. 56 MGD I (Treatment)	Water Treatment	100.00%	$9,084,000	$9,084,000	2006						
31	ESFP Exp. 56 MGD II (Intake Pump)	Water Treatment	100.00%	$4,944,000	$4,944,000	2006						
32	ESFP Exp. 56 MGD III (Storage)	Water Treatment	63.71%	$19,842,000	$12,642,000	2006						
33	Rio Vista Exp. 60 MGD	Water Treatment	100.00%	$23,683,000	$23,683,000	2010						
34	Rio Vista Exp. 90 MGD (Treatment)	Water Treatment	100.00%	$30,699,000	$30,699,000	2026						
35	Rio Vista Exp. 90 MGD (Storage)	Water Treatment	63.71%	$9,173,000	$5,844,000	2026						
36	Rio Vista Exp. 120 MGD	Water Treatment	100.00%	$22,438,000	$22,438,000	2040						
37	Rio Vista Exp. 130 MGD	Water Treatment	100.00%	$11,500,000	$11,500,000	2048						
38	Water Quality Improvements I	Water Treatment	0.00%	$8,365,000	$0	2009						
39	Water Quality Improvements II	Water Treatment	0.00%	$11,309,000	$0	2010						
40	Water Quality Improvements III	Water Treatment	0.00%	$11,309,000	$0	2015						
	Subtotal			**$172,108,000**	**$120,834,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Total Capital Improvement Program Cost			**$455,395,000**	**$343,662,000**		**$0**	**$0**	**$0**	**$60,000,000**	**$0**	**$0**

Castaic Lake Water Agency
FY03-04 Capital Improvement Program
Program Schedule

	Project	Project Type	Growth Portion	Total Cost	Growth Portion of Cost	Fiscal Year Required	2035	2036	2037	2038	2039	2040
	Water Supply Projects											
1	Recycled Water - Phase IB	Water Supply	61.24%	$4,547,000	$2,784,000	2004						
2	Recycled Water - Phase II	Water Supply	61.24%	$10,618,000	$6,502,000	2006						
3	Recycled Water - Phase III	Water Supply	61.24%	$9,072,000	$5,555,000	2007						
4	Recycled Water - Phase IV	Water Supply	61.24%	$12,809,000	$7,844,000	2008						
5	Recycled Water - Phase V	Water Supply	61.24%	$1,746,000	$1,069,000	2009						
6	Recycled Water - Phase VI	Water Supply	61.24%	$4,718,000	$2,889,000	2010						
7	Recycled Water - Phase VII	Water Supply	61.24%	$9,268,000	$5,675,000	2011						
8	Recycled Water - Phase VIII	Water Supply	61.24%	$5,453,000	$3,339,000	2012						
9	Recycled Water - Phase IX	Water Supply	61.24%	$1,804,000	$1,105,000	2013						
10	Recycled Water - Phase X	Water Supply	61.24%	$1,783,000	$1,092,000	2014						
11	Recycled Water - Phase XI	Water Supply	61.24%	$762,000	$467,000	2014						
12	Recycled Water - ASR	Water Supply	61.24%	$8,337,000	$5,105,000	2005						
13	Recycled Water Environmental Studies	Water Supply	61.24%	$515,000	$315,000	2004						
14	Additional Supply Purchase (40,000 AFY)	Water Supply	100.00%	$60,000,000	$60,000,000	2032						
	Subtotal			**$131,432,000**	**$103,741,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Water Supply Banking Projects											
15	Water Supply Banking I	Water Supply	63.71%	$17,366,000	$11,064,000	2004						
16	Water Supply Banking II	Water Supply	63.71%	$17,366,000	$11,064,000	2014						
17	Water Supply Banking III	Water Supply	63.71%	$17,366,000	$11,064,000	2022						
18	Water Supply Banking IV	Water Supply	63.71%	$17,366,000	$11,064,000	2028						
19	Saugus Aquifer Wells 1 and 2	Water Supply	63.71%	$2,745,000	$1,749,000	2004						
20	Saugus Aquifer Wells 3 and 4	Water Supply	63.71%	$2,745,000	$1,749,000	2004						
	Subtotal			**$74,954,000**	**$47,754,000**		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
	Pipeline/PS/Storage Projects											
21	Honby Extension & Storage II	Pipeline/PS/Storage	92.49%	$16,366,000	$15,137,000	2005						
22	Lateral Extension (Pitchess)	Pipeline	100.00%	$2,138,000	$2,138,000	2004						
23	Lateral Extension & Storage II	Pipeline/Storage	86.23%	$12,269,000	$10,579,000	2005						
24	Honby & Newhall Parallel II (Honby Parallel)	Pipeline/PS/Storage	89.17%	$24,462,000	$21,813,000	2017						
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	Pipeline	100.00%	$2,719,000	$2,719,000	2005						
26	System Appurtenances I (CC)	Pipeline	100.00%	$6,559,000	$6,559,000	2005						
27	System Appurtenances II (MWD Cap.)	Pipeline	100.00%	$6,898,000	$6,898,000	2035	$6,898,000					
28	Additional Water Supply IX (SWP Peaking)	Pipeline	100.00%	$5,490,000	$5,490,000	2010						
	Subtotal			**$76,901,000**	**$71,333,000**		**$6,898,000**	**$0**	**$0**	**$0**	**$0**	**$0**
	Water Treatment Projects											
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	Water Treatment	0.00%	$9,762,000	$0	2006						
30	ESFP Exp. 56 MGD I (Treatment)	Water Treatment	100.00%	$9,084,000	$9,084,000	2006						
31	ESFP Exp. 56 MGD II (Intake Pump)	Water Treatment	100.00%	$4,944,000	$4,944,000	2006						
32	ESFP Exp. 56 MGD III (Storage)	Water Treatment	63.71%	$19,842,000	$12,642,000	2006						
33	Rio Vista Exp. 60 MGD	Water Treatment	100.00%	$23,683,000	$23,683,000	2010						
34	Rio Vista Exp. 90 MGD (Treatment)	Water Treatment	100.00%	$30,699,000	$30,699,000	2026						
35	Rio Vista Exp. 90 MGD (Storage)	Water Treatment	63.71%	$9,173,000	$5,844,000	2026						
36	Rio Vista Exp. 120 MGD	Water Treatment	100.00%	$22,438,000	$22,438,000	2040				$4,487,600	$6,731,400	$11,219,000
37	Rio Vista Exp. 130 MGD	Water Treatment	100.00%	$11,500,000	$11,500,000	2048						
38	Water Quality Improvements I	Water Treatment	0.00%	$8,365,000	$0	2009						
39	Water Quality Improvements II	Water Treatment	0.00%	$11,309,000	$0	2010						
40	Water Quality Improvements III	Water Treatment	0.00%	$11,309,000	$0	2015						
	Subtotal			**$172,108,000**	**$120,834,000**		**$0**	**$0**	**$0**	**$4,487,600**	**$6,731,400**	**$11,219,000**
	Total Capital Improvement Program Cost			**$455,395,000**	**$343,662,000**		**$6,898,000**	**$0**	**$0**	**$4,487,600**	**$6,731,400**	**$11,219,000**

Castaic Lake Water Agency
FY03-04 Capital Improvement Program
Program Schedule

	Project	Project Type	Growth Portion	Total Cost	Growth Portion of Cost	Fiscal Year Required	2048	2049	2050	Totals
	Water Supply Projects									
1	Recycled Water - Phase IB	Water Supply	61.24%	$4,547,000	$2,784,000	2004				$2,784,000
2	Recycled Water - Phase II	Water Supply	61.24%	$10,618,000	$6,502,000	2006				$6,502,000
3	Recycled Water - Phase III	Water Supply	61.24%	$9,072,000	$5,555,000	2007				$5,555,000
4	Recycled Water - Phase IV	Water Supply	61.24%	$12,809,000	$7,844,000	2008				$7,844,000
5	Recycled Water - Phase V	Water Supply	61.24%	$1,746,000	$1,069,000	2009				$1,069,000
6	Recycled Water - Phase VI	Water Supply	61.24%	$4,718,000	$2,889,000	2010				$2,889,000
7	Recycled Water - Phase VII	Water Supply	61.24%	$9,268,000	$5,675,000	2011				$5,675,000
8	Recycled Water - Phase VIII	Water Supply	61.24%	$5,453,000	$3,339,000	2012				$3,339,000
9	Recycled Water - Phase IX	Water Supply	61.24%	$1,804,000	$1,105,000	2013				$1,105,000
10	Recycled Water - Phase X	Water Supply	61.24%	$1,783,000	$1,092,000	2014				$1,092,000
11	Recycled Water - Phase XI	Water Supply	61.24%	$762,000	$467,000	2014				$467,000
12	Recycled Water - ASR	Water Supply	61.24%	$8,337,000	$5,105,000	2005				$5,105,000
13	Recycled Water Environmental Studies	Water Supply	61.24%	$515,000	$315,000	2004				$315,000
14	Additional Supply Purchase (40,000 AFY)	Water Supply	100.00%	$60,000,000	$60,000,000	2032				$60,000,000
	Subtotal			**$131,432,000**	**$103,741,000**		**$0**	**$0**	**$0**	**$103,741,000**
	Water Supply Banking Projects									
15	Water Supply Banking I	Water Supply	63.71%	$17,366,000	$11,064,000	2004				$11,064,000
16	Water Supply Banking II	Water Supply	63.71%	$17,366,000	$11,064,000	2014				$11,064,000
17	Water Supply Banking III	Water Supply	63.71%	$17,366,000	$11,064,000	2022				$11,064,000
18	Water Supply Banking IV	Water Supply	63.71%	$17,366,000	$11,064,000	2028				$11,064,000
19	Saugus Aquifer Wells 1 and 2	Water Supply	63.71%	$2,745,000	$1,749,000	2004				$1,749,000
20	Saugus Aquifer Wells 3 and 4	Water Supply	63.71%	$2,745,000	$1,749,000	2004				$1,749,000
	Subtotal			**$74,964,000**	**$47,754,000**		**$0**	**$0**	**$0**	**$47,754,000**
	Pipeline/PS/Storage Projects									
21	Honby Extension & Storage II	Pipeline/PS/Storage	92.49%	$16,366,000	$15,137,000	2005				$15,137,000
22	Lateral Extension (Pitchess)	Pipeline	100.00%	$2,138,000	$2,138,000	2004				$2,138,000
23	Lateral Extension & Storage II	Pipeline/Storage	86.23%	$12,269,000	$10,579,000	2005				$10,579,000
24	Honby & Newhall Parallel II (Honby Parallel)	Pipeline/PS/Storage	89.17%	$24,462,000	$21,813,000	2017				$21,813,000
25	Honby & Newhall Parallel III (Newhall Parallel Ph 2)	Pipeline	100.00%	$2,719,000	$2,719,000	2005				$2,719,000
26	System Appurtenances I (CC)	Pipeline	100.00%	$6,559,000	$6,559,000	2005				$6,559,000
27	System Appurtenances II (MWD Cap.)	Pipeline	100.00%	$6,898,000	$6,898,000	2035				$6,898,000
28	Additional Water Supply IX (SWP Peaking)	Pipeline	100.00%	$5,490,000	$5,490,000	2010				$5,490,000
	Subtotal			**$76,901,000**	**$71,333,000**		**$0**	**$0**	**$0**	**$71,333,000**
	Water Treatment Projects									
29	ESFP Ozone/Contact Clarifiers/Washwater Treatment	Water Treatment	0.00%	$9,762,000	$0	2006				$0
30	ESFP Exp. 56 MGD I (Treatment)	Water Treatment	100.00%	$9,084,000	$9,084,000	2006				$9,084,000
31	ESFP Exp. 56 MGD II (Intake Pump)	Water Treatment	100.00%	$4,944,000	$4,944,000	2006				$4,944,000
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36	Rio Vista Exp. 120 MGD	Water Treatment	100.00%	$22,438,000	$22,438,000	2040				$22,438,000
37	Rio Vista Exp. 130 MGD	Water Treatment	100.00%	$11,500,000	$11,500,000	2048	$5,750,000			$11,500,000
38	Water Quality Improvements I	Water Treatment	0.00%	$8,365,000	$0	2009				$0
39	Water Quality Improvements II	Water Treatment	0.00%	$11,309,000	$0	2010				$0
40	Water Quality Improvements III	Water Treatment	0.00%	$11,309,000	$0	2015				$0
	Subtotal			**$172,108,000**	**$120,834,000**		**$5,750,000**	**$0**	**$0**	**$120,834,000**
	Total Capital Improvement Program Cost			**$455,396,000**	**$343,662,000**		**$5,750,000**	**$0**	**$0**	**$343,662,000**

CASTAIC LAKE WATER AGENCY
FACILITY CAPACITY FEE
FINANCIAL MODEL

OVERVIEW

Purpose

This paper provides an explanation of how Castaic Lake Water Agency (CLWA) has developed its facility capacity fee financial model and how the fees will be used to partially pay for the Capital Improvement Program (CIP) and/or any debt incurred attributable to it. The explanation includes a description of how the factors used to calculate the facility capacity fees are derived and the basis for the assumptions used.

Long-term accurate predictions of the future are difficult, if not impossible, to make. Therefore, good financial health requires a periodic review of the fees to ensure timely response to changing conditions.

The final product of this model is an annual update of the Agency's Facility Capacity Fee (Fee) for each of its water service areas (WSAs).

Projection of Future Water Demand

The need for Capital Facilities is driven by the projected demand for water. Projected water demand has been determined, for purposes of planning capital facilities development, from a parcel database generated by the Agency using County assessor use codes. These codes reflect the uses that are currently permitted for each parcel under the planning agency's current zoning ordinances. This database is on file with the Agency. The use codes are assigned a water demand recognizing that in many cases the use code permits a range of uses and thus a range of water demand. The projected demand of all of the parcels based upon their authorized uses is determined and accumulated to derive projected future demand.

Most of the vacant land is zoned for a particular land use by one of three local planning agencies: the County of Los Angeles, County of Ventura or the City of Santa Clarita. CLWA's water demand model (including both current and future consumption) uses the

Agency's database of all vacant and improved land within its service area. All county assessor parcels within the Agency's boundaries are contained in this database. A description of many planning attributes of each parcel is maintained by the County and the City of Santa Clarita on a parcel-by-parcel basis and continually updated. The Agency's database is periodically adjusted by matching the actual water delivered by the purveyors to the parcels in the database. This information is then extrapolated to the remaining vacant parcels. This provides the Agency with an estimate of the ultimate demand based on the currently authorized land uses. Each year the process is repeated as land is developed or the use changes, giving the Agency a better indication of water demand. Because the location and nature of development depends upon many factors, water demand can change in location, timing, or quantity.

The next step is to project when these demands will materialize. With the help of the purveyors, who provide historical data, and LA County Department of Regional Planning, which supplies growth projections into the future, the time of the demand is then estimated. It is recognized that the timing projections are merely best estimates based upon data available at the time. Actual water demand may change as a result of changes in the economic climate, for example, interest rates, general economy, etc. The projection of the timing of future demand determines when various elements of the CIP will need to be commenced in order to have capacity available in time to meet demand.

The timing is critical in that early construction results in increased borrowing which in turn increases interest costs. Early construction results in lower inflated project costs as a partial offset. If facilities are not commenced at the appropriate time capacity may be unavailable at the time needed by development, with the resulting delays and costs to private entities.

Water Services Areas

This section discusses how WSAs and sub-WSAs are used in capital planning and long-range financial planning.

For each land use type, there is a range of water demand factors related to development and use of that land. Specific demand factors for each sub-WSA are developed based on

historical water use. These demand factors are applied to the vacant parcel information in the database to yield potential water demand within the Agency service area.

Development plans and other available planning documents are reviewed to determine a potential growth rate. This growth rate is merged with water demand to produce an incremental increase in total water demand over any given planning horizon for the Agency service area.

A model of the available groundwater in each sub-WSA has been developed based on purveyor information and is contained in a report entitled "2000 Urban Water Management Plan", which is on file with the Agency. The available groundwater is subtracted from total water demand to yield the requirement for imported water.

Capital Facilities

The imported water demands are then translated into Capital Facility requirements. For compliance with the Agency Act, this particular activity is conducted on a water service area basis. The capital facility requirements are estimated in a manner which considers the amount of local water that is available, the anticipated demand for imported water, and the facilities required to treat and convey imported water to service those demands. The Capital Improvement Program, prepared by Kennedy Jenks, details the facilities planned to meet future demand. The Engineering News Record Index is used in projecting the inflationary pressures on utility construction costs for facilities the construction of which is expected to be done many years in the future.

Existing versus Future Needs

The Capital Improvement Program is then further examined to determine what portion of the CIP is necessary to accommodate existing service demand versus that which is necessary to accommodate future demands. The allocation is set forth in the body of the data document. The legal basis for the Facility Capacity Fee is that it can be attributed only to those facilities that are required to serve new users. Thus, that portion of the Capital Program attributable to existing users is removed to produce capital requirements for future users only, which provides the basis for the fees.

Board Policy

In developing the Facility Capacity Fee Program, the Board established policies with regard to the sources of revenue to fund the Capital Program. Facility capacity for **future growth** (future users' share of the CIP) are funded as follows:

—A portion of 1% property tax

—Standby charges, if levied

—Interest on investments

—Capital Facility Fees

That portion of the Capital Program attributable to **existing users** is funded by:

—A portion of 1% property tax

—Standby charges, if levied

—Interest on investments

—A portion of water sales attributable to the Capital Program

—Existing ad valorem tax in excess of the 1% basic levy, which is authorized to pay the State Water Project liability of the Agency.

Basic Structure of the Model as it Relates to the Formation of the Agency's Water Service Areas

For the purposes of developing the CIP and assigning rates and charges on a cost of service approach, the Agency developed 26 sub-water service areas ("Sub-WSAs") which are aggregated into 8 water service areas ("WSAs"). (See Figure 1.) The WSAs are required by the Agency's Act, and are recorded with the State Board of Equalization as well as the County of Los Angeles. This enables the Agency to levy different water rates, standby charges, tax rates, and capital facility fees by WSA. This is a special power authorized by the Agency's Act in an effort to accommodate a rapidly growing Agency in a developing area. The cost of service approach aptly reflects the needs of the area.

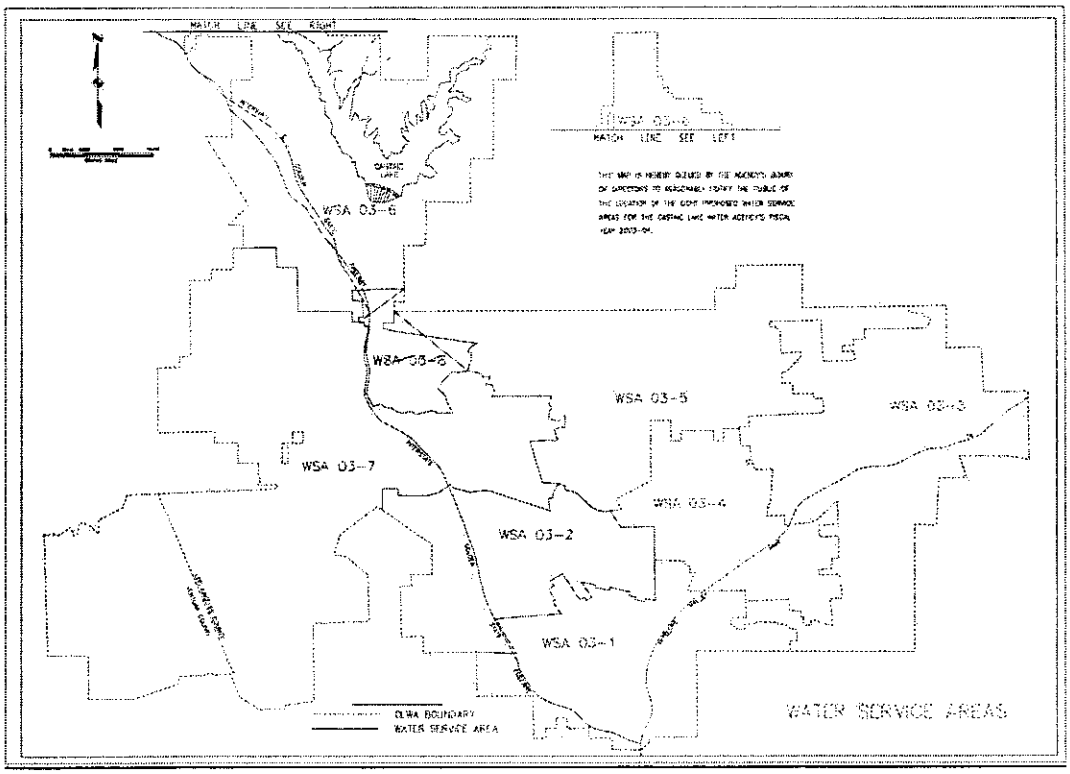


Figure 1
Water Service Area Map

Specific Benefit to WSA

The Agency's financing authority is based on a benefit assessment theory, which means that there must be an appropriate nexus between the amount of the charge and the cost of providing the benefit within each of the WSAs. The Agency Act allows the Board of Directors the flexibility to develop two or more WSAs. When the Agency was first divided into WSAs, there were four WSAs. Later, it was decided that eight would be more appropriate. Another important element is that each WSA can have its own unique set of charges, though the law does not require that the charges be different.

Agency-Wide Benefit

The Agency's CIP allocated to each WSA is based upon Board policy as follows: the cost attributable to acquire, treat and store water is considered an Agency-wide benefit, because the water is available for use in any WSA. Thus, the Fee that is derived from the calculation of these costs is applied uniformly across the entire Agency service area.

Water Service Area Specific Benefit

The transmission of the water to the various WSAs is considered to be a WSA-specific benefit. Thus, a cost of service approach is used that takes into consideration pipeline length, diameter, and other engineering parameters. The capital projects are apportioned to each of the water service areas in proportion to these mathematical relationships and then translated into a Fee for pipelines. This Fee is then aggregated with the treatment, storage, and water purchases component to create the total Facility Capacity Fee for each WSA.

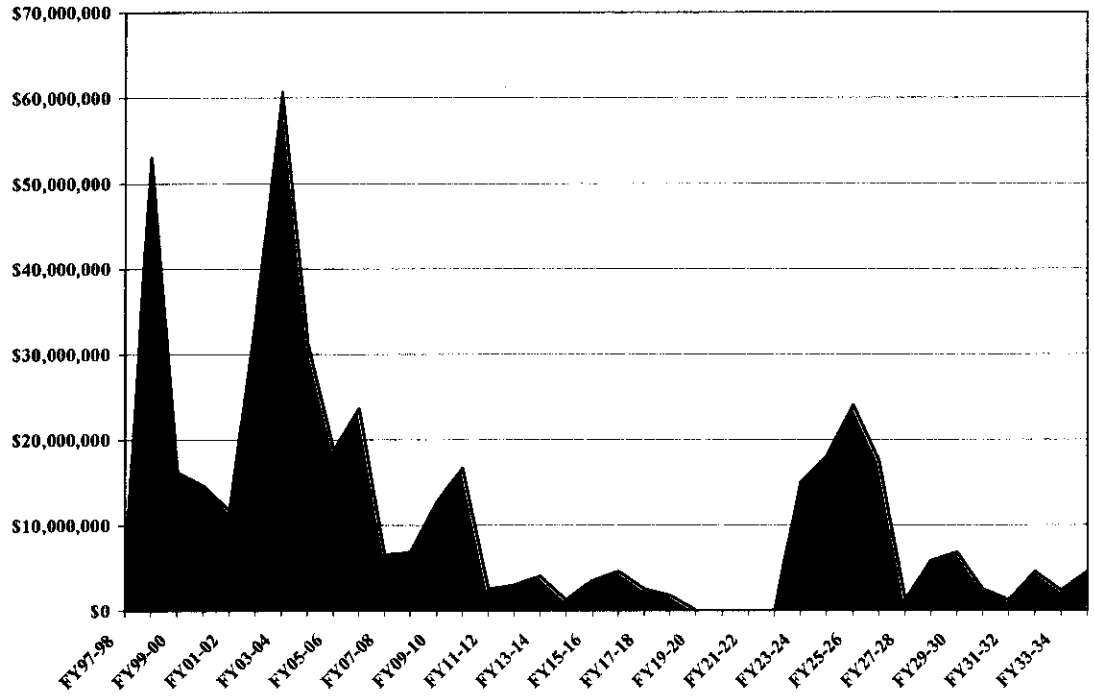
Capital Project Scheduling

The design and later construction of capital facilities are commenced approximately five years ahead of need to ensure that shortages do not occur. The rate of demand for water varies each year. While growth may be relatively small in one year, it gradually accumulates. For practical purposes, water facilities cannot be built in small increments; pipelines come in standard sizes, and it does not make economic sense to construct many parallel small pipes to respond to growing demands when one large pipeline can be planned in advance.

Therefore, Agency engineers are required to make estimates of the reasonable capacities required for the water user areas and to design pipelines appropriately. On the other hand, treatment, storage, and water supply can be more economically added by incremental units, though even these units must also be economically sized. For treatment purposes, expansion of existing treatment facilities according to staged facility enlargement plans is reasonable. Capital expenditures for the facilities projected in the CIP will take place over more than thirty (30) years, as shown in Figure 2. The expenditures under the CIP, however, are not uniformly spread; there may be years with little or no design/construction activity and then several years of intense capital outlay requirements.

Figure 2
Sample Capital Improvement Program

FACILITY CAPACITY FEE MODEL

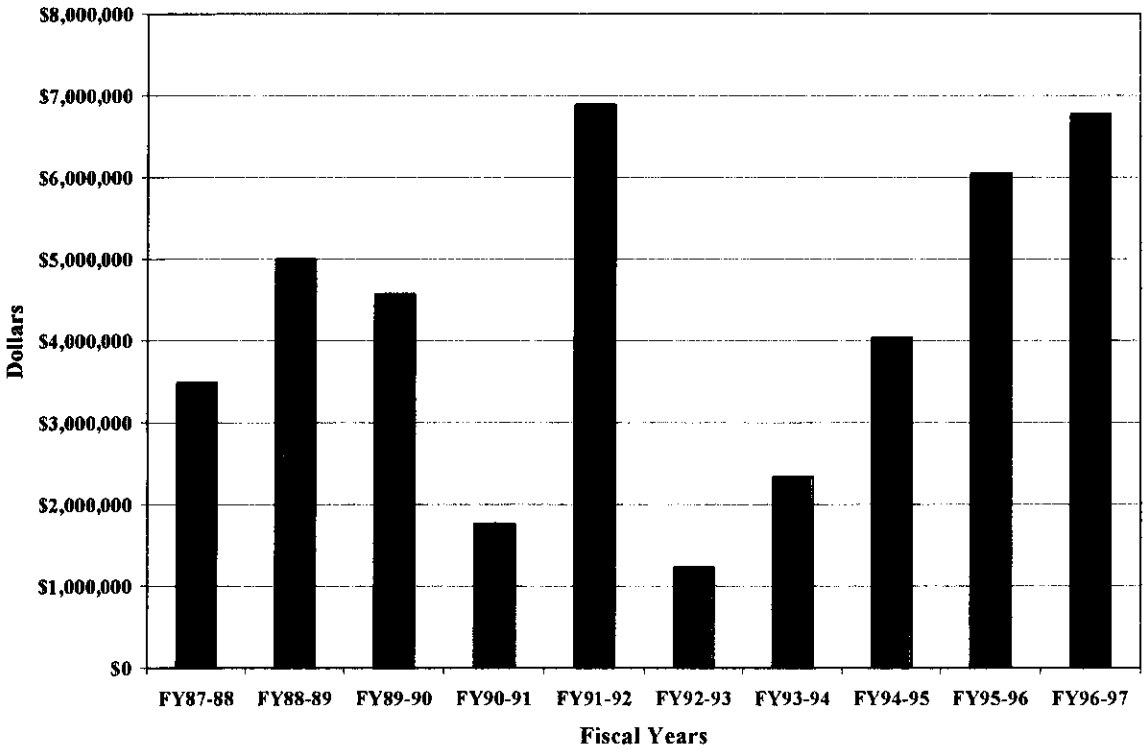


Without a systematic approach, the CIP would result in dramatic swings in fees. This would not be fair or equitable. As a result, a system was developed that recognizes the growth of the water demand compared to the requirements for capital facilities which are built in a less regular manner. Since many of the facilities are large and must be built prior to need, funds will likely not be available when needed to build these facilities. Thus, cash flow projections are developed which identify borrowing requirements and timing. With the cash outflow estimated, the next step is to consider sources of cash to offset the expense. These sources are 1% tax monies, standby charges, interest on investments, and Facility Capacity Fees.

Note that the flow of revenues is not always smooth. In recent years, 1% property tax funds have been relatively stable. However, facility capacity fees, which are a primary source of revenue for construction of facilities under the CIP, vary dramatically as the economy changes, as shown in Figure 3. The capacity fee model has to consider the above parameters

and translate them into a Fee that has a consistent long-term growth trend based upon known facts in order to avoid large changes on a year-to-year basis.

Figure 3
Facility Capacity Fee Collection History



Model Logic

The model is designed in such a way that it considers the cash demands on a year-by-year basis, and then accounts for anticipated revenues on a year-to-year basis as depicted in Figure 4. Note that there are wide discrepancies in the cash flow. Thus, it is necessary for the model to analyze how much money will be needed to cover the cumulative effect of all expenses during the study period (Figure 5). (The numbers used in Figures 4 and 5 are for illustration purposes only). Of course, cumulative revenue has to equal the cumulative expense amount although the expenses and the revenues may not match each other year by year (Figure 4). The model goes through repeated iterations to achieve the balance of cumulative revenue and expense.

Figure 4
Sample Cash Flow of Facility Capacity Fee Revenue v. Expense

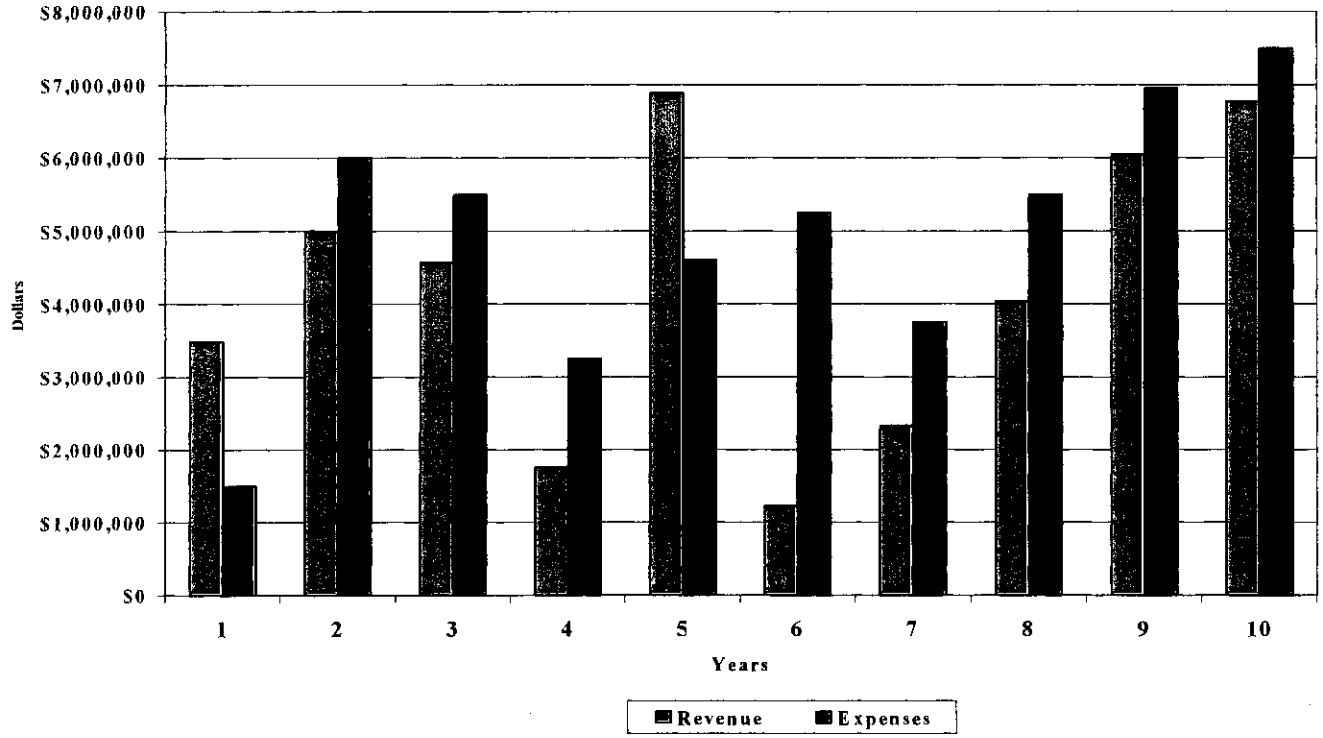
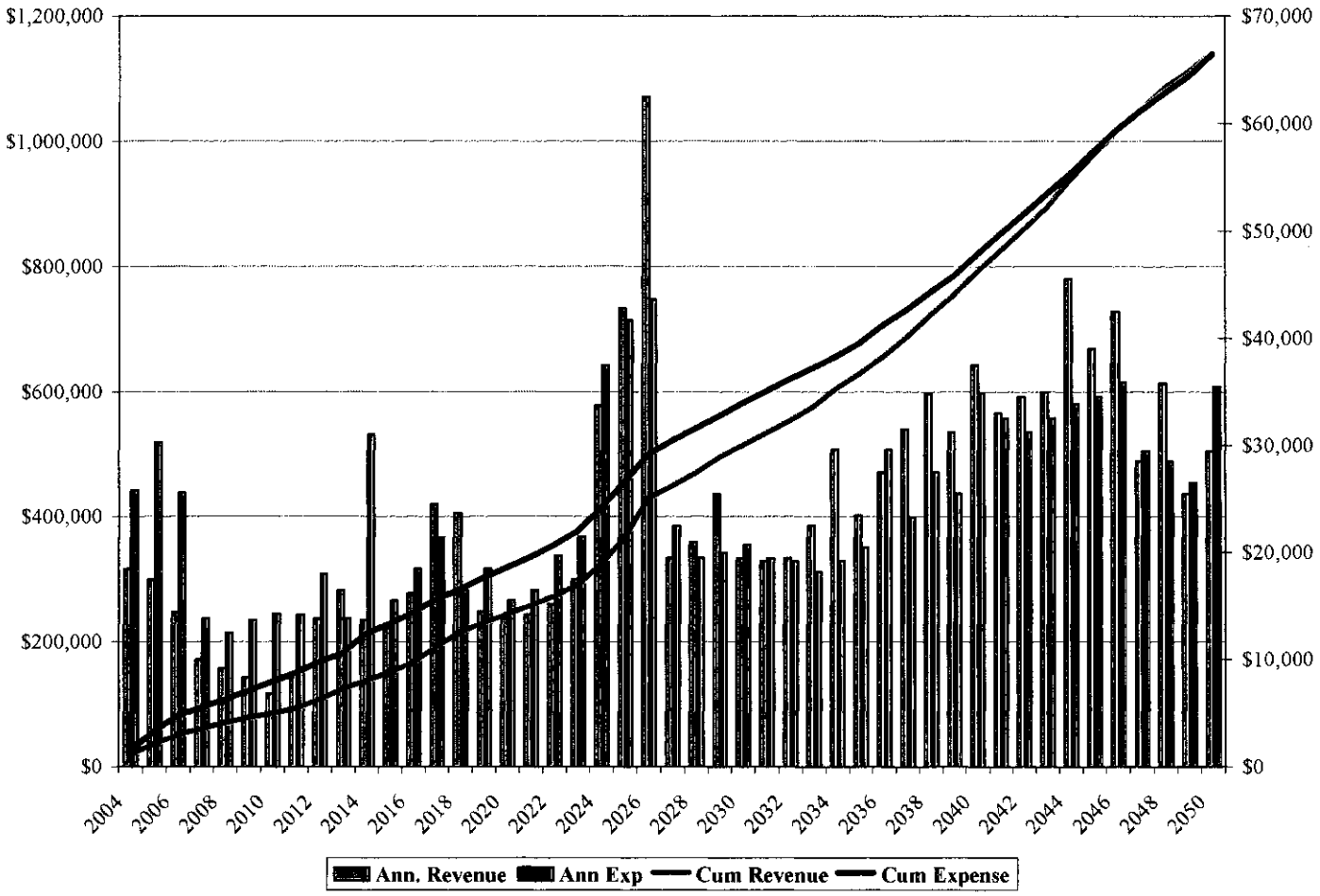


Figure 5
Example of Cumulative Revenue & Expenses



Variables/Assumptions

General

Although conceptually straightforward, the Fee calculation is mathematically complex. There are countless permutations and combinations that enter into the calculation. However, in order to obtain valid results, certain basic assumptions are made. These assumptions are examined each year to determine if they are still appropriate. The model contains many variables. For example, if the expenditures accelerate, the borrowings must be accelerated, which could mean an increase in interest cost, which adds to total costs. On the other hand, this can be offset by an increase in cash flow from the sale of Facility

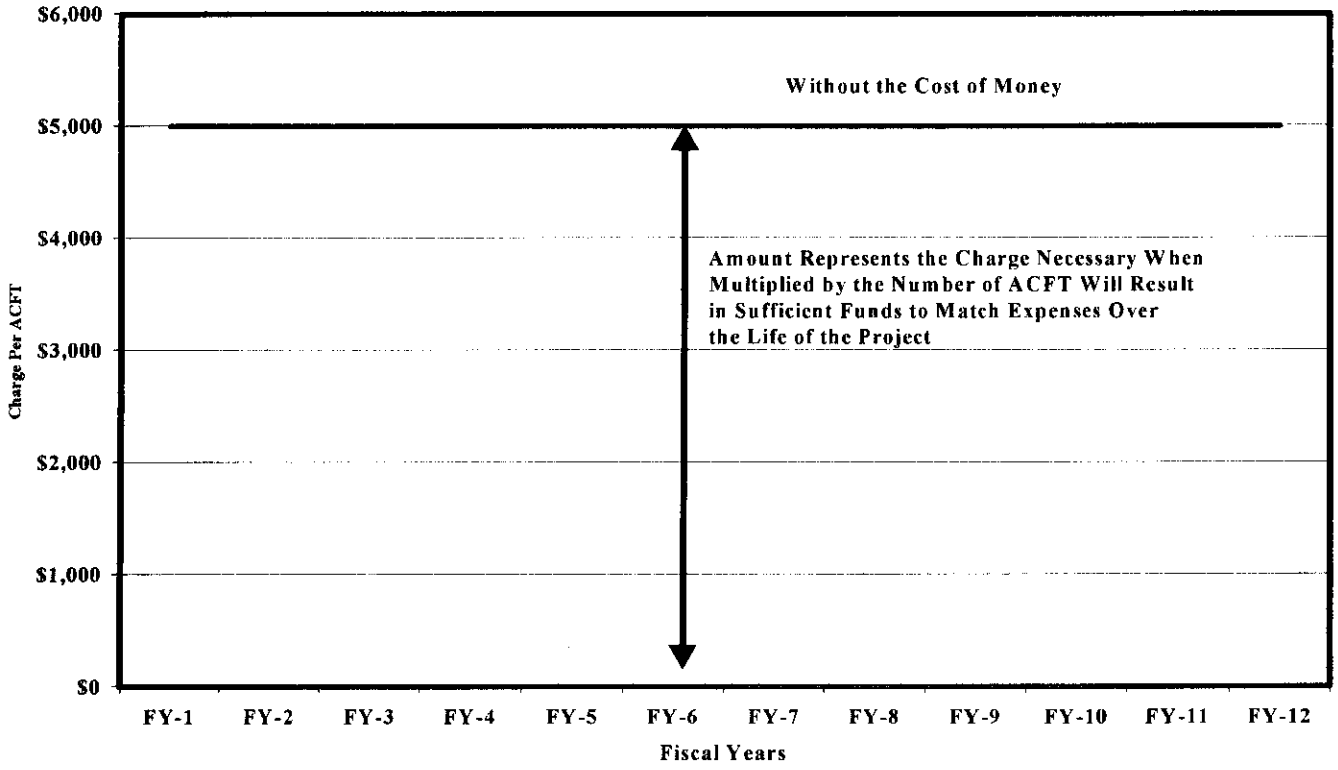
Capacity Fees and other revenue sources. This process is done on an annual basis, allowing minor adjustments and thus avoiding any abrupt changes and shortfalls in revenue. The key elements of the model are described below:

Inflation

Another major factor that is taken into consideration is the value of a dollar over time. Obviously, a dollar today is not a dollar 50 years hence. Thus, it is necessary to take into consideration the general economy or the CPI. This number is used in the model to recognize that a Fee paid today is different in value than a fee paid in 2030. Thus, it is necessary to reduce the fees in the near term recognizing that they are worth more having been paid in the early years.

Assuming no inflation and that a dollar today is worth a dollar in the future, all that would be required is a flat rate to accumulate the cash requirement as depicted in Figure 6.

Figure 6
Example of Flat Fee



Note that the connection fee rate is a horizontal line. The distance above the X-axis is sufficient so that when multiplied by the anticipated growth in sales, that volume of cash

flow will equal the volume of cash expenditures. However, costs are subject to inflation, cost of borrowing, and a CIP schedule that may vary. Thus, cash needs can dramatically change depending upon the assumptions.

Interest Income and Expense of Borrowing

The assumed interest cost for borrowing is based on the 3-year Treasury interest rate less 50 basis points, or 6.49%. The Agency invests in relatively short-term taxable paper and borrows at long-term tax-exempt rates. Since it is practically impossible to predict over 50 years what the interest rates will do the Agency determined that a prudent approach would be to use the three-year treasury rate as a guide. This approach recognizes that there are times when the Agency will earn more on interest than it pays for debt and others when it will earn less than it pays (as is the current situation). The interest cost for borrowing is based on a three-year Treasury rate less 50 basis points to approximate a high-grade tax-exempt municipal bond rate. The Agency borrows approximately every 3 to 5 years an amount expected to meet the Agency's capital needs as scheduled by the engineers.

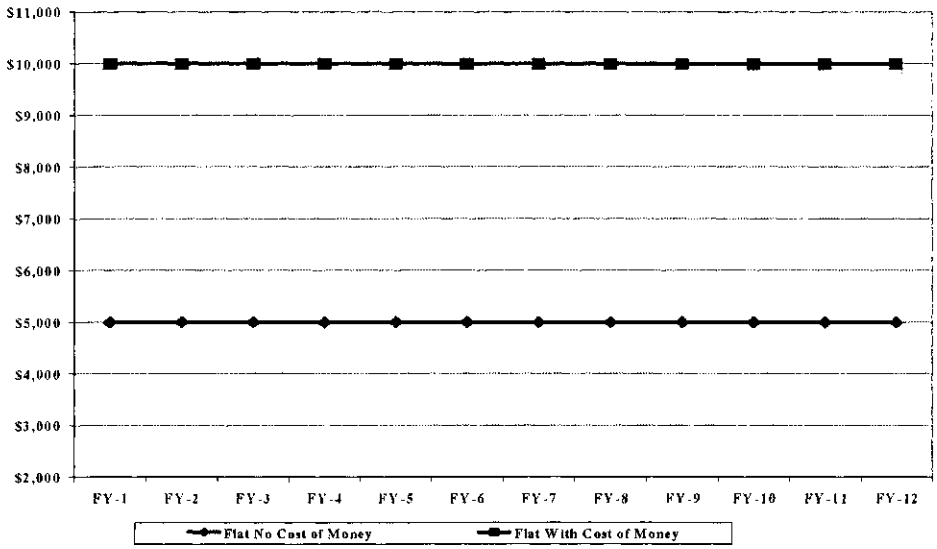
Good planning requires that capacity be available in time to meet expected demand. Since the lead time necessary to construct facilities requires that construction be commenced before fees are collected from the prospective development it is necessary for the Agency to borrow money necessary to construct facilities and then recover the cost from the Facility Capacity Fee. Interest on unspent funds is based on the current 3-year Treasury interest rate less 100 basis points, or 5.99%, to insure that the model assumes that interest earnings will be lower than borrowing costs.

It was determined that since public agencies invest over short periods of time and borrow over longer periods it was prudent to be conservative in the application of interest rates for borrowing as well as earnings. For that reason, the average interest paid and earned by the Agency was adjusted by 100 basis points to derive an interest rate to be used for calculation.

When the cost of money is added, the charge has to escalate each year to take this into account. If there is a shift in the CIP, this could result in greater or lesser cash requirements. It may also require an adjustment in the amplitude of the line, but may not necessarily change the slope, as depicted in Figure 7. If there is an unusual influx of cash in certain

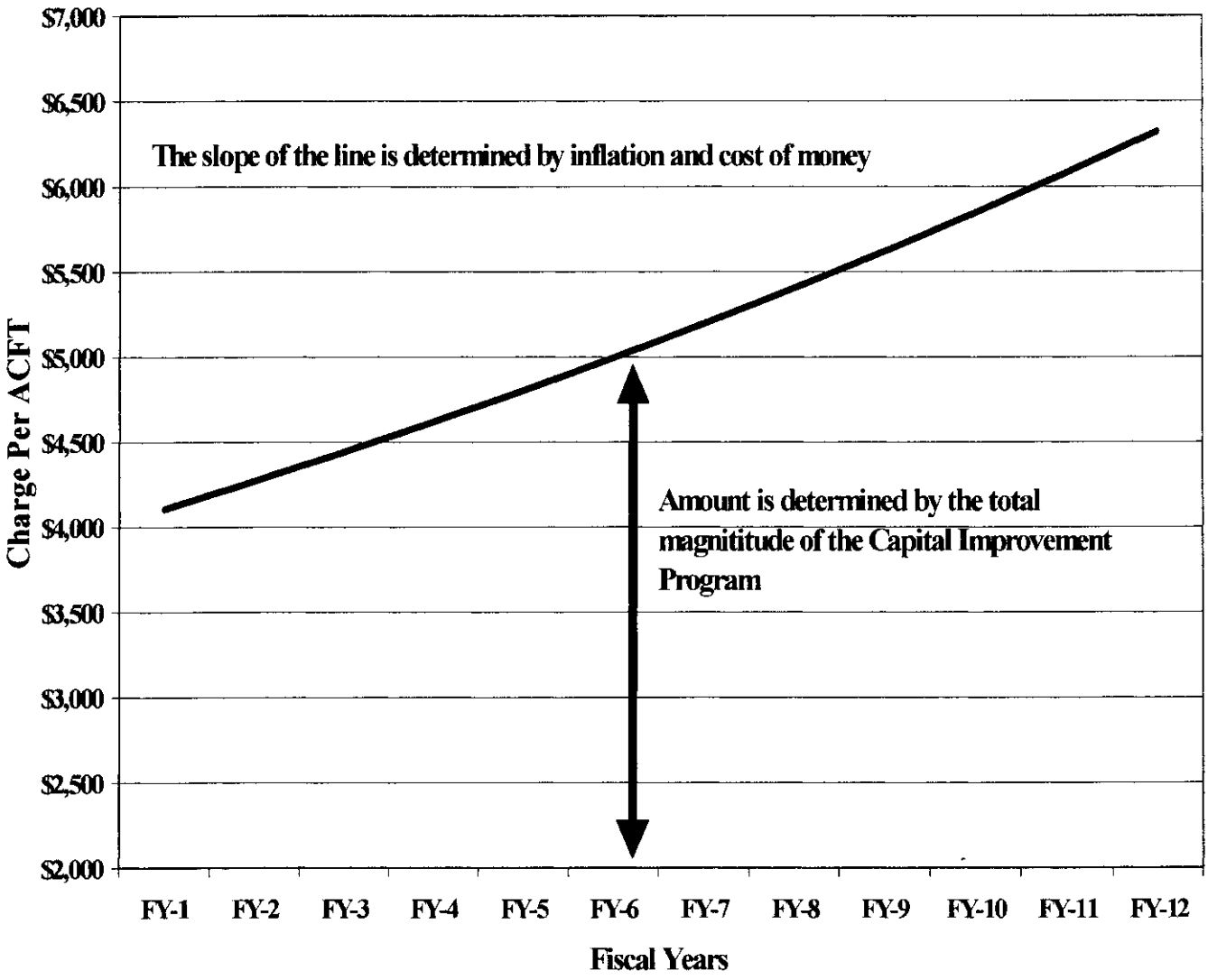
periods, it can then be reinvested, thereby increasing revenues. Thus the entire line can be shifted down, indicating a lower facility capacity fee rate, as a result of less borrowing and thus lower interest costs.

Figure 7
Facility Capacity Fee with Cost of Money



The model also has to take into consideration inflation in addition to the cost of money. As a result, the Capital Fee Schedule now takes on the appearance shown in Figure 8.

Figure 8
Facility Capacity Fee Escalated



The slope of the line takes into consideration inflation and the cost of money. The amplitude represents the magnitude or the total volume of dollars required. Each time the program is analyzed and the calculations re-run, the magnitude (the distance from the X axis) can vary as well as the slope of the line. Performing the calculations on a periodic basis minimizes changes in the rate, which could have adverse impacts on those paying the fees.

Likewise, the anticipated water demands and the facilities planned in the Capital Improvement Program are reexamined each year to determine whether changes are necessary.

Sales of Acre Feet of Capacity

The projected sale of acre feet of capacity is critical to the Agency's cash flow. The Agency has based its financial capacity to repay debt based on the revenue derived from the sale of capacity in the Agency's system, i.e. collection of facility capacity fees. Facility capacity fees are not considered by the municipal bond market to be a stable source of revenue to support bond payments, because they depend upon the progress of the housing market. It is necessary to use conservative projections of sales and demonstrate a conservative and responsible finance plan, in order to obtain a favorable bond rating. Over the past 17 years of the program the model has used 55% of projected capacity sales to calculate the capacity fee for purposes of providing sufficient revenues to support bond payments. Thus far this projection has proven to be satisfactory to the bond rating agencies as the Agency has an "A" rating. If this ever results in a potential of excess revenues, the ratio will be adjusted accordingly.

In addition to the foregoing discussion on sales it is important to point out that not all of the projected demands will be provided by the Agency. For example: there are golf courses and agricultural activities that may develop their own wells and do not require a connection to a purveyor's water system and thus are not subject to the fee. In addition there are developments that are not required to obtain building permits such as hospitals and schools. Thus, the Agency may not collect fees from these uses.

Since the fees are evaluated on a yearly basis, the Agency can adjust its sales as a percentage of demand if it is determined that more money will be collected than necessary; thus avoiding over collection.

Past Debt Allocation

As projects are built, they are removed from the CIP. However, the capital cost now has been replaced with debt. The engineers track the actual use of the proceeds of the various bond issues and allocate the debt service for each bond issue among the appropriate

benefiting cost centers such as Treatment facilities which are allocated to all WSAs , or to transmission facilities which are allocated only to the WSA(s) served by those facilities.

Unspent Bond Proceeds

If there are unspent bond proceeds, these likewise are attributed to the appropriate cost centers such as Treatment and WSA1 through WSA8. These unspent funds are an offset to projects scheduled in the program that are not yet built. The Agency currently has unspent bond proceeds because of delays in its construction program. These delays are a result of litigation and the need to prepare more environmental documentation before construction can proceed.

Allocation of 1% Property Tax

The Agency receives a portion of the 1% property tax revenue and allocates the proceeds to the future users and existing property owners based on the ratio of the assessed value of developed vs. undeveloped property. The calculation of the Facility Capacity Fee takes into account revenues available from the increment of the basic 1% property tax levy derived from undeveloped property. However, not all of the property tax revenue from undeveloped property is used to reduce the Facility Capacity Fee. Certain activities of the Agency funded with property taxes are deemed to benefit future users as well as existing users of the Agency's water system. Therefore, a portion of the property taxes on undeveloped property is used for the Agency's non-capital activities. The allocation of the Agency's tax revenue from the basic 1% levy between current uses and the CIP is based on the ratio between developed projects' assessed values (95%) and undeveloped properties' assessed values (5%). The model takes into consideration the effect of the changing ratio of developed to undeveloped property in calculating the funds available for the facility capacity program over time.

Calculation

In order to start the calculation, the model requires an initial facility capacity rate. This number is calculated by dividing the total CIP, plus financing cost including past debt, less cash sources, by the total anticipated water demand for the study period. Based on the initial rate, the model then generates a preliminary total cash revenue over the study period. If the

cash falls short, it begins a series of successive iterations until it achieves a matching of cumulative costs and revenues.

What makes this calculation complicated is that it considers cash needs on an annual basis and, if there is a cash shortfall, it takes into consideration costs attributable to borrowing this money. Each WSA effectively borrows and repays money to the Agency. The result of these borrowings and payments dictates the amount of cash required at the Agency. The Agency in turn borrows money when there is insufficient cash to cover the needs of the various WSAs.

Thus, the Facility Capacity Fee takes into account all the foregoing parameters and the cost of borrowing when it is necessary. It truly reflects the entire cost that is involved in developing and paying for a Capital Improvement Program in each WSA.

Facility Capacity Fee Calculation

A more detailed explanation of the calculation to derive the capacity fee is as follows:

A percentage of each element of the Facility Capacity Program benefiting future demand in the subject WSA is adjusted to reflect the expected change in the Construction Cost Index between now and the time of expected construction, plus the expected financing costs over the life of the financing, plus the actual cost of that percentage of facilities in place which will benefit future demand in the subject WSA, including financing costs, less estimated revenues available from property taxes collected on undeveloped property, less estimated revenues from interest on Facility Capacity Fees and tax revenues, until they are expended.

The sum of the total costs as calculated above is divided by the projected future sales in the WSA (expressed in acre feet) which will be met by the capacity of facilities planned under the CIP, and facilities currently in existence, which are of benefit to the WSA. The basic Facility Capacity Fee amount for the WSA is then adjusted to take into consideration the time value of money by reducing the fee in earlier years and increasing the fee expected to be levied in later years so that the present value of the fee in each year is equal based upon a discount rate of 4.42%.

The initial Facility Capacity Fee projected for each year is multiplied by the estimated sales of capacity (i.e. estimated facility capacity fee revenues) for each year in the future. This creates a Facility Capacity trial cash flow. This initial cash flow is then accumulated and is reduced by the accumulated annual CIP costs. The result will indicate years where there is not enough cash and other years where there is an excess. Borrowing must occur in the deficit years and the excess revenues over capital outlays may be invested to generate interest income in the surplus years. The initial Facility Capacity Fee calculation will typically result in a situation where, at the end of the build out, a WSA will either have excess cash or remaining debt. In order to minimize the projected difference between total revenues and expenses over the time period addressed in the CIP, a series of iterations must be run to adjust the initial Facility Capacity Fee either lower or higher incrementally in all time periods until a state of no excess cash and no remaining debt is reached at build out. Hundreds of iterations may occur to end up with an acceptable closing tolerance of less than 1%. Because many of the factors which go into the calculation are based on projections, estimates and assumptions regarding future growth patterns and economic conditions, the results are not guaranteed to be exact reflections of future costs and revenues. The calculations represent the Agency's best effort to set facility capacity fees based on information available today. Annual review of the capacity fees will be conducted to determine whether adjustments are necessary.

WSAs versus Agency – Model View

The Agency is the legal entity that has the authority to collect funds, spend and borrow money, and thus, for the purpose of the model, it is a "central bank". Each WSA functions as a sub-account; each has a CIP, estimated service requirements, anticipated growth and sales. Those elements that are considered Agency-wide are calculated at the Agency-wide level. The Agency-wide elements include the treatment plant, purchased water and storage. Elements which are WSA-specific (i.e., the Pipeline Capital Program), are distributed to each affected WSA. The logic previously described is also used to calculate the pipeline portion of the Facility Capacity Fee.

The very nature of the calculation is self-adjusting. As parameters change -- inflation, interest, time, sales, borrowing, value of money, amount of borrowing, increase or decrease

in CIP -- the model automatically shifts the Facility Capacity Fee projection line up or down, flatter or steeper.

Summary

The model is extremely dynamic and attempts to reflect real world conditions. It allows the Agency to make annual adjustments after reviewing past history and expected financial impacts. Further, it results in a smooth increase in connection fees that is relatively predictable over the foreseeable future.

The ultimate goal is to collect sufficient money to fund the Agency's Capital Improvement Program as well as to minimize borrowings attributable to that program in a manner that is fair, equitable and in compliance with law and Board policy.

Appendix F
Assumptions

Inflation:

Construction Cost Index	Since 1913	4.82%
Consumer Price Index	Since 1960	4.42%

Interest:

Interest Income	1962 – 2002	5.99%
3-Year Treasury less 100 Basis Points		
Interest Expense	1962 – 2002	6.49%
3-Year Treasury less 50 Basis Points		

2005 Santa Clarita Valley Water Report
Dated April 2006

2005
Santa Clarita Valley Water Report

Castaic Lake Water Agency (CLWA)
CLWA Santa Clarita Water Division
Los Angeles County Waterworks District 36
Newhall County Water District
Valencia Water Company

April, 2006

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

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Executive Summary

This annual report, which is the eighth in a series that began in 1998, provides current information about the water requirements and water supplies of the Santa Clarita Valley. The report was prepared for Castaic Lake Water Agency (CLWA) and its Santa Clarita Water Division, Los Angeles County Waterworks District 36, Newhall County Water District, and Valencia Water Company.

The Santa Clarita Valley is served by four local retail water Purveyors: Castaic Lake Water Agency's Santa Clarita Water Division (SCWD), Los Angeles County Waterworks District 36 (LA36), Newhall County Water District (NCWD), and Valencia Water Company (VWC). The CLWA provides water from California's State Water Project (SWP) to the water Purveyors for distribution. Management from these entities and representatives from the City of Santa Clarita and the County of Los Angeles meet as required to coordinate the management of imported SWP water with local groundwater, now augmented by recycled water, to meet water requirements in the Valley.

This report provides information about local groundwater resources, SWP water supplies, water conservation, and recycled water. The report reviews the sufficiency and reliability of supplies in the context of existing water demand, with focus on actual conditions in 2005, and it provides a short-term outlook of water supply and demand for 2006.

In 2005, total water demands in the Santa Clarita Valley were about 83,600 acre-feet (af), of which about 85 percent (70,800 af) was for municipal use and the remainder (12,800 af) was for agricultural and other (miscellaneous) uses, including individual domestic uses. Total demand in 2005 was about five percent lower than in 2004, and about nine percent lower than had been estimated in the previous Water Report, all attributable to the significantly wet conditions that prevailed through winter and spring in the Valley. These total water demands were met by a combination of about 45,100 af from local groundwater resources (nearly 32,300 af for municipal and about 12,800 af for agricultural and other uses), about 38,000 af of SWP water, and about 450 af of recycled water.

Of the 45,100 af of total groundwater pumpage in the Valley in 2005, about 38,700 af were pumped from the Alluvium and slightly less than 6,500 af were pumped from the underlying, deeper Saugus Formation. Alluvial pumpage represented about a 5,000 af increase from 2004, and Saugus pumpage was essentially unchanged from 2004. Neither pumping volume resulted in any overall change in ongoing groundwater conditions (water levels, water quality, etc.) in either aquifer system. SWP deliveries to the Purveyors decreased by about 9,000 af from the previous year, again primarily as a result of decreased water demand due to significantly wet conditions in the early part of the year. Water uses and supplies in 2005 are summarized in the following Table ES-1.

Table ES-1
Santa Clarita Valley
Summary of 2005 Water Supplies and Uses
(acre-feet)

Municipal		
State Water Project		38,034
Groundwater (Total)		32,316
Alluvium	*26,368*	
Saugus	*5,948*	
Recycled Water		438
Subtotal		**70,788**
Agriculture/Miscellaneous		
State Water Project		-
Groundwater (Total)		12,785
Alluvium	*12,280*	
Saugus	*505*	
Subtotal		**12,785**
Total		***83,573***

In accordance with the California Urban Water Management Planning Act, the Valley-wide UWMP was updated in 2005 to extend projected water demands through 2030, and to describe the combination of local groundwater, imported water supplies from the State Water Project, local recycled water supplies, and planned other water supplies to meet the existing and projected water demands in the Valley. The 2005 UWMP describes the reliability of local groundwater resources and the adequacy of groundwater supplies to meet groundwater demand, including consideration of the impacts of perchlorate contamination on several municipal water supply wells. The 2005 UWMP also describes the plans and ongoing work for integrated control of perchlorate migration and full restoration of perchlorate-impacted groundwater supply.

Notable details about each component of water supply in the Valley, and about the water supply outlook for 2006, include the following.

ES.1 Alluvial Aquifer

The groundwater operating plan in the UWMP includes Alluvial pumpage in the range of 30,000 to 40,000 acre-feet per year (afy) in average/normal years, and slightly reduced pumpage (30,000 to 35,000 afy) in dry years. Pumpage from the Alluvium was 38,700 af in 2005, and remained in the overall UWMP range as it has over the last ten years.

On a long-term basis, there is no evidence of any historic or recent trend toward permanent water level or storage decline. In general, throughout a large part of the basin, Alluvial groundwater levels have generally remained near historic highs during the last 30 years. Higher than average precipitation in late 2004 and 2005 resulted in significant water level recovery in the eastern part of the basin, continuing the overall trend of fluctuating groundwater levels within a generally constant range over the last 30 years. These ongoing data indicate that the Alluvium remains in good operating condition and can continue to support pumpage in the range included in the UWMP, as has been the case for the last decade, without adverse results (e.g., long-term water level decline or degradation of groundwater quality.)

Based on an integration of water quality records from multiple wells completed in the Alluvium, there have been historical fluctuations in groundwater quality, typically associated with variations in precipitation and streamflow. However, like groundwater levels, there has been no long-term trend toward groundwater quality degradation; groundwater produced from the Alluvial aquifer remains a viable municipal and agricultural water supply.

In 2002, as part of ongoing monitoring of wells for perchlorate contamination, perchlorate was detected in one Alluvial well located near the former Whittaker-Bermite facility. The detected concentration was slightly below the Notification Level for perchlorate (6 ug/l), and the well has been inactivated for municipal water supply since the detection of perchlorate. In early 2005, perchlorate was detected in a second Alluvial well, VWC's Well Q2. In response, Valencia removed the well from active service, and commissioned the preparation of an analysis and report assessing the impact of, and response to, the perchlorate contamination of that well. Valencia's response plan for Well Q2 was to pursue permitting and installation of wellhead treatment by the fall of 2005, all of which was successfully completed with the return of the well to water supply service in October 2005. All other Alluvial wells operated by the Purveyors continue to be used for municipal water supply service; those wells near the Whittaker-Bermite property are routinely sampled and perchlorate has not been detected. As detailed in the 2005 UWMP and the Q2 Report, the inactivation of either of the Alluvial wells due to perchlorate contamination does not limit the Purveyors' ability to produce groundwater from the Alluvium in accordance with the groundwater operating plan in the UWMP.

The ongoing characterization and plan for control and cleanup of perchlorate in the Valley has focused on the Saugus Formation. In addition, however, on-site cleanup and control activities also extended to the initiation of soil cleanup on one part of the Whittaker-Bermite site, and the initiation of pump and treatment action in the Northern Alluvium.

ES.2 Saugus Formation

The groundwater operating plan in the UWMP includes pumping from the Saugus in the range of 7,500 to 15,000 afy in average/normal years; it also includes planned dry-year pumping from the Saugus of 21,000 to 35,000 afy for one to three consecutive dry years. The UWMP recognizes that such short-term pumping can be recharged during subsequent wet/normal years to allow groundwater levels and storage to recover, as it has in historical periods.

Pumpage from the Saugus Formation was slightly less than 6,500 af in 2005; on average, Saugus pumpage has been about 7,000 afy since 1980. Both rates are near the lower end of the range included in the UWMP. As a result of long-term relatively low pumpage from the Saugus Formation, groundwater levels in that aquifer have remained essentially constant over the last 35 to 40 years; that trend continued in 2005.

In 1997, ammonium perchlorate was discovered in four wells completed in the Saugus Formation in the vicinity of the former Whittaker-Bermite facility located generally toward the east, on the south side of the basin. All four of those impacted wells remain out of active supply service. All other Saugus wells owned and operated by the Purveyors are available for municipal water supply service. As part of regular operation, those wells are sampled on a routine basis and perchlorate has not been detected. Despite the inactivated Saugus wells, the Purveyors still have sufficient pumping capacity in other wells to meet the planned normal range of Saugus pumping in the UWMP.

Work toward the ultimate remediation of perchlorate contamination, including the restoration of impacted groundwater supply continued to progress in 2005, with focus on permitting of a jointly developed plan "pump and treat" contaminated water from two wells to stop migration of the contaminant plume, and to deliver treated water to partially replace impacted well capacity. Environmental review of the project was completed with adoption of a Mitigated Negative Declaration in September. The Final Interim Remedial Action Plan was completed and approved by the State Department of Toxic Substances Control in December. Construction of facilities and pipelines necessary to implement the pump and treat program and to also restore inactivated well capacity is anticipated to commence in the fall of 2006.

ES.3 Imported Water

CLWA's contractual Table A Amount is 95,200 af of water from the SWP. CLWA operates two water filtration plants and has a current total treatment capacity of 86 million gallons per day of capacity where the water is treated, filtered, and disinfected prior to being delivered to Purveyors for distribution. Included in the total CLWA treatment plant capacity is the expansion of its Earl Schmidt Filtration Plant, which was completed in 2005 and added 22.5 mgd of capacity.

CLWA's final allocation of Table A for 2005 was 90 percent, or 85,680 af. On December 1, 2004, the initial allocation for 2005 was announced as 40 percent. On May 27, 2005, it was raised to the final allocation of 90 percent. Utilizing SWP contract provisions, CLWA elected to "carry over" unused remaining Table A Amount into 2006.

The total available SWP supply in 2005 was 88,382 af, including 2,702 af of 2004 carryover delivered in early 2005. CLWA deliveries were 38,034 af to the Purveyors and 20,000 af to the Rosedale-Rio Bravo Water Storage District's Storage and Recovery Program, with 31,377 af of the 2005 Table A Amount for potential carryover to 2006.

CLWA has two groundwater banking agreements with the Semitropic Water Storage District in Kern County. In accordance with those agreements, over a ten-year period (until 2012/13), CLWA can withdraw up to 50,870 af of water that it stored in 2002 and 2003 to meet Valley

demands when needed. In addition to the banking in Semitropic, CLWA finalized an agreement with the Rosedale-Rio Bravo Water Storage District in 2005, and banked 20,000 af of surplus Table A Amount in Rosedale-Rio Bravo's Water Storage and Recovery Program in 2005. In accordance with the provisions of that agreement, CLWA can withdraw up to 17,800 of that water to meet Valley water demands when needed.

Since SWP water deliveries are subject to reduction when dry conditions occur in Northern California, the UWMP includes programs, like the Semitropic and Rosedale-Rio Bravo programs, for enhancing water supply reliability during such occurrences. A capital improvement program funded by CLWA has been established to provide facilities and additional water supplies needed to firm up SWP water supplies during times of drought.

ES.4 Recycled Water

Recycled water service was initiated in July 2003 in accordance with CLWA's Draft Reclaimed Water System Master Plan (2002). The amount of recycled water used for irrigation purposes, at a golf course and in roadway median strips, was approximately 450 af in 2005.

ES.5 Water Supply Outlook

In 2006, total water demands are expected to be about 91,500 af, consistent with the growth rate and related water demand projections in the UWMP. It is expected that water demands in 2006 will continue to be met with a generally similar mix of water supplies comprised of imported SWP water, local groundwater, and recycled water.

As of March 23, 2006, the allocation of water from the SWP is 80 percent of CLWA's Table A Amount, representing 76,160 af. Combined with local groundwater from the two aquifer systems (42,500 af), total Flexible Storage Account (6,060 af), net carryover SWP water from 2005 (3,718 af), and recycled water (500 af), the total available water supplies for 2006 are nearly 129,000 af. As a result, CLWA and the Purveyors anticipate having more than adequate supplies to meet all water demands in 2006.

In any given year, SWP supplies may be reduced due to dry weather conditions or regulatory factors. During such an occurrence, the remaining water demands are planned to be met by a combination of alternate supplies such as returning water from CLWA's accounts in the Semitropic Groundwater Storage Program and the Rosedale-Rio Bravo Water Storage District's Banking Program, deliveries from CLWA's flexible storage account in Castaic Lake Reservoir, local groundwater pumping, short-term water exchanges, and participation in DWR dry-year water purchase programs in accordance with the Urban Water Management Plan. Due to the banking of excess 2002 and 2003 SWP water in the Semitropic Groundwater Storage Program, and banking CLWA can draw upon its account as needed, pursuant to the terms of the banking agreements. The banked excess 2002 and 2003 SWP water in Semitropic now represents nearly 51,000 af of recoverable water for drought water supply, and the banked excess 2005 SWP water in Rosedale-Rio Bravo now represents an additional 17,800 af of recoverable water for drought water supply.

Drought periods may affect available water supplies in any single year and for a duration usually not longer than three consecutive years. It is important to note that hydrologic conditions vary from region to region throughout the state. Dry conditions in Northern California affecting SWP supply may not affect local groundwater and other supplies in Southern California, and the reverse situation can also occur (as it did in 2002 and 2003). For this reason, CLWA and the Purveyors have emphasized developing water supplies that add diversity in water supply options, especially in dry years. Diversity of supply is considered a key element of reliability, giving Valley water Purveyors the ability to draw on multiple sources of supply during dry year conditions and thereby making the Purveyors less dependent upon direct deliveries from the SWP water supplies.

I. Introduction

1.1 Background

For most residents of the Santa Clarita Valley (Valley), domestic water service is provided by four retail water Purveyors. They are the Castaic Lake Water Agency Santa Clarita Water Division (SCWD), Los Angeles County Waterworks District 36 (LA36), Newhall County Water District (NCWD), and Valencia Water Company (VWC). Together, the Purveyors provide water to approximately 66,000 service connections. Castaic Lake Water Agency (CLWA) contracts for State Water Project water from Castaic Lake where it is treated, filtered, and disinfected at two treatment plants before distribution to the Purveyors. The staff of these entities meet regularly to coordinate the supply of water in the Valley. Their respective service areas are shown in Figure I-1.

Water supply for a small percentage of Valley residents is provided by individual private water supply wells. The locations, construction details, annual pumpage and other information about these private wells are not currently available. CLWA is currently working with private well owners to receive information about their wells for incorporation in future reports and for planning purposes. Pumping as reported herein includes an estimate of groundwater pumped from private wells; it is expected that this estimate will be refined in future reports as more information about the private wells is obtained.

In addition to municipal and individual private water uses in the Valley, there remains an agricultural water demand that is predominately dependent on local groundwater for its water supply. Accordingly, ongoing agricultural water requirements and the use of local groundwater to meet those requirements are considered in analyses and reports on water supplies such as this report.

Over the years, CLWA and the Purveyors have reviewed and documented the availability of water supplies to meet all water requirements in the Valley. Those reports have also addressed the status of water resources in the region. Past studies have assessed the condition of the local groundwater aquifers, their hydrogeologic character, aquifer storage capacity, operational yield and recharge rate, groundwater quality and contamination, and the potential for conjunctive use of groundwater and imported water resources.

Other efforts have included developing drought contingency plans, evaluating the impact of landfills on the groundwater basin, coordinating emergency response procedures and implementing Valley-wide conservation programs. In 1985, the Purveyors prepared the area's first Urban Water Management Plan (UWMP.) Information in the plan had been coordinated among CLWA and the Purveyors to provide accurate, comprehensive and consistent water supply and demand information for long term planning purposes. In accordance with the California Urban Water Management Planning Act, the Valley-wide UWMP was updated in 2005 to extend projected water demands through 2030, and to describe the combination of local groundwater, imported water supplies from the State Water Project, local recycled water supplies, and planned other water supplies to meet the existing and projected water demands in

the Valley. The 2005 UWMP describes the reliability of local groundwater resources and the adequacy of groundwater supplies to meet groundwater demand, including consideration of the impacts of perchlorate contamination on several municipal water supply wells. The 2005 UWMP also describes the plans and ongoing work for integrated control of perchlorate migration and full restoration of perchlorate-impacted groundwater supply.[1]

1.2 Purpose and Scope of the Report

The purpose of this report, which is the eighth in a series of annual water reports that began in 1998, is to provide current information about the available water supplies and demands of the Santa Clarita Valley. CLWA and the Purveyors have prepared this series of reports in response to a request made by the Los Angeles County Board of Supervisors in 1998. This report was prepared for Castaic Lake Water Agency (CLWA) and its Santa Clarita Water Division, for Los Angeles County Waterworks District 36, for Newhall County Water District, and for Valencia Water Company. It continues a format for providing information regarding water uses and the availability of water supplies on an annual basis. It is intended to be a helpful resource for use by water planners and local planning agencies. This report is complemented by the more detailed UWMP for the area, which provides longer-term water supply planning over a 25-year period.

1.3 Santa Clarita Valley Water Purveyors

As introduced above, four retail water Purveyors provide water service to most residents of the Santa Clarita Valley. Brief summary descriptions of those four Purveyors are as follows.

Castaic Lake Water Agency Santa Clarita Water Division has a service area that includes a portion of the City of Santa Clarita and unincorporated portions of Los Angeles County in the communities of Saugus, Canyon Country, and Newhall. Water is supplied from both groundwater and CLWA turnouts to nearly 27,000 service connections.

Los Angeles County Waterworks District 36 has a service area that encompasses approximately 7,635 acres in the Hasley Canyon area and the unincorporated community of Val Verde. LACWWD 36 has 1,320 service connections. The District has traditionally obtained its full water supply from a connection to the CLWA's Castaic Conduit. In 2005, as it had in 2004, the District supplemented its surface water supply with groundwater purchased from the Los Angeles County Peter J. Pitchess Detention Center.

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[1] The 2005 UWMP was challenged in a lawsuit filed in early 2006 by the California Water Impact Network and the Friends of the Santa Clara River, ultimately seeking a mandate that the approval of the UWMP by CLWA and the Purveyors be invalidated. Allegations in the lawsuit include claims that the 2005 UWMP ignored or failed to adequately address cumulative impacts of urbanization on groundwater recharge and on habitat; the impacts of private well use, a number of water quality issues, the timely remediation of perchlorate contamination, and the inability to utilize existing groundwater for Newhall Ranch water supply. Additional allegations include an overstatement of surface water reliability from the State Water Project, uncertainty of 41,000 af of CLWA's SWP Table A Amount, erroneous reliance on 24,000 af of banked groundwater, erroneous reliance on "paper water" in DWR's SWP Delivery Reliability Report, and failure to address known, foreseeable declines in SWP deliveries due to global warming. The 2005 UWMP remains valid unless affected by a future judgment or order of the court. The Purveyors believe the lawsuit is without merit, and will vigorously defend the plan in court.

Newhall County Water District's service area includes portions of the City of Santa Clarita and unincorporated portions of Los Angeles County in the communities of Newhall, Canyon Country, Saugus, and Castaic. NCWD supplies water from both groundwater and CLWA turnouts to approximately 9,200 service connections.

Valencia Water Company's service area serves about 28,800 service connections in a portion of the City of Santa Clarita and in the unincorporated communities of Castaic, Newhall, Saugus, Stevenson Ranch, and Valencia. VWC supplies water from both groundwater and CLWA turnouts; VWC also delivers recycled water for some non-potable uses.

1.4 The Upper Santa Clara River Hydrologic Area

The Upper Santa Clara River Hydrologic Area (HA), as defined by the California Department of Water Resources (DWR), is located almost entirely in northwestern Los Angeles County (Figure I-2). The area encompasses about 654 square miles comprised of flat valley land (about 6 percent of the total area) and hills and mountains (about 94 percent of the total area) that border the valley area. The mountains include the Santa Susana and San Gabriel Mountains to the south and the Sierra Pelona and Leibre-Sawmill Mountains to the north. Elevations range from about 800 feet on the valley floor to about 6,500 feet in the San Gabriel Mountains. The headwaters of the Santa Clara River are at an elevation of about 3,200 feet at the divide separating this hydrologic area from the Mojave Desert.

The Santa Clara River and its tributaries flow intermittently from Lang Station westward about 35 miles to Blue Cut, just west of the Los Angeles-Ventura County line, where it forms the outlet for the Upper Santa Clara River Hydrologic Area. The principal tributaries of the upper river are Castaic Creek, San Francisquito Creek, Bouquet Creek, and the South Fork of the Santa Clara River. Additionally, the Santa Clara River receives treated wastewater discharge from the Saugus and Valencia Water Reclamation Plants, which are operated by the Sanitation Districts of Los Angeles County (Figure I-2).

The Santa Clara River traverses the Santa Clarita Valley. The mountainous area to the north of the river is dissected by long southwest draining canyons - San Francisquito, Bouquet and Mint Canyons. Castaic Lake and Lagoon are within this Sub-Area. The South Fork of the Santa Clara River, draining the mountains along the southern boundary, traverses the valley floor where it joins with the main stem of the Santa Clara River.

Beneath the Santa Clarita Valley, there are two aquifer systems that comprise the Santa Clara River Valley East Groundwater Subbasin. This groundwater basin is the source of essentially all local groundwater used for water supply in the Santa Clarita Valley. Below Blue Cut, the Santa Clara River continues westward through Ventura County to its mouth near Oxnard. Along that route, the River traverses all or parts of six groundwater basins in Ventura County (Piru, Fillmore, Santa Paula, Oxnard Forebay, Oxnard Plain and Mound) as shown in Figure I-3.

There are two primary precipitation gages in the Santa Clarita Valley, the Newhall-Soledad 32c gage and the Newhall County Water District gage (shown in Figure I-4). The National Climatic

Data Center (NCDC) and Los Angeles County Department of Public Works (LADPW) have maintained records for the Newhall-Soledad 32c gage since 1931. Newhall County Water District has maintained records for the NCWD gage since 1979. The cumulative records from these two gages correlate very closely, with the NCWD gage recording approximately 25 percent more precipitation than the Newhall-Soledad 32c gage. This is likely due to the location of the NCWD gage, which is at the base of the mountains rimming the southern edge of the Santa Clarita Valley.

The Santa Clarita Valley is characterized as having an arid climate. Intermittent periods of less-than-average precipitation are typically followed by periods of greater-than-average precipitation in a cyclical pattern, with each wetter or drier period typically lasting from one to five years. Long-term precipitation records for the Newhall-Soledad 32c gage are illustrated in Figure I-5. The long-term average precipitation is 18.16 inches (1931-2005). Figure I-5 also shows the yearly departure from mean annual precipitation. In general, periods of less-than-average precipitation are longer and more moderate than periods of greater-than-average precipitation. Recently, the periods from 1971 to 1976, 1984 to 1991 and 1999 to 2003 have been drier than average; the periods from 1977 to 1983 and 1992 to 1996 have been wetter than average. 2004 was a slightly wet year, with total precipitation of approximately 23 inches, about 5 inches above average. Wet conditions that began in late 2004 continued into early 2005. Significant storm events in January 2005 produced over 13 inches of measured precipitation, or more than 70 percent of average annual precipitation in the first month of the year. Significant storm events continued in February, resulting in nearly 17 inches of additional measured precipitation, or nearly 100 percent of average annual precipitation in February alone. In total, 2005 had about 37 inches of measured precipitation, or slightly more than 200 percent of long-term average precipitation.

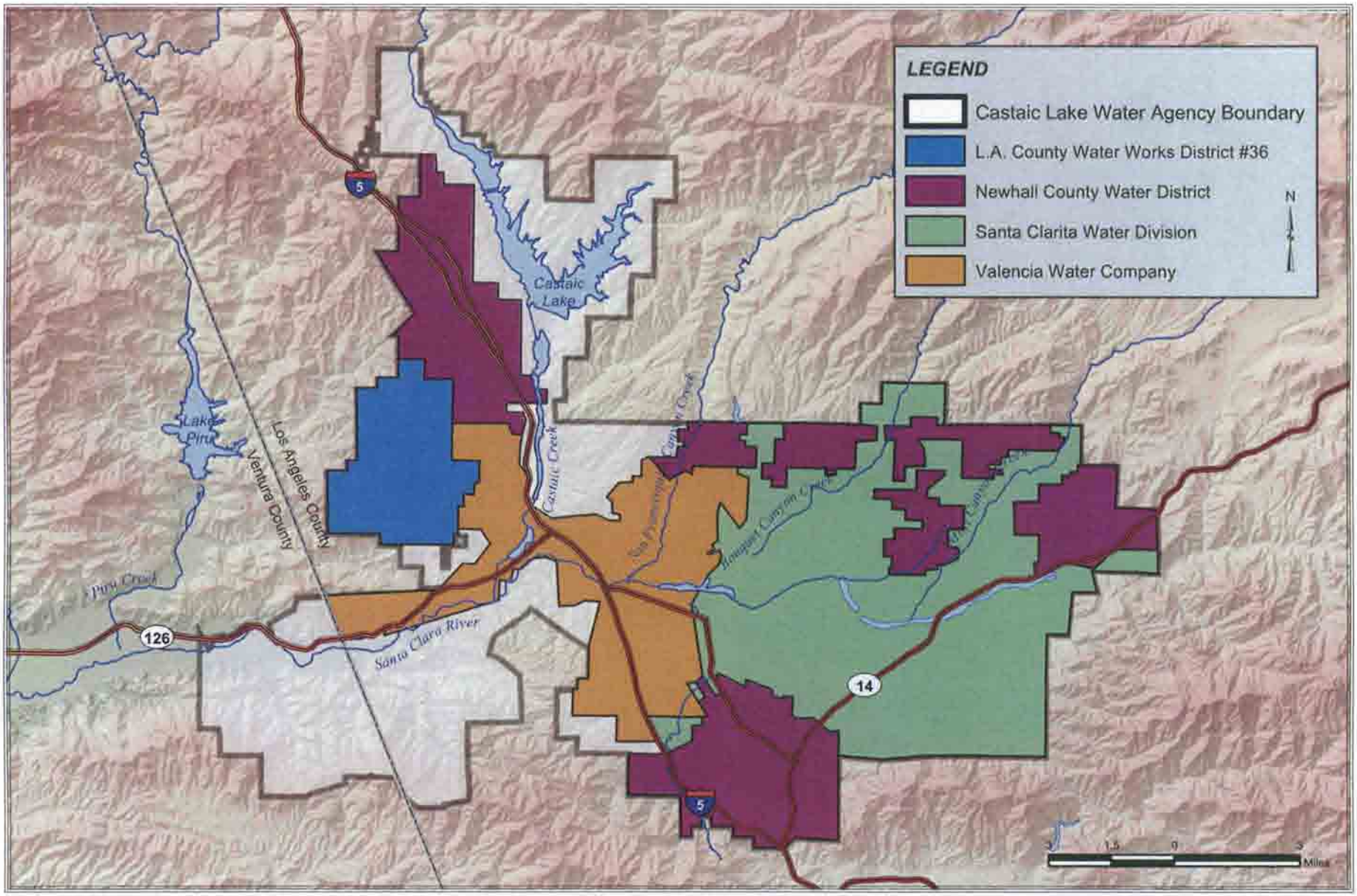

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Figure I-1
CLWA and Purveyor Service Areas

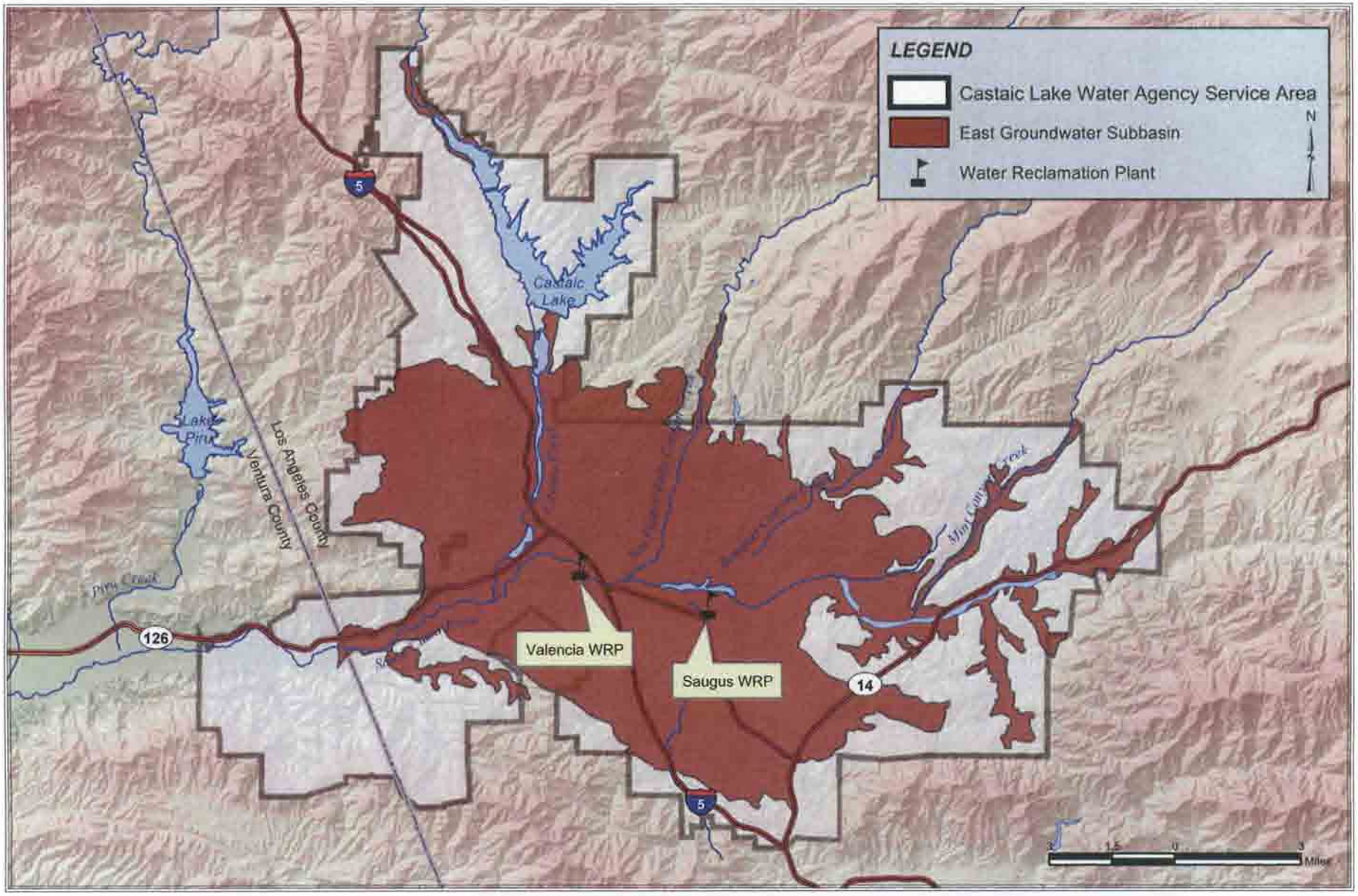

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Figure I-2
Santa Clara River Valley
East Groundwater Subbasin

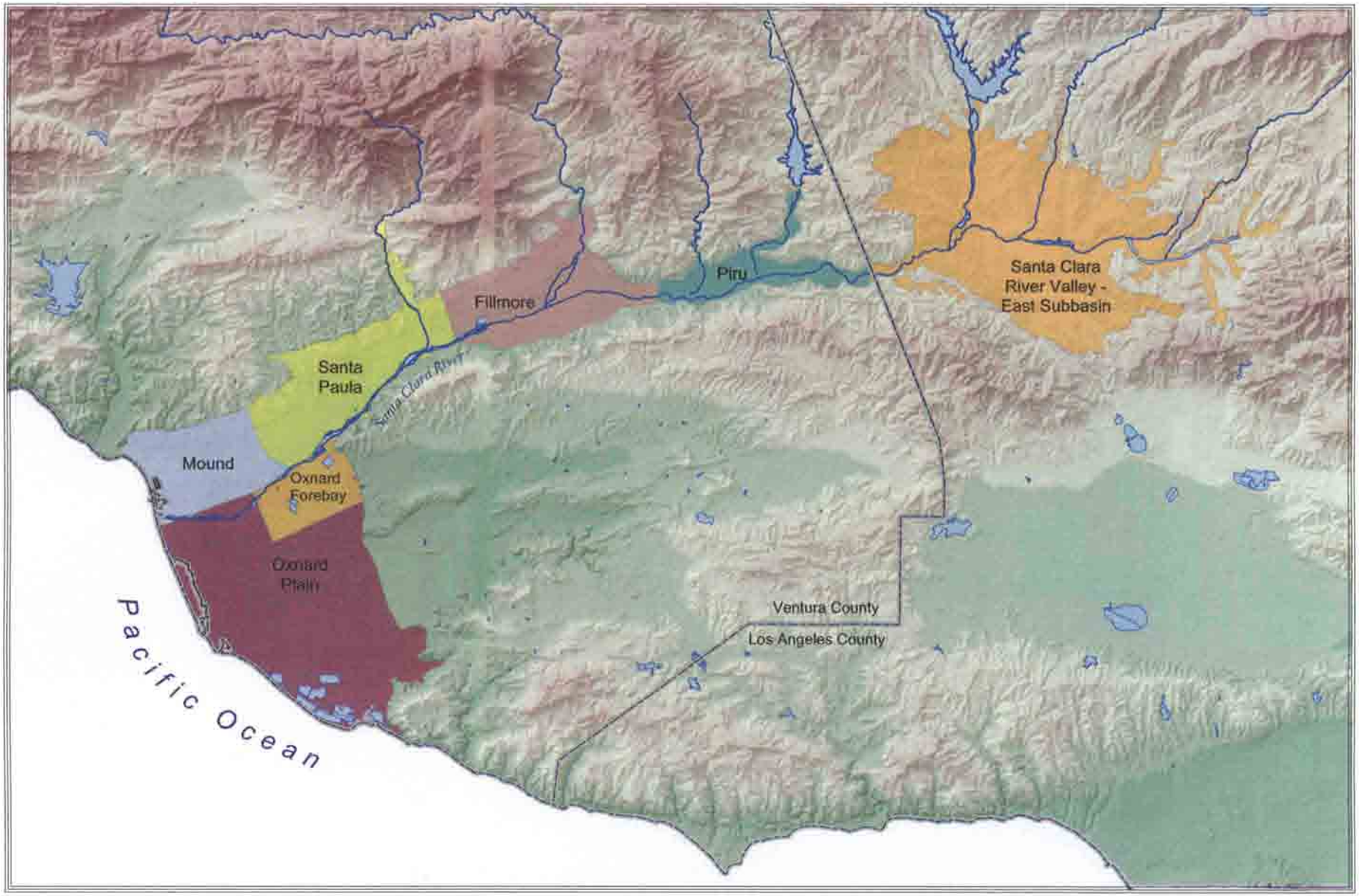

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Figure I-3
Upper and Lower Santa Clara River Basins

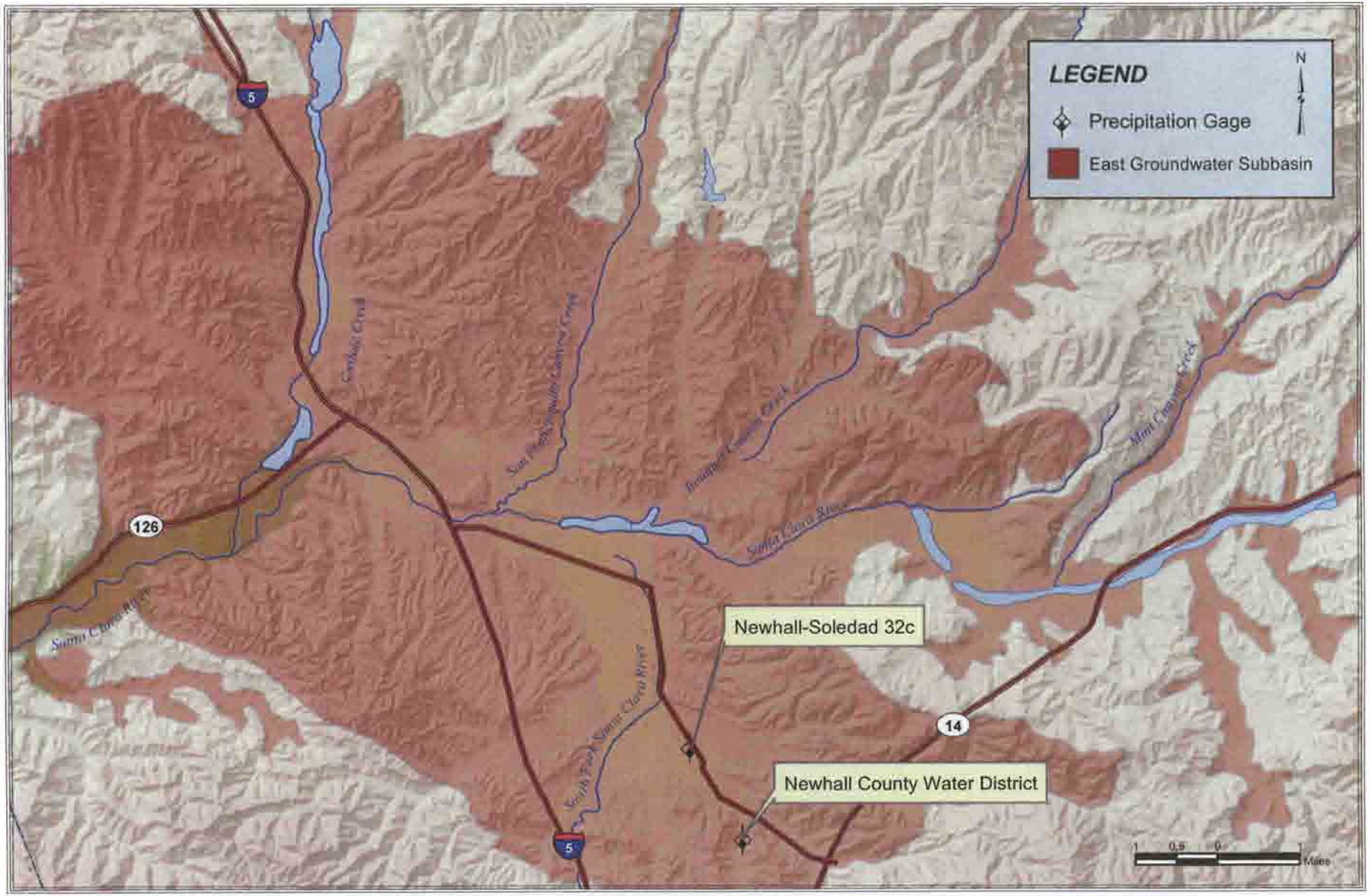

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Figure I-4
Precipitation Gage Locations
Santa Clara River Valley, East Groundwater Subbasin

Annual Precipitation and Departure from Mean Annual Precipitation
Santa Clara River Valley, East Groundwater Subbasin
(Newhall-Soledad 32c Gage)

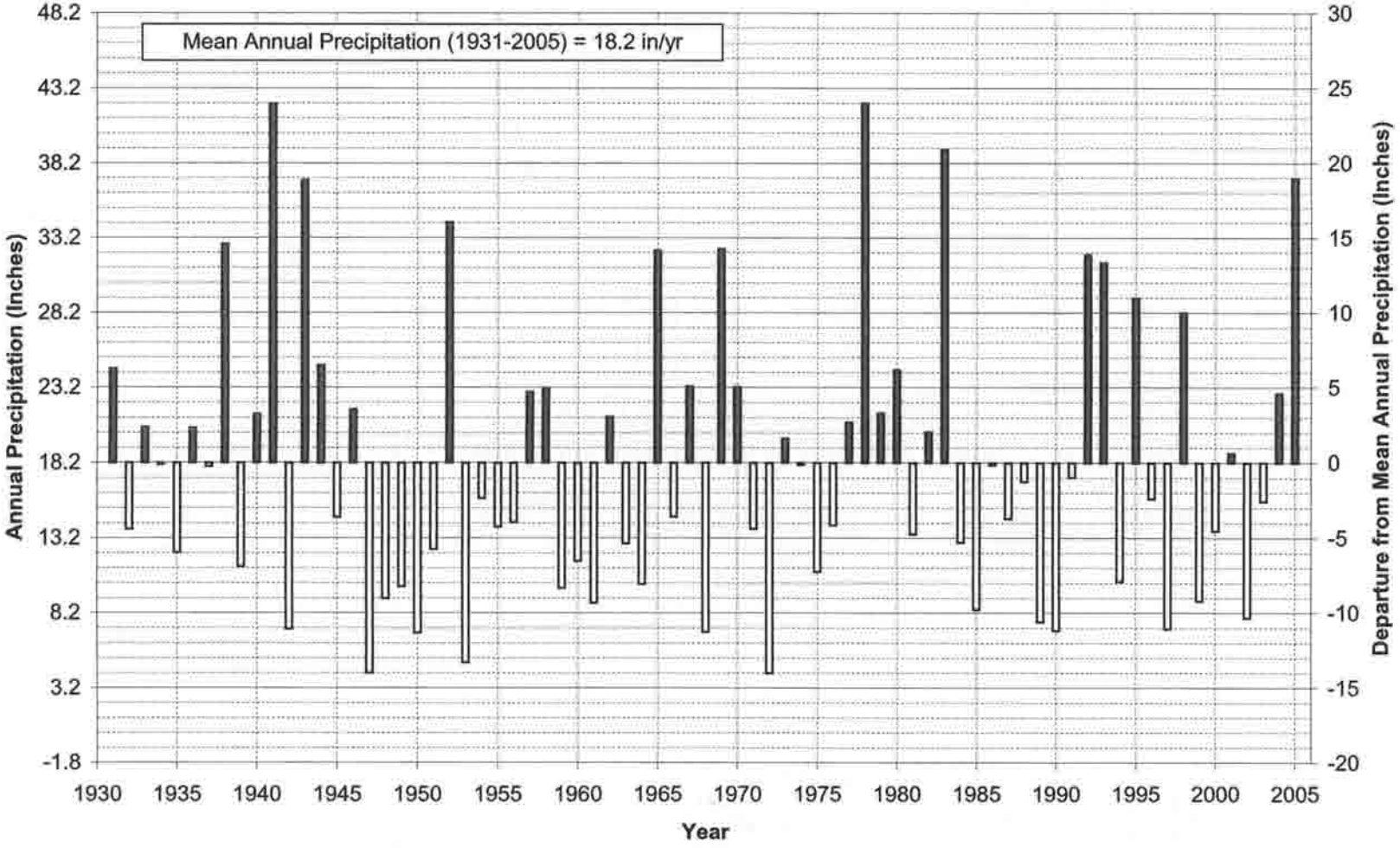


Figure I-5

II. 2005 Water Demands and Supplies

In 2005, total water demands in the Santa Clarita Valley were 83,600 af, a decrease of about 4,400 af from the previous year. Of the total water demand, 85 percent (70,800 af) was for municipal use and the remaining 15 percent (12,800 af) was for agricultural and other (miscellaneous) uses, including individual domestic uses. These total water demands were met by a combination of 45,100 af from local groundwater resources (nearly 32,300 af for municipal and about 12,800 af for agricultural and other uses), about 38,000 af of SWP water, and 438 af of recycled water.

Compared to the previous year, the total water demand in the Santa Clarita Valley decreased by about five percent in 2005. Actual water use in 2005 was also about nine percent lower than the short-term projected water requirement of about 89,000 acre-feet presented in last year's Water Report. The decrease in water use in 2005 was despite an increase of about 1,500 municipal service connections, from 64,800 in 2004 to 66,300 in 2005. The magnitude of decreased water use in 2005, which resulted from the significantly wet winter of 2004-05, was consistent with the analysis of weather impacts on water usage in the 2005 Urban Water Management Plan. As summarized in that Plan, examination of historical water use patterns in the Valley since 1980, when State Water Project deliveries began, show that weather variations have influenced water use by nine to ten percent of normal, or average, use. In hotter, dry years, water demands have been as much as nine percent higher than normal while in cooler, wet years, water demands have been as much as ten percent less than normal. In summary, the extended and significantly wet conditions in early 2005 resulted in a water demand decrease that, over the entire calendar year, was about equal to the largest historical single-year decrease from normal water demands over the last 25 years.

The uses of local and imported water supplies to meet municipal water requirements since 1980, when the importation of SWP water began, are summarized in Table II-1. Water supply utilization by each individual municipal Purveyor is tabulated in Tables II-2 through II-5 for the same period of time.

Water supply utilization for all agricultural and other non-municipal uses is summarized in Table II-6 and tabulated by three categories of agricultural and other users in Table II-7.

Water supply utilization for all uses in the Santa Clarita Valley, again for the period 1980 to present, is summarized in Table II-8. The trends in utilization of local groundwater and imported SWP water, complemented by the recent addition of recycled water, are graphically illustrated in Figure II-1. As can be seen by inspection of Table II-8 and Figure II-1, total water use in the Valley has nearly linearly increased over the last 25 years, with some weather-related fluctuations in certain years. The resultant increase in total water demand, since the inception of supplemental SWP importation, has been from about 37,000 acre-feet in 1980 to the mid-80,000 acre-feet per year range over the last four years. As can also be seen by inspection of Table II-8 and Figure II-1, that increase in water demand has essentially all been met with increasing importation of SWP water; groundwater pumping has remained close to constant, particularly within a very narrow range over the last 15 years.

Table II-1
Water Supply Utilization by Municipal Purveyors*
(Acre-Feet)

* includes CLWA-SCWD, LACWD 36, NCWD and VWC

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	*Recycled Water*	**Total**
1980	1,125	16,625	4,569	-	**22,319**
1981	5,816	14,056	4,950	-	**24,822**
1982	9,659	8,684	3,569	-	**21,912**
1983	9,185	8,803	3,398	-	**21,386**
1984	10,996	12,581	3,809	-	**27,386**
1985	11,823	12,519	4,140	-	**28,482**
1986	13,759	12,418	4,975	-	**31,152**
1987	16,285	12,630	4,962	-	**33,877**
1988	19,033	12,197	6,404	-	**37,634**
1989	21,618	13,978	7,217	-	**42,813**
1990	21,613	13,151	8,302	-	**43,066**
1991	7,968	17,408	14,417	-	**39,793**
1992	13,911	16,897	10,458	-	**41,266**
1993	13,393	19,808	10,151	-	**43,352**
1994	14,389	20,068	11,531	-	**45,988**
1995	16,996	20,590	8,087	-	**45,673**
1996	18,093	24,681	7,373	-	**50,147**
1997	22,148	25,273	6,752	-	**54,173**
1998	20,254	23,898	4,706	-	**48,858**
1999	27,282	27,240	2,728	-	**57,250**
2000	32,579	25,216	3,193	-	**60,988**
2001	35,369	22,055	3,267	-	**60,691**
2002	41,768	22,097	4,360	-	**68,225**
2003	44,419	19,397	3,581	700	**68,097**
2004	47,205	18,970	5,701	448	**72,324**
2005	38,034	26,368	5,948	438	**70,788**

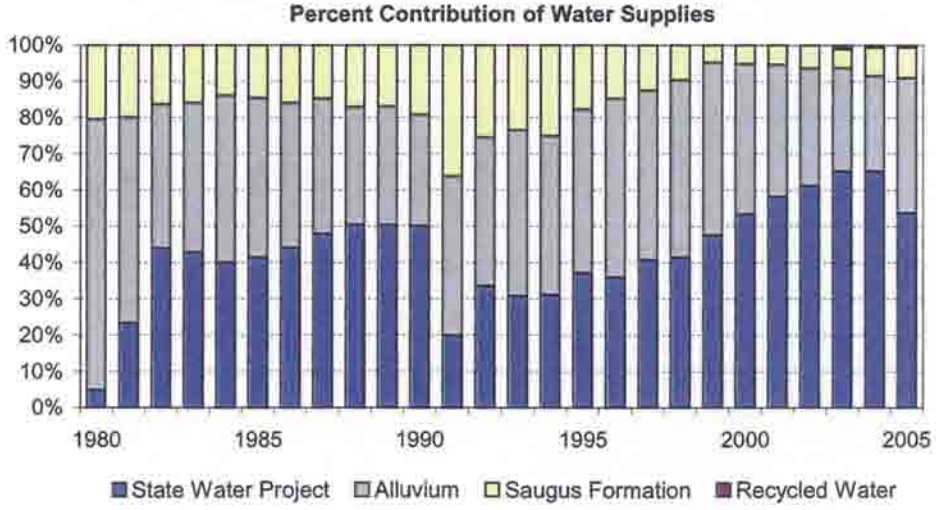


Table II-2
Water Supply Utilization by CLWA Santa Clarita Water Division
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	**Total**
1980	1,125	9,460	0	**10,585**
1981	4,602	7,109	0	**11,711**
1982	6,454	4,091	0	**10,545**
1983	5,214	4,269	0	**9,483**
1984	6,616	6,057	0	**12,673**
1985	6,910	6,242	0	**13,152**
1986	8,366	5,409	0	**13,775**
1987	9,712	5,582	0	**15,294**
1988	11,430	5,079	63	**16,572**
1989	12,790	5,785	0	**18,575**
1990	12,480	5,983	40	**18,503**
1991	6,158	5,593	4,781	**16,532**
1992	6,350	8,288	2,913	**17,551**
1993	3,429	12,016	2,901	**18,346**
1994	5,052	10,996	3,863	**19,911**
1995	7,955	10,217	1,726	**19,898**
1996	9,385	10,445	2,176	**22,006**
1997	10,120	11,268	1,068	**22,456**
1998	8,893	11,426	0	**20,319**
1999	10,772	13,741	0	**24,513**
2000	13,751	11,529	0	**25,280**
2001	15,648	9,896	0	**25,544**
2002	18,921	9,513	0	**28,434**
2003	20,668	6,424	0	**27,092**
2004	22,045	7,146	0	**29,191**
2005	16,513	12,408	0	**28,921**

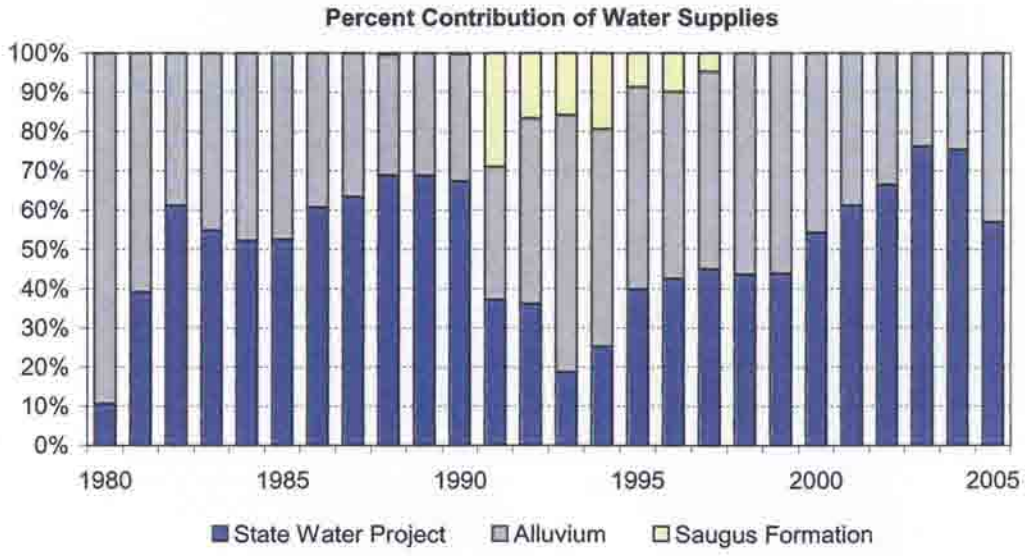


Table II-3
Water Supply Utilization by Los Angeles County Waterworks District 36
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	**Total**
1980	0	-	-	**0**
1981	0	-	-	**0**
1982	145	-	-	**145**
1983	207	-	-	**207**
1984	240	-	-	**240**
1985	272	-	-	**272**
1986	342	-	-	**342**
1987	361	-	-	**361**
1988	434	-	-	**434**
1989	457	-	-	**457**
1990	513	-	-	**513**
1991	435	-	-	**435**
1992	421	-	-	**421**
1993	465	-	-	**465**
1994	453	-	-	**453**
1995	477	-	-	**477**
1996	533	-	-	**533**
1997	785	-	-	**785**
1998	578	-	-	**578**
1999	654	-	-	**654**
2000	800	-	-	**800**
2001	907	-	-	**907**
2002	1,069	-	-	**1,069**
2003	1,175	-	-	**1,175**
2004	854	380	-	**1,234**
2005	857	343	-	**1,200**

Groundwater purchased from Los Angeles County Honor Farm

Percent Contribution of Water Supplies

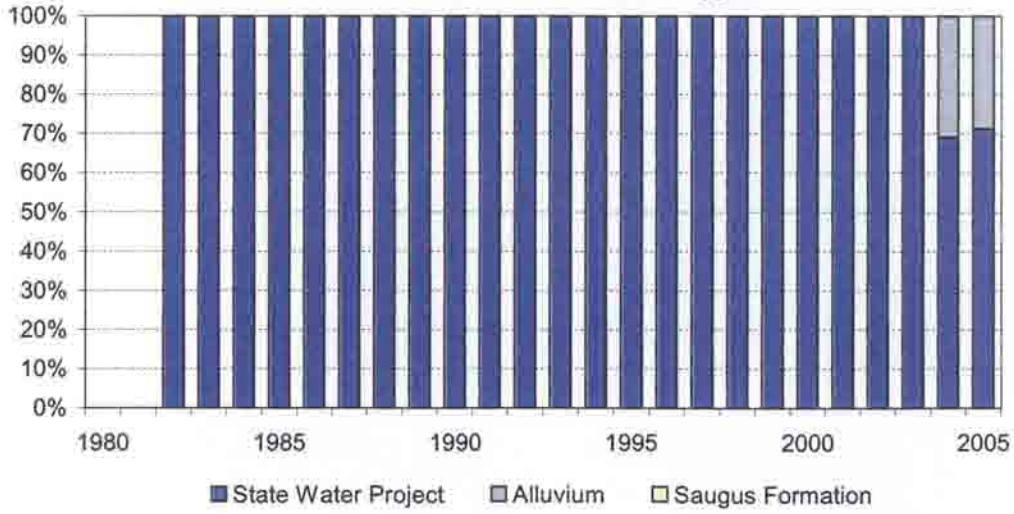


Table II-4
Water Supply Utilization by Newhall County Water District
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	**Total**
1980	0	1,170	2,363	**3,533**
1981	0	1,350	2,621	**3,971**
1982	0	1,178	2,672	**3,850**
1983	0	1,147	2,787	**3,934**
1984	0	1,549	2,955	**4,504**
1985	0	1,644	3,255	**4,899**
1986	0	1,842	3,548	**5,390**
1987	22	2,127	3,657	**5,806**
1988	142	2,283	4,041	**6,466**
1989	428	2,367	4,688	**7,483**
1990	796	1,936	4,746	**7,478**
1991	675	1,864	4,994	**7,533**
1992	802	1,994	5,160	**7,956**
1993	1,075	1,977	5,068	**8,120**
1994	906	2,225	5,103	**8,234**
1995	1,305	1,675	4,775	**7,755**
1996	1,213	1,803	4,871	**7,887**
1997	1,324	2,309	5,168	**8,801**
1998	1,769	1,761	4,557	**8,087**
1999	5,050	1,676	2,622	**9,348**
2000	6,024	1,508	2,186	**9,718**
2001	5,452	1,641	2,432	**9,525**
2002	5,986	981	3,395	**10,362**
2003	6,572	1,266	2,513	**10,351**
2004	5,896	1,582	3,739	**11,217**
2005	5,932	1,389	3,435	**10,756**

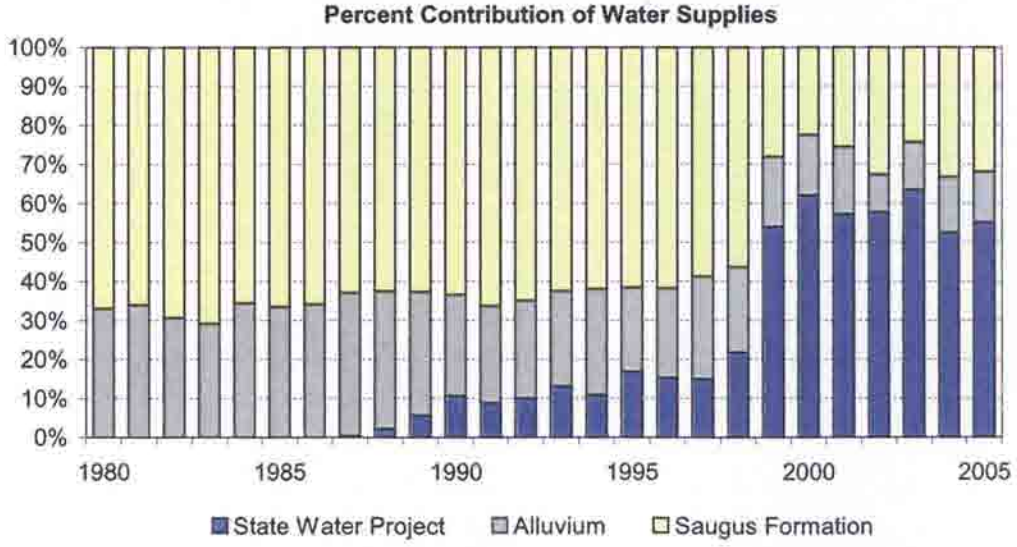


Table II-5
Water Supply Utilization by Valencia Water Company
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	*Recycled Water*	**Total**
1980	0	5,995	2,206	-	**8,201**
1981	1,214	5,597	2,329	-	**9,140**
1982	3,060	3,415	897	-	**7,372**
1983	3,764	3,387	611	-	**7,762**
1984	4,140	4,975	854	-	**9,969**
1985	4,641	4,633	885	-	**10,159**
1986	5,051	5,167	1,427	-	**11,645**
1987	6,190	4,921	1,305	-	**12,416**
1988	7,027	4,835	2,300	-	**14,162**
1989	7,943	5,826	2,529	-	**16,298**
1990	7,824	5,232	3,516	-	**16,572**
1991	700	9,951	4,642	-	**15,293**
1992	6,338	6,615	2,385	-	**15,338**
1993	8,424	5,815	2,182	-	**16,421**
1994	7,978	6,847	2,565	-	**17,390**
1995	7,259	8,698	1,586	-	**17,543**
1996	6,962	12,433	326	-	**19,721**
1997	9,919	11,696	516	-	**22,131**
1998	9,014	10,711	149	-	**19,874**
1999	10,806	11,823	106	-	**22,735**
2000	12,004	12,179	1,007	-	**25,190**
2001	13,362	10,518	835	-	**24,715**
2002	15,792	11,603	965	-	**28,360**
2003	16,004	11,707	1,068	700	**29,479**
2004	18,410	9,862	1,962	448	**30,682**
2005	14,732	12,228	2,513	438	**29,911**

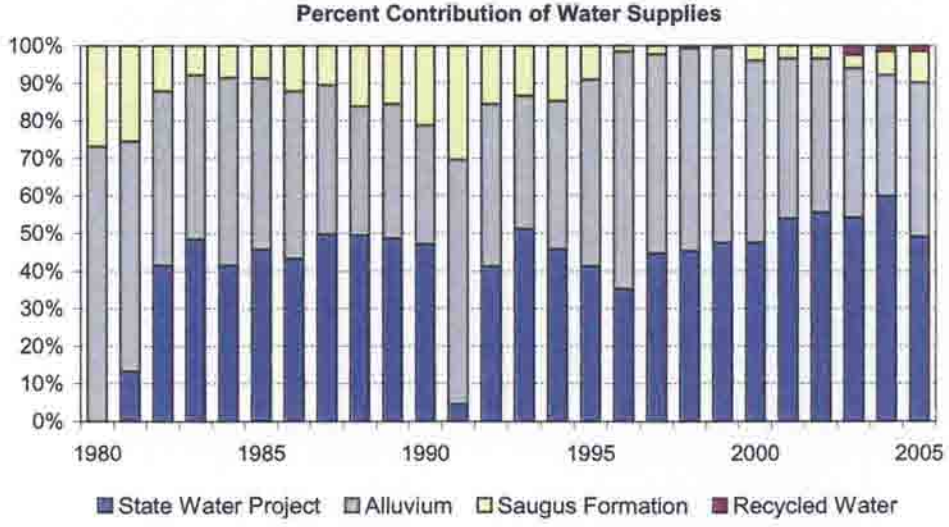


Table II-6
Water Supply Utilization for Agricultural and Other Uses
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	**Total**
1980	0	14,831	20	**14,851**
1981	0	16,737	20	**16,757**
1982	0	13,184	521	**13,705**
1983	0	11,483	454	**11,937**
1984	0	14,737	640	**15,377**
1985	0	12,828	575	**13,403**
1986	0	11,787	510	**12,297**
1987	0	10,012	599	**10,611**
1988	0	9,451	524	**9,975**
1989	0	9,743	542	**10,285**
1990	0	10,725	559	**11,284**
1991	0	9,779	500	**10,279**
1992	987	10,694	466	**12,147**
1993	443	10,318	459	**11,220**
1994	311	13,065	494	**13,870**
1995	6	13,874	473	**14,353**
1996	780	13,757	813	**15,350**
1997	1,067	14,326	993	**16,386**
1998	12	12,750	849	**13,611**
1999	20	16,166	988	**17,174**
2000	3	14,433	887	**15,323**
2001	0	15,218	873	**16,091**
2002	0	16,006	800	**16,806**
2003	0	14,181	626	**14,807**
2004	0	14,787	803	**15,590**
2005	0	12,280	505	**12,785**

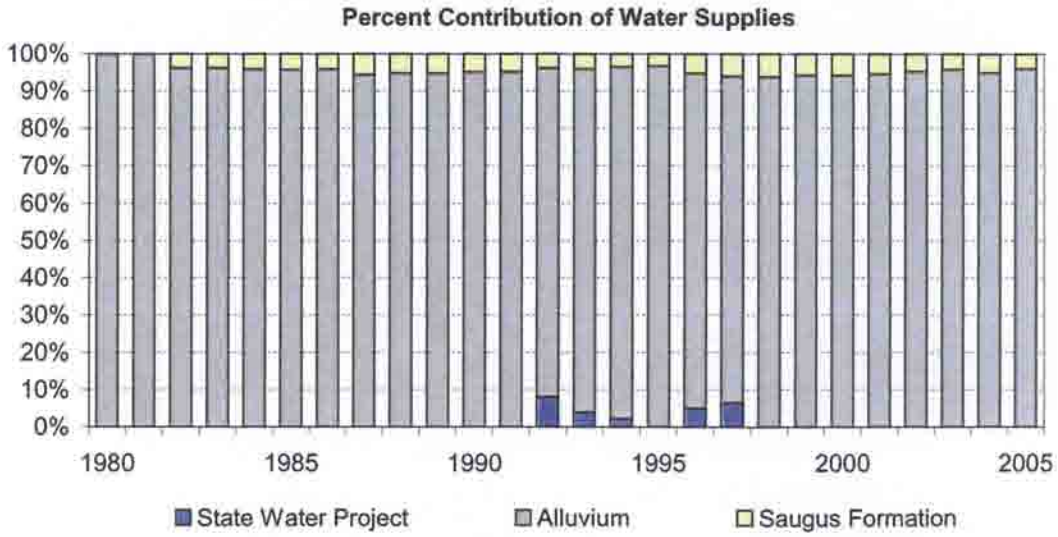


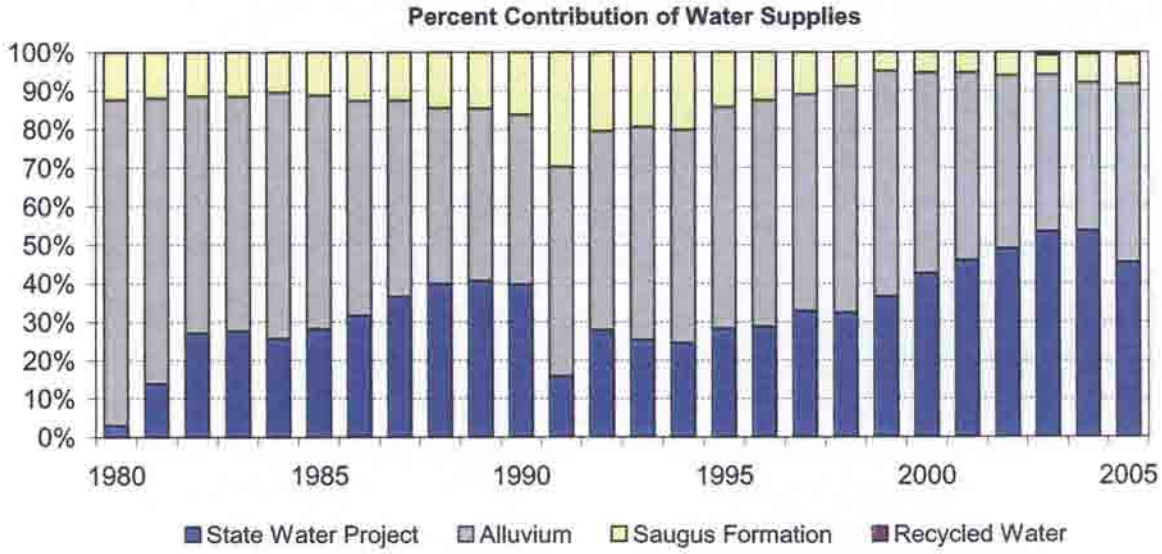
Table II-7
Individual Water Supply Utilization by Agricultural and Other Users
(Acre-Feet)

	Newhall Land and Farming			Los Angeles County Honor Farm			Small Private Domestic, Irrigation and Golf Courses Uses		
Year	Alluvium	Saugus Formation	Total	Alluvium	State Water Project	Total	Alluvium [1]	Saugus Formation [2]	Total
1980	11,331	20	**11,351**	3,000	0	**3,000**	500	0	**500**
1981	13,237	20	**13,257**	3,000	0	**3,000**	500	0	**500**
1982	9,684	20	**9,704**	3,000	0	**3,000**	500	501	**1,001**
1983	7,983	20	**8,003**	3,000	0	**3,000**	500	434	**934**
1984	11,237	20	**11,257**	3,000	0	**3,000**	500	620	**1,120**
1985	9,328	20	**9,348**	3,000	0	**3,000**	500	555	**1,055**
1986	8,287	20	**8,307**	3,000	0	**3,000**	500	490	**990**
1987	6,512	20	**6,532**	3,000	0	**3,000**	500	579	**1,079**
1988	5,951	20	**5,971**	3,000	0	**3,000**	500	504	**1,004**
1989	6,243	20	**6,263**	3,000	0	**3,000**	500	522	**1,022**
1990	8,225	20	**8,245**	2,000	0	**2,000**	500	539	**1,039**
1991	7,039	20	**7,059**	2,240	0	**2,240**	500	480	**980**
1992	8,938	20	**8,958**	1,256	987	**2,243**	500	446	**946**
1993	8,020	20	**8,040**	1,798	443	**2,241**	500	439	**939**
1994	10,606	20	**10,626**	1,959	311	**2,270**	500	474	**974**
1995	11,174	20	**11,194**	2,200	6	**2,206**	500	453	**953**
1996	12,020	266	**12,286**	1,237	780	**2,017**	500	547	**1,047**
1997	12,826	445	**13,271**	1,000	1,067	**2,067**	500	548	**1,048**
1998	10,250	426	**10,676**	2,000	12	**2,012**	500	423	**923**
1999	13,824	479	**14,303**	1,842	20	**1,862**	500	509	**1,009**
2000	11,857	374	**12,231**	1,644	3	**1,647**	932	513	**1,445**
2001	12,661	300	**12,961**	1,604	0	**1,604**	953	573	**1,526**
2002	13,514	211	**13,725**	1,602	0	**1,602**	890	589	**1,479**
2003	10,999	122	**11,121**	2,273	0	**2,273**	909	504	**1,413**
2004	10,991	268	**11,259**	2,725	0	**2,725**	1,071	535	**1,606**
2005	8,648	6	**8,654**	2,499	0	**2,499**	1,133	499	**1,632**

1. Robinson Ranch Golf Course irrigation and estimated private pumping.
2. Valencia Country Club and Vista Valencia Golf Course irrigation.

Table II-8
Total Water Supply Utilization for Municipal, Agricultural and Other Uses
(Acre-Feet)

Year	*State Water Project*	*Alluvium*	*Saugus Formation*	*Recycled Water*	**Total**
1980	1,125	31,456	4,589	-	**37,170**
1981	5,816	30,793	4,970	-	**41,579**
1982	9,659	21,868	4,090	-	**35,617**
1983	9,185	20,286	3,852	-	**33,323**
1984	10,996	27,318	4,449	-	**42,763**
1985	11,823	25,347	4,715	-	**41,885**
1986	13,759	24,205	5,485	-	**43,449**
1987	16,285	22,642	5,561	-	**44,488**
1988	19,033	21,648	6,928	-	**47,609**
1989	21,618	23,721	7,759	-	**53,098**
1990	21,613	23,876	8,861	-	**54,350**
1991	7,968	27,187	14,917	-	**50,072**
1992	14,898	27,591	10,924	-	**53,413**
1993	13,836	30,126	10,610	-	**54,572**
1994	14,700	33,133	12,025	-	**59,858**
1995	17,002	34,464	8,560	-	**60,026**
1996	18,873	38,438	8,186	-	**65,497**
1997	23,215	39,599	7,745	-	**70,559**
1998	20,266	36,648	5,555	-	**62,469**
1999	27,302	43,406	3,716	-	**74,424**
2000	32,582	39,649	4,080	-	**76,311**
2001	35,369	37,273	4,140	-	**76,782**
2002	41,768	38,103	5,160	-	**85,031**
2003	44,419	33,577	4,207	700	**82,904**
2004	47,205	33,757	6,503	448	**87,913**
2005	38,034	38,648	6,453	438	**83,573**



Total Water Supply Utilization
Santa Clarita Valley

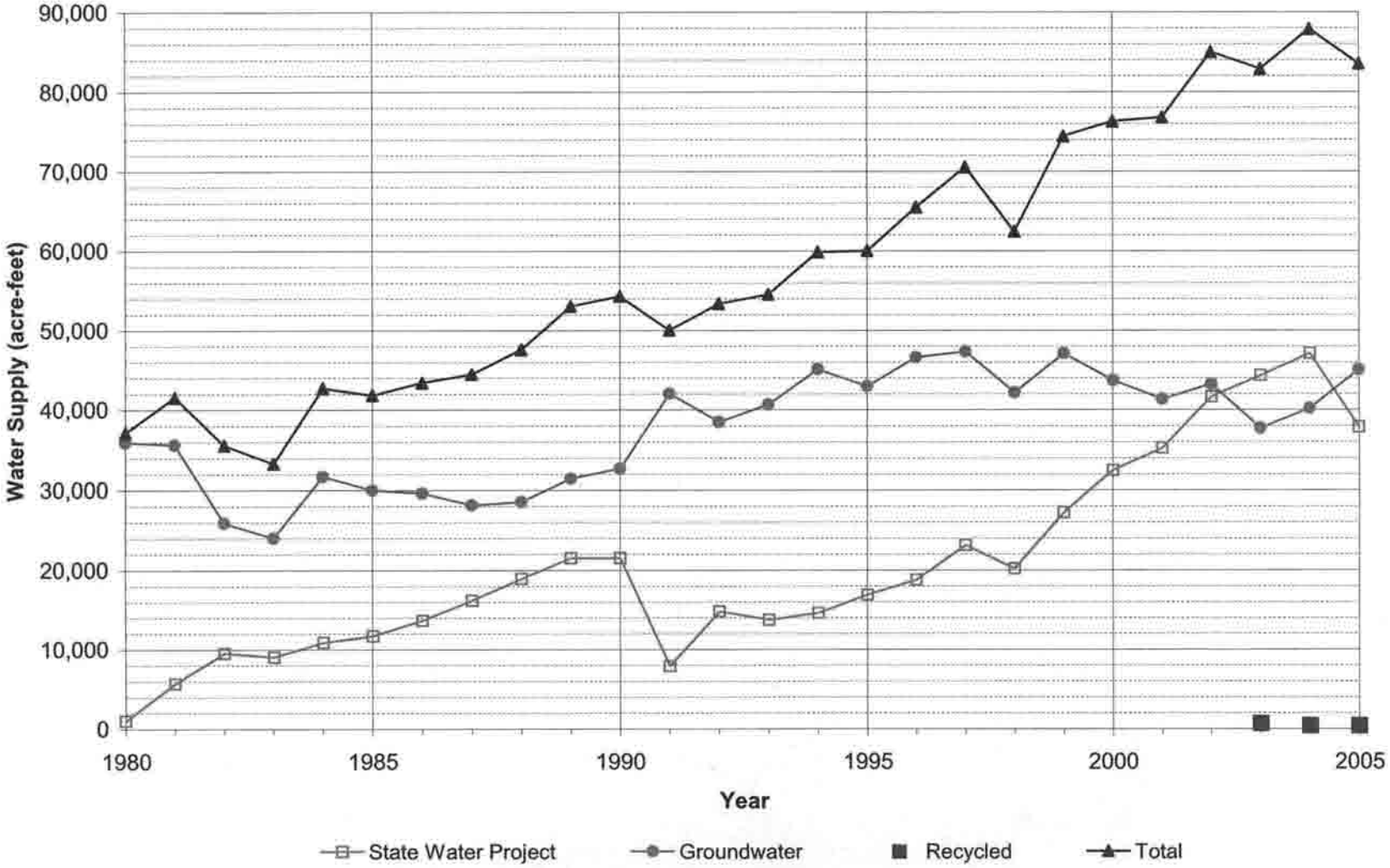


Figure II-1

III. Water Supplies

Prior to 1980, local groundwater extracted from the Alluvium and the Saugus Formation was the sole source of water supply in the Santa Clarita Valley. Since 1980, local groundwater supplies have been supplemented with imported SWP water supplies. Those water supplies were further augmented by the initiation of deliveries from CLWA's recycled water program in 2003. This section describes the groundwater resources of the Santa Clarita Valley, SWP water supplies, and CLWA's recycled water program.

3.1 Santa Clara River Valley Groundwater Basin – East Subbasin

The groundwater basin generally beneath the Santa Clarita Valley, identified in the State Department of Water Resources' Bulletin 118 as the Santa Clara River Valley Groundwater Basin, East Subbasin (Basin No. 4-4.07), is comprised of two aquifer systems. The Alluvium generally underlies the Santa Clara River and its several tributaries, and the Saugus Formation underlies practically the entire Upper Santa Clara River area. The mapped extent of the Santa Clara River Valley East Subbasin in DWR Bulletin 118 and its relationship to the extent of the CLWA service area are illustrated in Figure III-1. The subbasin boundary approximately coincides with the outer extent of the Alluvium and Saugus Formation.

A 2001 Update Report on both the Alluvium and Saugus Formation Aquifers (Slade, 2002), which updated analyses and interpretation of hydrogeologic conditions from earlier reports (Slade, 1986 and 1988), included extensive detail on major aspects of the groundwater basin. Notable parts of the Update Report relative to water supply include:

- Analysis of historical groundwater levels and production indicates that there have been no conditions that would be illustrative of groundwater overdraft;
- Utilization of operational yield (as opposed to perennial yield) as a basis for managing groundwater production would be more applicable in this basin to reflect fluctuating utilization of groundwater in conjunction with imported SWP water;
- Operational yield of the Alluvium would be 30,000 to 40,000 afy for wet and normal rainfall years, with an expected reduction into the range of 30,000 to 35,000 afy in dry years;
- Operational yield of the Saugus Formation would be in the range of 7,500 to 15,000 afy on a long-term basis, with short-term increases during dry periods into a range of 15,000 to 25,000 afy, and to 35,000 afy if dry conditions continue.

In 2004, as part of analyzing the restoration of perchlorate-impacted groundwater supply in the Valley, a numerical groundwater flow model was developed and calibrated for use in analyzing the response of the groundwater basin to long-term operation at the operational yields noted above, with focus on perchlorate extraction and the control of perchlorate migration in the basin. Subsequently, in 2005, the groundwater flow model was utilized to specifically analyze the sustainability of groundwater supplies in both the Alluvium and the Saugus Formation through a

long-term (78 year) hydrologic period that was selected to examine groundwater basin response to variations in pumping in accordance with the operating plan. Resultant projections of groundwater levels, groundwater storage, and surface water flows showed the basin to respond in a long-term sustainable manner, with no chronic depletion of groundwater levels, storage, or stream flows. The primary findings of the Basin Yield Report on the preceding work (CH2M Hill and LSCE, 2005), which also assessed current basin conditions based on historical data utilized in the model, included:

- The groundwater basin has historically been, and continues to be, in good operating condition and not in overdraft conditions, as indicated by historical data.

- The groundwater plan is sustainable over varying hydrologic conditions, because it is feasible to intermittently exceed a long-term average yield for one or more years without creating long-term adverse impacts to the groundwater system and the Santa Clara River.

- The groundwater operating plan for the Alluvium and the Saugus Formation can be used for long-term water supply planning purposes. In particular, although increased pumping from the Saugus Formation during dry periods can be expected to cause short-term declines in groundwater levels, it is not projected to cause permanent declines in groundwater discharges or streamflow. Additionally, Saugus groundwater levels will rapidly recover to pre-drought conditions.

- The strategy around which the groundwater operating plan was designed (maximizing the use of Alluvial Aquifer and imported water during years of normal or above-normal availability of these supplies, while limiting the use of the Saugus Formation during these periods, then temporarily increasing Saugus pumping during years when SWP supplies are significantly reduced because of drought conditions) is viable on a long-term basis.

- The historical observations of basin conditions and the model simulations together support the historical and ongoing confidence that groundwater can continue to be a sustainable source of water supply under the groundwater operating plan.

3.2 Alluvium – General

The spatial extent of the aquifers used for groundwater supply in the Valley, the Alluvium and the Saugus Formation, are illustrated in Figure III-1. Geologic descriptions and hydrogeologic details related to both aquifers are included in several other technical reports including Slade (1986, 1988 & 2002), CH2M Hill (2005) and LSCE (2005), and in the 2005 Urban Water Management Plan.

Consistent with the 2001 Update Report (Slade), the 2005 Basin Yield Report (CH2M Hill and LSCE), and the 2005 UWMP, the management practice of the Purveyors continues to be to utilize the Alluvium in accordance with the groundwater operating plan, 30,000 to 40,000 afy in wet and normal years, with possible reduction to 30,000 to 35,000 afy in dry years. Such operation will maximize use of the Alluvium because of the aquifer's ability to store and produce good quality water on a sustainable basis, and because the Alluvium is capable of rapid recovery

of water levels and storage in wet periods. As with many groundwater basins, it is possible to intermittently exceed a long-term average yield for one or more years without long-term adverse effects. Higher pumpage for short periods may temporarily lower groundwater storage and related water levels, as has been the case in the Alluvium several times since the 1930's. However, subsequent decreases in pumpage limit the amount of water level decline, and normal to wet-period recharge result in a rapid return of groundwater levels to historic highs. Historical groundwater data collected from the Alluvium over numerous hydrologic cycles continue to provide assurance that groundwater elevations, if locally lowered during dry periods, recover in subsequent average or wet years. Such water level response to rainfall is a significant characteristic of permeable, porous, alluvial aquifer systems that occur within large watersheds. In light of these historical observations, complemented by the long-term sustainability analysis using the numerical groundwater flow model, there is ongoing confidence that groundwater will continue to be a sustainable source of water supply at the rates of pumping described in the Basin Yield Report, now incorporated in the 2005 UWMP.

Long-term adverse impacts to the Alluvium could occur if the amount of water extracted from the aquifer were to exceed the amount of water that recharges the aquifer over an extended period. However, the quantity and quality of water in the Alluvium and pumpage from the Alluvium are routinely monitored, and no long-term adverse impacts have ever been evident. Ultimately, the Purveyors have identified cooperative measures to be taken, if needed, to ensure sustained use of the aquifer. Such measures include but are not limited to the continuation of conjunctive use of imported SWP surface water with local groundwater, artificial recharge of the aquifer with local runoff or other surface water supplies, financial incentives discouraging extractions above a selected limit, expanded use of other alternative supplies such as recycled water, and expanded implementation of demand-side management, including conservation.

3.2.1 Alluvium – Historical and Current Conditions

Total pumpage from the Alluvium in 2005 was about 38,700 af, an increase of nearly 5,000 af from the preceding year. Total Alluvium pumping thus remains within the groundwater operating plan range. Of the total Alluvial pumpage in 2005, about 68 percent (26,400 af) was for municipal water supply, and the balance, about 12,300 af, was for agriculture and other smaller uses, including individual domestic uses. In a longer-term context, there has been a change in municipal/agricultural pumping distribution since SWP deliveries began in 1980, toward a slightly higher fraction for municipal water supply (from about 50 percent to more than 60 percent of Alluvial pumpage), which reflects the general land use changes in the area. Ultimately, on a long-term average basis since the importation of SWP water, total Alluvial pumpage has been slightly less than 31,000 afy, which is at the lower end of the range of operational yield of the Alluvium. The overall historic record of Alluvial pumping is illustrated in Figure III-2.

Groundwater levels in various parts of the basin have historically exhibited different responses to both pumpage and climatic fluctuations. During the last 20 to 30 years, depending on location, Alluvial groundwater levels have remained nearly constant (generally toward the western end of the basin), or have fluctuated from near the ground surface when the basin is full, to as much as 100 feet lower during intermittent dry periods of reduced recharge (generally toward the eastern

end of the basin). For illustration of the various groundwater level conditions, the Alluvial wells have been grouped into areas with similar groundwater level patterns as illustrated in Figure III-3. Figures III-4 and III-5 present historical groundwater levels organized into hydrograph form (groundwater elevation vs. time) for four areas throughout the basin. The other areas shown in Figure III-2 exhibit groundwater level responses that are similar to those in these four areas.

The 'Mint Canyon' area, located at the far eastern end of the groundwater basin, and the nearby 'Above Saugus WRP' and 'Bouquet Canyon' areas generally exhibit similar groundwater level responses. Those parts of the Alluvium have historically experienced a number of alternating wet and dry hydrologic conditions (Figures III-4 and III-5) during which groundwater level declines have been followed by returns to historic highs. When water levels are low, well yields and pumping capacities in this area can be impacted. The affected Purveyors respond by increasing use of Saugus Formation and imported (SWP) supplies, as shown in Table II-8. The Purveyors also shift a fraction of the Alluvial pumpage that would normally be supplied by 'Mint Canyon' area wells to areas further west, where well yields and pumping capacities remain fairly constant because of smaller groundwater level fluctuations. As shown in Figure III-6, the Purveyors decreased total Alluvial pumpage from the 'Mint Canyon' area steadily from 2000 through 2003, and correspondingly increased pumpage in the 'Below Saugus WRP' and 'Below Valencia WRP' areas. In spite of a continued period of below-average precipitation from 1999 to 2003, that progressive decrease in pumping resulted in a cessation of groundwater level decline in the 'Mint Canyon' area in 2002 and 2003. Subsequently, wet conditions in late 2004, continuing into 2005, resulted in full recovery of groundwater storage. With such high groundwater levels, pumping in the 'Mint Canyon' area was increased in 2005, with no significant change in groundwater levels as a result.

The 'Below Saugus WRP' area (Figure III-4), along the Santa Clara River immediately downstream of the Saugus Water Reclamation Plant, and the 'San Francisquito Canyon' area generally exhibit similar groundwater levels. In this middle part of the basin, historical groundwater levels were lower in the 1950's and 60's than current levels. Groundwater levels in this area notably recovered as pumpage declined through the 1960's and 1970's. They have subsequently sustained generally high levels for much of the last 30 years, with three dry-period exceptions: mid-1970's, late 1980's to early 1990's, and the late 1990's to early 2000's. Recoveries to previous high groundwater levels followed both of the short dry-period declines in the 1970's and 1990's. Most recently, groundwater levels have recovered significantly following a wetter-than-average year in 2004 and significantly wet 2005, indicating that the groundwater level decline that occurred from 1999-2004 also represented a temporary dry-period decline.

The 'Castaic Valley' area is located along Castaic Creek below Castaic Lake. In that area, groundwater levels have remained fairly constant, with slight responses to climatic fluctuations, since the 1950's (Figure III-5).

The 'Below Valencia' WRP area is located along the Santa Clara River downstream of the Valencia Water Reclamation Plant, where discharges of treated effluent from the Valencia WRP to the Santa Clara River contribute to groundwater recharge. Groundwater levels in this area exhibit slight, if any, response to climatic fluctuations, and have remained fairly constant since

the 1950's despite, over the last 20 years, a notable increase in pumping in that area (Figure III-5 and III-6).

In summary, depending on the period of available data, all the history of groundwater levels in the Alluvium show the same general picture: recent (last 30 years) groundwater levels have exhibited historic highs; in some locations, there are intermittent dry-period declines (and an associated use of some groundwater from storage) followed by wet-period recoveries (and associated refilling of storage space). On a long-term basis, whether over the last 26 years since importation of supplemental SWP water, or over the last 40 to 50 years (since the 1950's - 60's), the Alluvium shows no signs of water level-related overdraft, i.e., no trend toward decreasing water levels and storage. Consequently, pumpage from the Alluvium has been and continues to be sustainable within the operational yield of that aquifer.

3.3 Saugus Formation – General

Saugus wells operated by the Purveyors are located in the southern portion of the basin south of the Santa Clara River (Figure III-7). Consistent with the 2001 Update Report (Slade) and the 2005 Basin Yield Report (CH2M Hill and LSCE), the management practice of the Purveyors is to utilize the Saugus in accordance with the groundwater operating plan, in the range of 7,500 to 15,000 afy in average/normal years, and planned dry-year pumping of 15,000 to 35,000 afy for one to three consecutive dry years, when shortages to CLWA's SWP water supplies could occur. Such high pumping would be followed by periods of lower pumpage (the 7,500 to 15,000 afy in average/normal years as noted above) in order to allow recharge to recover water levels and storage in the Saugus. Maintaining the substantial volume of water in the Saugus Formation is an important strategy to help maintain water supplies in the Santa Clarita Valley during drought periods.

3.3.1 Saugus Formation – Historical and Current Conditions

Total pumpage from the Saugus in 2005 was slightly less than 6,500 af, essentially the same as in the preceding year. Of the total Saugus pumpage in 2005, most (nearly 6,000 af) was for municipal water supply, and the balance (500 af) was for agricultural and other irrigation uses. Groundwater pumpage from the Saugus peaked in the early 1990's and then steadily declined through the remainder of that decade. Since then, Saugus pumpage has been in the range of about 4,000 to 6,500 afy. On a long-term average basis since the importation of SWP water, total pumpage from the Saugus Formation has ranged from a low of about 3,700 afy (in 1999) to a high of nearly 15,000 afy (in 1991); average pumpage from 1980 to present has been about 6,700 afy. These pumping rates remain well within, and generally at the lower end of the range of operational yield of the Saugus Formation. The overall historic record of Saugus pumping is illustrated in Figure III-8.

Unlike the Alluvium, which has an abundance of wells with extensive water level records, the water level data for the Saugus Formation are limited by the distribution of the wells in this Formation and the periods of record. The wells that do have water level records extending back to the mid-1960's indicate that groundwater levels in the Saugus Formation were highest in the mid-1980's and are currently higher than they were in the mid-1960's (Figure III-9). Based on

these data, there is no evidence of any historic or recent trend toward permanent water level or storage decline.

Consistent with the 2001 Update Report (Slade), the 2005 Basin Yield Report (CH2M Hill and LSCE), and the 2005 UWMP, the management practice of the Purveyors continues to be to maintain groundwater storage and associated water levels in the Saugus Formation so that supply is available during drought periods, when Alluvial pumping might be reduced and SWP supplies could be decreased. The period of increased pumpage during the late 1980's and early 1990's is a good example of this management strategy. Most notably, in 1991, when SWP deliveries were substantially reduced, increased pumpage from the Saugus made up almost half of the decrease in SWP deliveries. This increased Saugus pumpage resulted in short-term declining water levels reflecting the use of stored water. However, the water levels subsequently rose when pumpage declined, reflecting recovery of storage capacity of the Saugus Formation.

3.4 Imported Water

CLWA obtains water supplies from the SWP, which is owned and operated by the California Department of Water Resources (DWR). CLWA is one of 29 contractors holding long-term SWP contracts with DWR. SWP water originates as rainfall and snowmelt in northern and central California. Runoff is stored in Lake Oroville, which is the project's largest storage facility. The water is then released from Lake Oroville down the Feather River to the Sacramento River and the Sacramento-San Joaquin Delta. Water is diverted from the Delta into the Clifton Court Forebay, and then pumped into the 444-mile long California Aqueduct. SWP water is temporarily stored in San Luis Reservoir, which is jointly operated by DWR and the U.S. Bureau of Reclamation. Prior to delivery to CLWA, SWP supplies are stored in Castaic Lake, located at the end of the West Branch of the California Aqueduct.

CLWA's service area covers approximately 195 square miles (124,800 acres), including the entire City of Santa Clarita and surrounding unincorporated communities. CLWA obtains SWP water from a SWP terminal reservoir, Castaic Lake. The water is treated, filtered and disinfected at CLWA's Earl Schmidt Filtration Plant and Rio Vista Water Treatment Plant, which have a combined treatment capacity of 86 million gallons per day. Treated water is delivered from the treatment plants by gravity flow to each of the four Purveyors through a distribution network of pipelines and turnouts. At present, CLWA delivers water to the four Purveyors through 18 turnouts.

In 2005, CLWA fulfilled the following major accomplishments in order to enhance, preserve, and strengthen the quality and reliability of existing and future supplies:

- Completed expansion of the Earl Schmidt Filtration Plant from 33.5 mgd to 56 mgd;
- Progressed on construction of the Sand Canyon Pipeline and Reservoir;
- Completed construction of the Pitchess Pipeline;
- Adopted the 2005 Urban Water Management Plan;
- Initiated participation in a long-term water banking program with Rosedale-Rio Bravo Water Storage District and delivered 20,000 af of water into storage, as recommended in the UWMP;

- Obtained the right to utilize 1,376 af of flexible storage in Castaic Lake through an agreement with Ventura County SWP contractors;
- Continued implementation of various water supply programs recommended in the UWMP;
- Continued implementation of the AB 3030 Groundwater Management Plan;
- Continued implementation of the water conservation Best Management Practices;
- Continued cooperative effort with the U.S. Army Corps of Engineers for characterization studies of the former Whittaker-Bermite site and in a task force effort with the City of Santa Clarita, local legislators, and state agencies to effect the clean-up and remediation of all aspects of the former Whittaker-Bermite site, including the perchlorate groundwater contamination;
- Continued work on the design and construction of facilities for restoration of groundwater supply wells impacted by perchlorate contamination;
- Continued recycled water service.

3.4.1 State Water Project Table A Supplies

Each SWP contractor has a specified water supply amount shown in Table A of its contract that currently totals approximately 4.1 million af. The term of the contract is through 2035 and is renewable after that year. Although the SWP has not been fully completed, the SWP can deliver all of the 4.1 million af of Table A Amounts during very wet years.

CLWA has a contractual Table A Amount of 95,200 af per year of water from SWP.[2] CLWA's final allocation of Table A Amount for 2005 was 90 percent, or 85,680 af. On December 1, 2004, the initial allocation for 2004 was announced as 40 percent. On January 14, 2005, it was

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[2] 41,000 af of CLWA's 95,200 af Table A Amount was acquired from the Wheeler Ridge-Maricopa Water Storage District by way of a Table A water transfer agreement executed in March 1999. CLWA prepared an environmental impact report (EIR) to address the environmental consequences of the transfer agreement. The environmental review for the project by CLWA was the subject of litigation in Los Angeles Superior Court. CLWA prevailed in the EIR litigation at the trial court; however, the project opponents (Friends of the Santa Clara River) filed an appeal.

In January 2002, the Court of Appeal issued a decision ordering the Superior Court to decertify the EIR for the transfer agreement on the grounds that it had tiered off of another EIR that had been subsequently decertified in other litigation. In doing so, however, the Court of Appeal also examined all of the plantiffs' other arguments, found them to be without merit, and held that, if the tiering problem had not arisen, it would have affirmed the earlier trial court judgment upholding the EIR.

The Court of Appeal did not invalidate any portion of the completed 41,000 afy transfer agreement. Instead, the Court directed the trial court to vacate certification of the EIR, and to retain jurisdiction until CLWA corrects the tiering technicality by preparing a new EIR. In September 2002, the Los Angeles Superior Court refused to prohibit CLWA from using the 41,000 af of Table A water while a new EIR is being prepared. The Superior Court decision on remand was appealed by Friends of the Santa Clara River to the appellate court in January 2003. In December 2003, the appellate court denied any relief to Friends and affirmed the trial court's ruling.

The revised EIR was released for public review and comment in April 2004. It was subsequently certified by the CLWA Board of Directors on December 23, 2004. On January 24, 2005, separate lawsuits challenging the environmental review for this same project were filed by California Water Impact Network and Planning and Conservation League in the Ventura County Superior Court.

raised to 60 percent. On April 21, 2005 the allocation was raised to 80 percent. On May 27, 2005, it was raised to the final allocation of 90 percent. Utilizing SWP contract provisions, CLWA elected to "carry over" unused remaining Table A Amount into 2006.

CLWA also has access to 4,684 af of "flexible storage" in Castaic Lake. In addition, during 2005 CLWA negotiated an agreement with the Ventura County SWP contractors to allow CLWA to utilize their flexible storage account of 1,376 af. This provides total flexible storage of 6,060 af, which is maintained in Castaic Lake for use in a future dry period or an emergency. This amount was available in 2005, but was not utilized due to wet conditions statewide.

As shown in Table III-1, due to the 90 percent allocation, CLWA had excess SWP water in 2005. As DWR increased the allocation through the year, and due to a total of 2,702 af of carryover from 2004, the total available SWP supply in 2005 was 88,382 af. CLWA deliveries were 38,034 af to the Purveyors, and 20,000 af to its Rosedale-Rio Bravo Banking Program, leaving more than 31,000 af of Table A Amount available for carryover to 2006. Portions of the carryover water from 2004 and 2005 were utilized for local deliveries to the Purveyors, as well as Rosedale-Rio Bravo banking program deliveries; the remainder reverted to overall SWP use, and was allocated among all SWP contractors.

In 2005 CLWA completed an agreement to participate in a long-term water banking program with Rosedale-Rio Bravo Water Storage District in Kern County and delivered 20,000 af of Table A Amount water into storage. This long-term program will allow the storage of 100,000 af at any one time, and will provide significant dry year reliability for the Santa Clarita Valley.

As described in earlier Water Reports, agreements were reached in 2002 and 2004 with the Semitropic Water Storage District in Kern County for groundwater banking purposes. CLWA banked portions of its allocated 2002 and 2003 SWP Table A Amounts in Semitropic and, as a result, has short-term dry year supply available for extraction from that groundwater storage in Kern County until 2012/13.

3.4.2 Imported Water Supply Reliability

In May 2003 the Department of Water Resources finalized its State Water Project Delivery Reliability Report. This report is intended to assist SWP contractors in assessing the adequacy of the SWP component of their overall supplies. The report is updated with new information and calculations of delivery reliability every two years, and an updated draft was provided to the SWP Contractors in May 2005 for use in producing their 2005 UWMPs. A discussion of the Reliability Report, as well as the most significant opportunities for meeting the future water supply needs of the Santa Clarita Valley, is provided in the 2005 UWMP.

Groundwater banking and conjunctive use offer significant opportunities to improve water supply reliability for CLWA. Groundwater banking is the process of storing available supplies of water during wet years in groundwater basins. Conjunctive use is the coordinated operation of multiple water supplies to achieve improved supply reliability. During wet periods, additional surface water supplies from the SWP can be used to recharge a local groundwater basin and then recovered for delivery during dry periods.

Table III-1
2005 CLWA State Water Project Supply and Disposition
(acre-feet)

Supply		
Net 2004 Carryover to 2005 [1]		2,702
CLWA 2005 Final Allocation [2]		85,680
Total 2005 SWP Supply		**88,382**
Disposition		
Purveyor Deliveries (Total)		38,034
CLWA SCWD	*16,513*	
Valencia Water Company	*14,732*	
Newhall County Water District	*5,932*	
Los Angeles County WWD 36	*857*	
CLWA/DWR/Purveyor Metering [3]		(1,029)
Rosedale – Rio Bravo WSD Storage Program		20,000
2005 Table A Carryover to 2006 [4]		31,377
Total 2005 SWP Disposition [4]		**88,382**

1. Amount used by CLWA, based on final DWR delivery accounting; total 2004 carryover was 15,522 af.

2. Final 2005 allocation was 90% of contractual Table A amount of 95,200 acre-feet, which progressed as follows:
   Initial allocation (Dec. 1, 2004) 40%
   Allocation increase (Jan. 14, 2005) 60%
   Allocation increase (Apr. 21, 2005) 80%
   Final allocation (May 27, 2005) 90%
   Does not include 2,451 af of Article 21 water used at CLWA's Devil's Den Ranch in Kern and Kings Counties.

3. Reflects meter reading differences and meter outage in 2005 winter storms.

4. Total 2005 Table A carryover to 2006.

As previously described, CLWA entered into two 10-year agreements with Semitropic Water Storage District to bank water for subsequent use in dry years. During that period, CLWA can withdraw up to 50,870 af of 2002 and 2003 SWP Table A water that it stored in Semitropic to meet Valley demands when needed.[3]

As also previously described, CLWA's long-term water banking program with Rosedale-Rio Bravo Water Storage District in Kern County provides significant dry year reliability for the Santa Clarita Valley.

3.5 Water Quality – General

Water delivered by the Purveyors consistently meets drinking water standards set by the Environmental Protection Agency (EPA) and the California Department of Health Services (DHS). An annual Consumer Confidence Report is provided to all Santa Clarita Valley residents who receive water from one of the four water retailers. There is detailed information in that report, about the results of quality testing of the groundwater and treated SWP water supplied to the residents of the Santa Clarita Valley during 2004.

Water quality regulations are constantly changing as contaminants that are typically not found in drinking water are being discovered, and new standards are adopted. In addition, existing water quality standards are becoming more stringent in terms of allowable levels in drinking water. In light of these changes, several constituents of particular interest are discussed in more detail below.

Total Trihalomethanes

In 2002, the United States Environmental Protection Agency implemented the new Disinfectants and Disinfection Byproducts Rule. In part, this rule establishes a new MCL of 80 ug/L (based on an annual running average) for Total Trihalomethanes (TTHM). TTHMs are a byproduct that is created when free chlorine is used as a means for disinfection. To address potential TTHM formation, CLWA and the Purveyors implemented an alternative method of disinfection, chloramination, in 2005 to be able to maintain compliance with the new rule and future regulations relating to disinfection byproducts. TTHM concentrations have remained significantly below the MCL since implementation of alternative disinfection.

Perchlorate

Perchlorate has been a water quality concern in the Valley since 1997 when it was originally detected in four Saugus wells operated by the Purveyors in the eastern part of the Saugus Formation, near the former Whittaker-Bermite facility. In late 2002, perchlorate was detected in a fifth municipal well, in this case an Alluvial well also located near the former Whittaker-Bermite site. In early 2005, perchlorate was detected in a second Alluvial well near the former Whittaker-Bermite site. The six perchlorate-impacted wells were removed from active water supply service after detection of perchlorate. One of the Alluvial wells was returned to active water supply service, with treatment, in late 2005 as discussed below; the other impacted wells remain out of service. The 2005 UWMP specifically addressed the adequacy of groundwater

[3] Legal challenges to the 2002 banking program with Semitropic were resolved by the appellate court in favor of CLWA on all issues. It is expected the that appellate court decision should become final before July 2006.

supply in light of the inactivation of the impacted Alluvial and Saugus wells; and it addressed the plan and schedule for restoration of perchlorate-impacted wells, including the protection of existing non-impacted wells. As summarized in the 2005 UWMP, the inactivation of the impacted wells does not constrain the ability to meet the groundwater component of water supply in the Valley.

The Purveyors are continuing to test for perchlorate in all of their active Alluvial and Saugus wells at risk. The current DHS Notification Level for perchlorate is 6 micrograms per liter (ug/l). DHS had anticipated proposing a Maximum Contaminant Level (MCL) for perchlorate in 2005; the State Department of Finance is apparently considering the economic impact of several alternative MCL concentrations between 4 and 25.6 ug/l.

In 2005, the impacted Purveyors (SCWD, NCWD, and VWC) and CLWA continued working toward implementation of a jointly developed plan that will combine pumping from two of the impacted wells and a water treatment process to restore the impacted pumping capacity and control the migration of contamination in the aquifer. The plan for restoring "severely impaired" water sources such as the perchlorate-impacted wells must comply with the provisions of the State Department of Health Services' (DHS) Policy Memo 97-005. Work on the documentation required by Policy Memo 97-005 continued in 2005 such that DHS approval is anticipated by early fall, 2006.

The development and implementation of a cleanup plan for the Whittaker-Bermite site and the impacted groundwater is being coordinated among CLWA, the impacted Purveyors, the State Department of Toxic Substance Control (DTSC), and U.S. Army Corps of Engineers. DTSC is the lead agency responsible for regulatory oversight of the Whittaker-Bermite site. In February 2003, DTSC and the impacted Purveyors entered into a voluntary cleanup agreement entitled *Environmental Oversight Agreement*. Under the Agreement, DTSC is providing review and oversight of the response activities being undertaken by the Purveyors related to the detection of perchlorate in the impacted wells. Under the Agreement's Scope of Work, the impacted Purveyors have prepared a Work Plan for sampling the production wells, prepared a report in the results and findings of the production well sampling, prepared a draft Human Health Risk Assessment, prepared a draft Remedial Action Workplan, completed the evaluation of treatment technologies, and completed an analysis to show the integrated effectiveness of a project to restore impacted pumping capacity, extract perchlorate for treatment, and control the migration of perchlorate in the Saugus Formation. Environmental review of that project was completed in September with adoption of a mitigated Negative Declaration. The Final Interim Remedial Action Plan (IRAP) for containment and extraction of perchlorate was completed and approved by DTSC in December. Construction of facilities and pipelines necessary to implement the pump and treat program and to also restore inactivated well capacity is anticipated to commence in the fall of 2006. On the Whittaker-Bermite site, notable accomplishments in 2005 included startup of soil remediation activities in operating unit subareas, and initiation of groundwater pump and treat operations in the Northern Alluvium.

As noted above, perchlorate was detected in a second Alluvial well, VWC's Well Q2, in early 2005. In response, Valencia removed the well from active service, and commissioned the preparation of an analysis and report assessing the impact of, and response to, the perchlorate

contamination of that well. The Q2 Report (LSCE, 2005) documented that the temporary inactivation of Well Q2 would not significantly impact the water supplies used to meet demand in the Santa Clarita Valley for the period of time required to respond to the contamination. The results of the Q2 analysis and Report are consistent with the analysis and conclusions in the UWMP. Valencia's response plan for Well Q2 was to pursue permitting and installation of wellhead treatment through the summer of 2005, and to then return the well to water supply service. That work was successfully completed, with wellhead treatment installed by September, and Well Q2 was returned to active water supply service in October.

In 2000, CLWA and the impacted Purveyors had filed a lawsuit against Whittaker Corporation (the former owner of the contaminated property) and Santa Clarita LLC and Remediation Financial, Inc. (the current owners). The lawsuit seeks to have defendants pay all necessary costs of response, removal of the contaminant, remedial action costs, and any liabilities or damages associated with the contamination. Although an Interim Settlement Agreement expired in January 2005, the parties, under California Department of Toxic Substances oversight, jointly developed a plan in 2005 to "pump and treat" contaminated water from two of the Purveyors' impacted wells to stop migration of the contaminant plume. Also during the year, the parties continued negotiations intended to achieve a long term settlement to the litigation; as of March 2006 the negotiations are ongoing.

3.5.1 Groundwater Quality – Alluvium

Groundwater quality is, of course, a key factor in assessing the Alluvial aquifer as a municipal and agricultural water supply. Groundwater quality details and long-term conditions, examined by integration of individual records from several wells completed in the same aquifer materials and in close proximity to each other, have been discussed in previous Annual Water Reports and, most recently, in the 2005 UWMP. There were no changes in groundwater quality in 2005 that would change any of the fluctuations, trends, or other groundwater quality conditions as illustrated in Figures III-10 and III-11. In summary, those conditions include: no long-term overall trend, and most notably no long-term decline in Alluvial groundwater quality; a general groundwater quality "gradient" from east to west, with lowest dissolved mineral content to the east, increasing in a westerly direction; and periodic fluctuations in some parts of the basin, where groundwater quality has inversely varied with precipitation and stream flow. Those variations are typically characterized by increased mineral concentrations through dry, lower stream flow, and lower recharge conditions, followed by lower mineral concentrations through wetter, higher stream flow, higher recharge conditions.

The presence of long-term consistent water quality patterns, although intermittently affected by wet and dry cycles, supports the conclusion that the Alluvial aquifer remains a viable ongoing water supply source in terms of groundwater quality.

3.5.2 Groundwater Quality – Saugus Formation

As discussed above for the Alluvium, groundwater quality is a key factor in also assessing the Saugus Formation as a municipal and agricultural water supply. As with groundwater level data, long-term Saugus groundwater quality data are not sufficiently extensive to permit any sort of

basin-wide analysis or assessment of pumping-related impacts on quality. However, integration of individual records from several wells has been used to examine general water quality trends. Based on those records, water quality in the Saugus Formation has not historically exhibited the precipitation-related fluctuations seen in the Alluvium. Based on available data over the last 50 years, groundwater quality in the Saugus has exhibited a slight overall increase in dissolved mineral content as illustrated in Figure III-12. More recently, several wells within the Saugus Formation have exhibited an additional increase in dissolved mineral content, similar to short-term changes in the Alluvium, possibly as a result of recharge to the Saugus Formation from the Alluvium. Dissolved mineral concentrations in the Saugus Formation remain below the Secondary (aesthetic) Upper Maximum Contaminant Level. Groundwater quality within the Saugus will continue to be monitored to ensure that degradation to the long-term viability of the Saugus as an agricultural or municipal water supply does not occur.

3.5.3 Imported Water Quality

CLWA operates two water treatment plants, the Earl Schmidt Filtration Plant located near Castaic Lake and the Rio Vista Water Treatment Plant located in Saugus. CLWA produces water that meets drinking water standards set by the U.S. EPA and California DHS. SWP water has different aesthetic characteristics than groundwater with lower dissolved mineral concentrations (total dissolved solids) of approximately 280 to 314 mg/L, and lower hardness (as calcium carbonate) of 130 to 170 mg/l.

3.6 Recycled Water

Recycled water is available from two existing water reclamation plants operated by the Sanitation Districts of Los Angeles County. In 1993, CLWA prepared a draft Reclaimed Water System Master Plan that outlined a multi-phase program to deliver recycled water in the Valley. CLWA has completed environmental review on the construction of Phase I of the project, which will deliver 1,700 afy of water. Deliveries of recycled water began in 2003 for irrigation water supply at a golf course and in roadway median strips. In 2005, recycled water deliveries were 438 af.

Surveys conducted by CLWA indicate an interest for recycled water by existing water users as well as future development when it becomes available. In 2002, CLWA produced an updated Draft Recycled Water Master Plan. Overall, the program is expected to ultimately reclaim up to 17,000 af of treated (tertiary) wastewater suitable for reuse on golf courses, landscaping and other non-potable uses, as set forth in the UWMP.

CLWA has initiated California Environmental Quality Act (CEQA) analysis of the Recycled Water Master Plan (2002). This analysis will result in a Program Environmental Impact Report covering the various options for a recycled water system outlined in the Master Plan. A Notice of Preparation was released for public review in April 2005. The EIR is expected to be finalized by September 2006.

3.7 Santa Clara River

A significant accomplishment in 2001 was the preparation and execution of a Memorandum of Understanding (MOU) between the Santa Clarita Valley Purveyors and the United Water Conservation District, which manages surface and groundwater resources in seven groundwater basins in the Lower Santa Clara River Valley Area. The MOU initiated a collaborative and integrated approach to data collection; database management; groundwater flow modeling; assessment of groundwater basin conditions, including determination of basin yield amounts; and preparation and presentation of reports, including continued annual reports such as this one for current planning and consideration of development proposals, and also including more technically detailed reports on geologic and hydrologic aspects of the overall stream-aquifer system. Meetings of the MOU participants have continued, and integration of the Upper (Santa Clarita Valley) and Lower (United WCD) Santa Clara River databases has been accomplished. As discussed above, a numerical groundwater flow model of the entire Santa Clarita groundwater basin was developed and calibrated in 2002-2004. Subsequent to its initial use in 2004 for assessing the effectiveness of various scenarios to restore pumping capacity impacted by perchlorate contamination by pumping and treating groundwater for water supply while simultaneously controlling the migration of contaminated groundwater, the model was used in 2005 for evaluation of basin yield under varying management actions and hydrologic conditions. The results completed the determination of sustainable operating yield values for both the Alluvium and the Saugus Formation, which are now incorporated in the 2005 UWMP.

On occasion, issues have been raised about whether use and management of groundwater in the Santa Clarita Valley have adversely impacted surface water flows into Ventura County. Part of the groundwater modeling work has addressed the surface water flow question as well as groundwater levels and storage. While the sustainability of groundwater has logically derived primarily from projected long-term stability of groundwater levels and storage, it has also derived in part from modeled simulations of surface water flows and the lack of stream flow depletion by groundwater pumping. In addition, the long-term history of groundwater levels in the western and central part of the basin, as illustrated in Figures III-4 and III-5, supports the modeled analysis and suggests that groundwater has not been lowered in such a way as to induce infiltration from the river and thus impact surface water flows. Finally, long-term stream flow data gauged near the County line show notably higher flows from the Santa Clarita Valley into the uppermost downstream basin, the Piru Basin, over the last 30 to 35 years, as illustrated in Figure III-13.

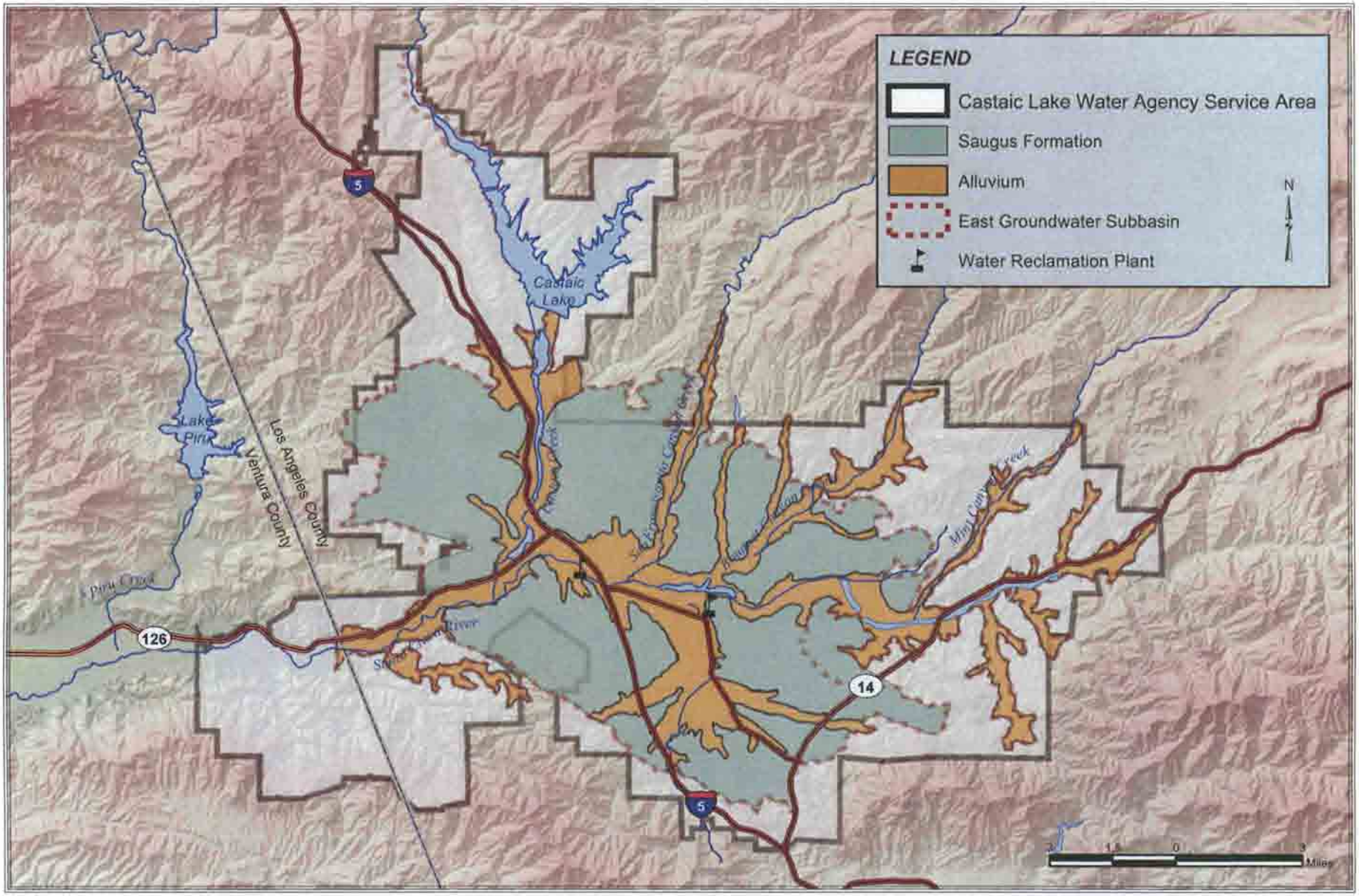

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Figure III-1
Alluvium and Saugus Formation
Santa Clara River Valley East Groundwater Subbasin

IV. Summary of 2005 Water Supply and 2006 Outlook

As reported herein, total water demands in the Santa Clarita Valley were 83,600 af in 2005. This represented a decrease of about five percent from total demand in 2004. Of the total demand in 2005, about 70,800 af was for municipal water supply, and the balance (12,800 af) was for agricultural and other uses, including individual domestic uses. As also discussed herein, the total demand in 2005 was met by a combination of local groundwater and imported SWP water, each within its respective operational yield and contractual Table A Amount, and by a small amount of recycled water.

The water demand in 2005 was less than the short-term projected demand that was estimated in the 2004 Water Report and it was also less than the demand estimated in the UWMP. For illustration, historical water use from 1980 through 2005 is plotted in Figure IV-1; also shown with that historical record are the projected total water demands in the UWMP through 2030. As discussed in the 2005 UWMP, the year-to-year fluctuations in historical water demand range from about ten percent below to about nine percent above the average or "normal" projection that would describe the long-term historical trend in the Valley's total water demand. The primary factor causing the year-to-year fluctuations is weather. In the short term, wetter years have typically resulted in decreased water demand, and drier years have typically resulted in higher water demand. Extended drier periods, however, have resulted in decreases in demand due to conservation and water shortage awareness. The decline in water demand toward the end of the 1987-92 drought is a good example of such reduced demand.

For short-term planning, recognizing the continuation of growth and near normal precipitation in early 2006, water demand in 2006 is projected to be consistent with the projections in the 2005 UWMP, or about 91,500 af. It is expected that both municipal and agricultural water demands in 2006 will be met with a generally similar mix of water supplies as in previous years, notably local groundwater and imported SWP water, complemented by recycled water that will continue to supply a small fraction of total water demand.

As of March 23, 2006, the allocation of water from the SWP in 2006 is 80 percent of CLWA's Table A Amount, or 76,160 af. Combined with local groundwater from the two aquifer systems (42,500 af), total Flexible Storage Account water (6,060 af), net carryover SWP water from 2005 (3,718 af), and recycled water (500 af), the total available water supplies for 2006 are nearly 129,000 af. Consequently, CLWA and the Purveyors anticipate having more than adequate supplies to meet all water demands in 2006. Projected 2006 water supplies and demand are summarized in Table IV-1.

Recognizing the projected surplus of supply in 2006, CLWA intends to bank an additional 20,000 af in its Rosedale-Rio Bravo WSD Banking Program in 2006.

In addition to the preceding, it is noteworthy that, while not required to meet projected demand in 2006, a total of nearly 51,000 af of recoverable water has been stored in the Semitropic Groundwater Storage Bank in Kern County. Another 17,800 af of recoverable water has been stored in a long-term water banking program with Rosedale Rio Bravo Water Storage District,

Table IV-1
2006 Water Supply and Demand
(acre-feet)

Projected 2006 Demand [1]		**91,500**
Available Water Supplies		
Local Groundwater		42,500
Alluvial Aquifer [2]	*35,000*	
Saugus Formation [3]	*7,500*	
Imported Water		85,938
Table A Amount [4]	*76,160*	
Net Carryover from 2005 [5]	*3,718*	
Flexible Storage Account (CLWA) [6]	*4,684*	
Flexible Storage Account (Ventura County) [6]	*1,376*	
Recycled Water		500
Total Available 2006 Supplies		**128,938**
Dry Year Supplies [7]		
Semitropic Groundwater Storage Bank		50,870
2002 Account	*21,600*	
2003 Account	*29,270*	
Rosedale-Rio Bravo Groundwater Storage Bank		17,800
Total Supplemental Dry Year Supplies		**68,670**

1. Interpolated from 2005 and 2010 projections in UWMP.

2. The Alluvium represents 30,000 – 40,000 afy of available supply under wet-normal conditions, and 30,000 – 35,000 afy under dry conditions. Available supply in 2006 is shown to be mid-range for average/wet conditions.

3. The Saugus represents 7,500 – 15,000 afy of available water supply under non-drought conditions, and up to 35,000 afy under increasingly dry conditions. Available supply in 2006 is shown to be limited to very wet conditions; no short-term increase in Saugus pumping is required or shown for 2006 water supply.

4. CLWA's SWP Table A amount is 95,200 af. The 2006 allocation, as of March 23, 2006 is 80 percent (76,160 af).

5. Amount used by CLWA, including 1,450 af banked in Rosedale-Rio Bravo WSD; total carryover was 31,377 af.

6. CLWA can directly utilize up to 4,684 af of storage capacity in Castaic Lake. By agreement in 2005, CLWA can also utilize 1,376 af of Ventura County SWP contractors' flexible storage capacity in Castaic Lake.

7. Does not include other reliability measures available to CLWA and the retail water Purveyors. These measures include short-term exchanges, participation in DWR's dry-year water purchase programs, local dry-year supply programs and other future groundwater storage programs.

also in Kern County. Total recoverable water in Kern County storage banks is now more than 68,000 af. However, that component of overall water supply is separately reflected in Table IV-1 because it is intended for dry-year supply and will not be used for 2006 water supply.

A significant number of local projects are part of an overall program currently funded by CLWA to provide facilities needed to firm up imported water supplies during times of drought. These involve water conservation, surface and groundwater storage, water transfers and exchanges, water recycling, additional short-term pumping from the Saugus Formation, and increasing CLWA's imported supply. This overall strategy is designed to meet increasing water demands while assuring a reasonable degree of supply reliability.

The Purveyors strive to provide a blend of groundwater and imported water to area residents to ensure consistent quality and reliability of service. The actual blend of imported water and groundwater in any given year and location in the Valley is an operational decision and varies over time due to source availability and operational capacity of Purveyor and CLWA facilities. The goal is to conjunctively use the available water resources so that the overall reliability of water supply is maximized.

Dry periods may affect available water supplies in any single year and for a duration usually not longer than three consecutive years. It is important to note that hydrologic conditions vary from region to region throughout the state. Dry conditions in Northern California affecting SWP supply may not affect local groundwater and other supplies in Southern California, and vice versa.

For this reason, CLWA and the Purveyors have emphasized developing water supplies that add diversity to water supply options especially in dry years. Diversity of supply is considered a key element of reliability, giving the Purveyors the ability to draw on multiple sources of supply during dry-year conditions and thereby making the Purveyors' water deliveries more reliable. As a result of this advance planning, no water shortages are anticipated in CLWA's service area for the foreseeable future.

For long-term planning purposes, water supplies and facilities are added on an incremental basis and ahead of need. It would be economically unsound to immediately, or in the short term, acquire all the facilities and water supplies needed for the next twenty to thirty years. This would unfairly burden existing customers with costs that should be borne by future customers. There are many ongoing efforts to produce an adequate and reliable supply of good quality water for Valley residents. Water consumers expect that their needs will continue to be met with a high degree of reliability and quality of service. To that end, CLWA's and the Purveyors' stated reliability goal is to deliver a reliable and high quality water supply for their customers, even during dry periods. Based on conservative water supply and demand assumptions contained in the 2005 UWMP over the next 25 years, in combination with conservation of non-essential demand during certain dry years, CLWA and the Purveyors believe implementing their water plan will successfully achieve this goal.

Groundwater Production - Alluvium
Santa Clara River Valley, East Groundwater Subbasin

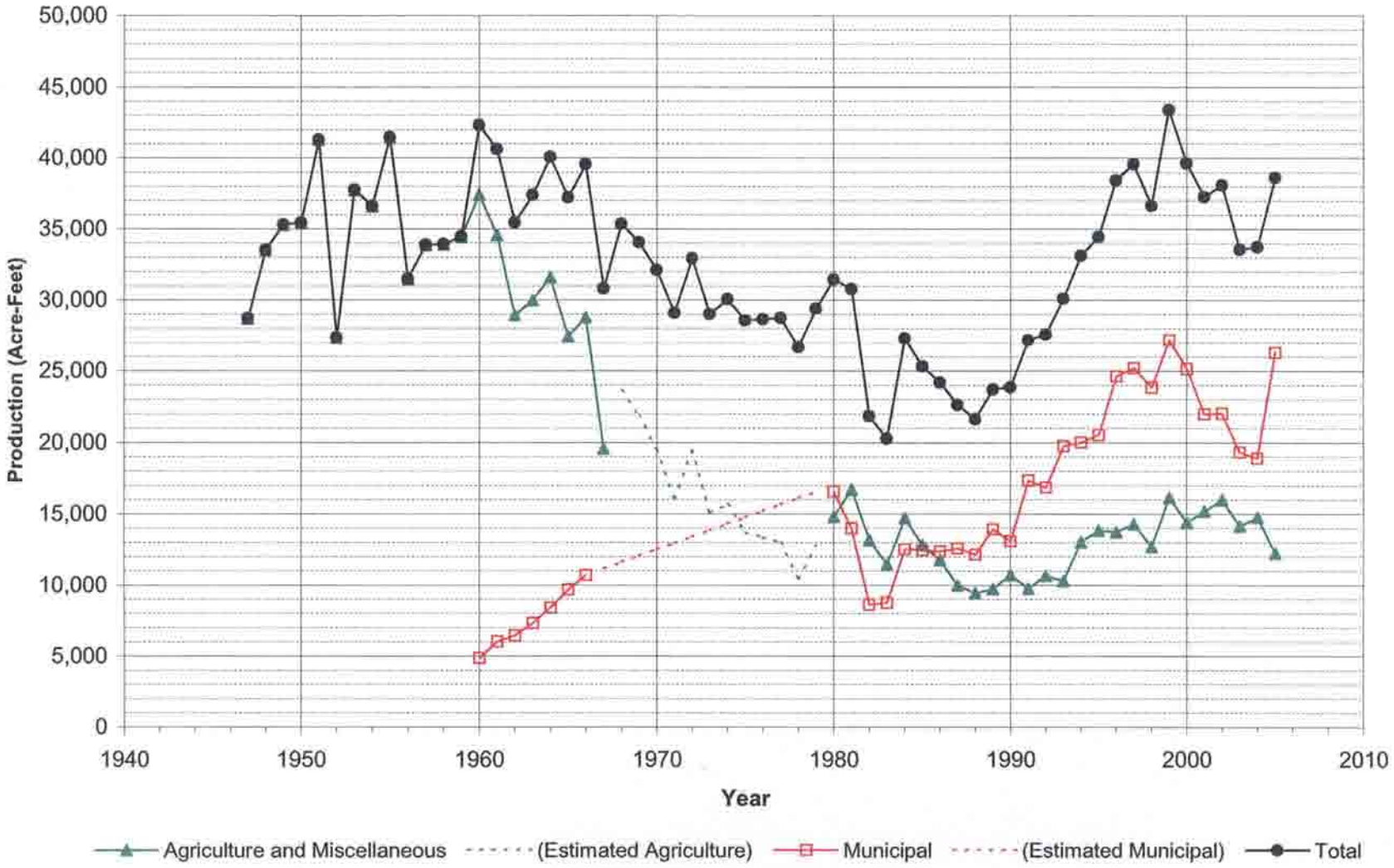

Figure III-2

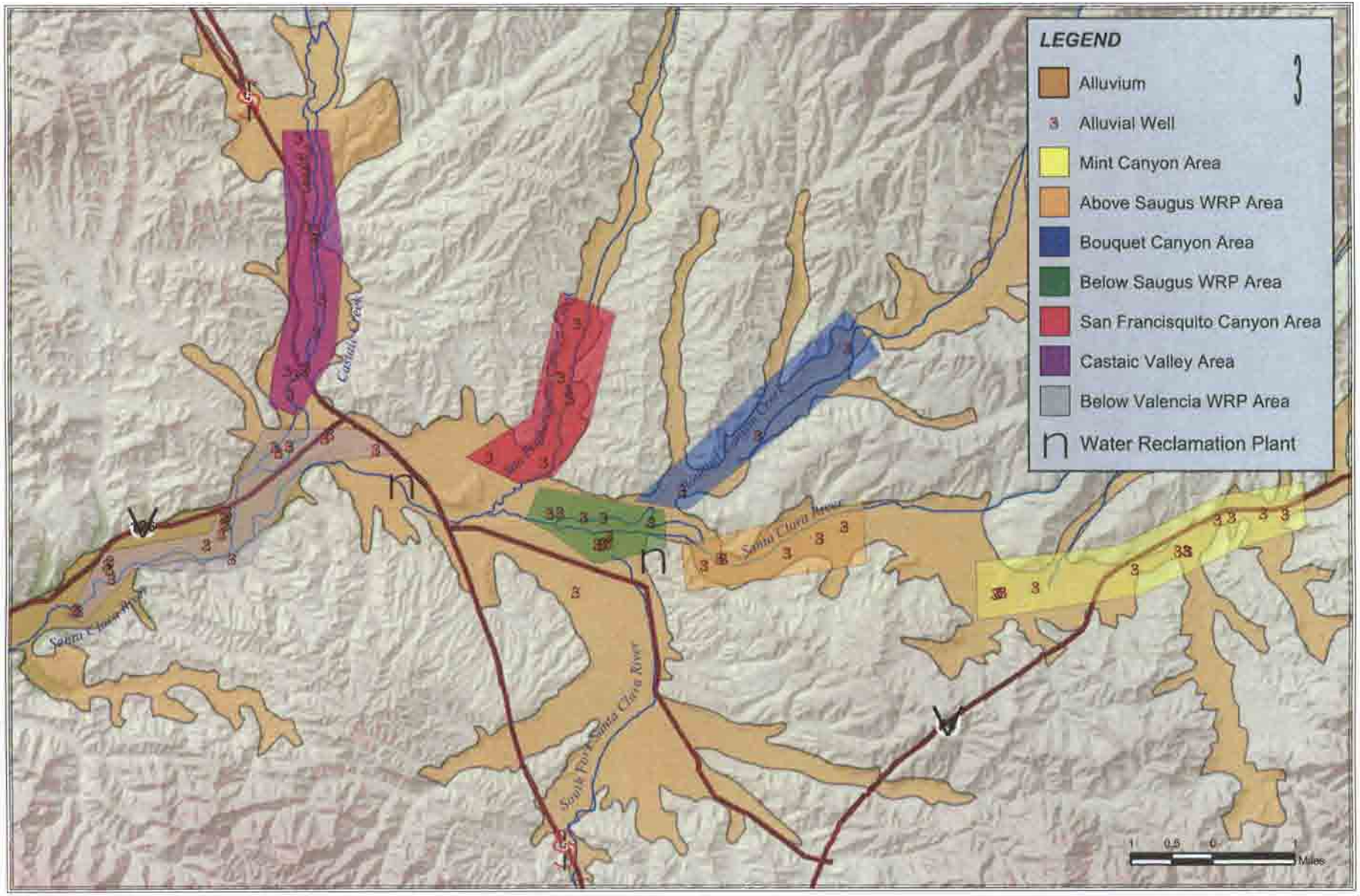

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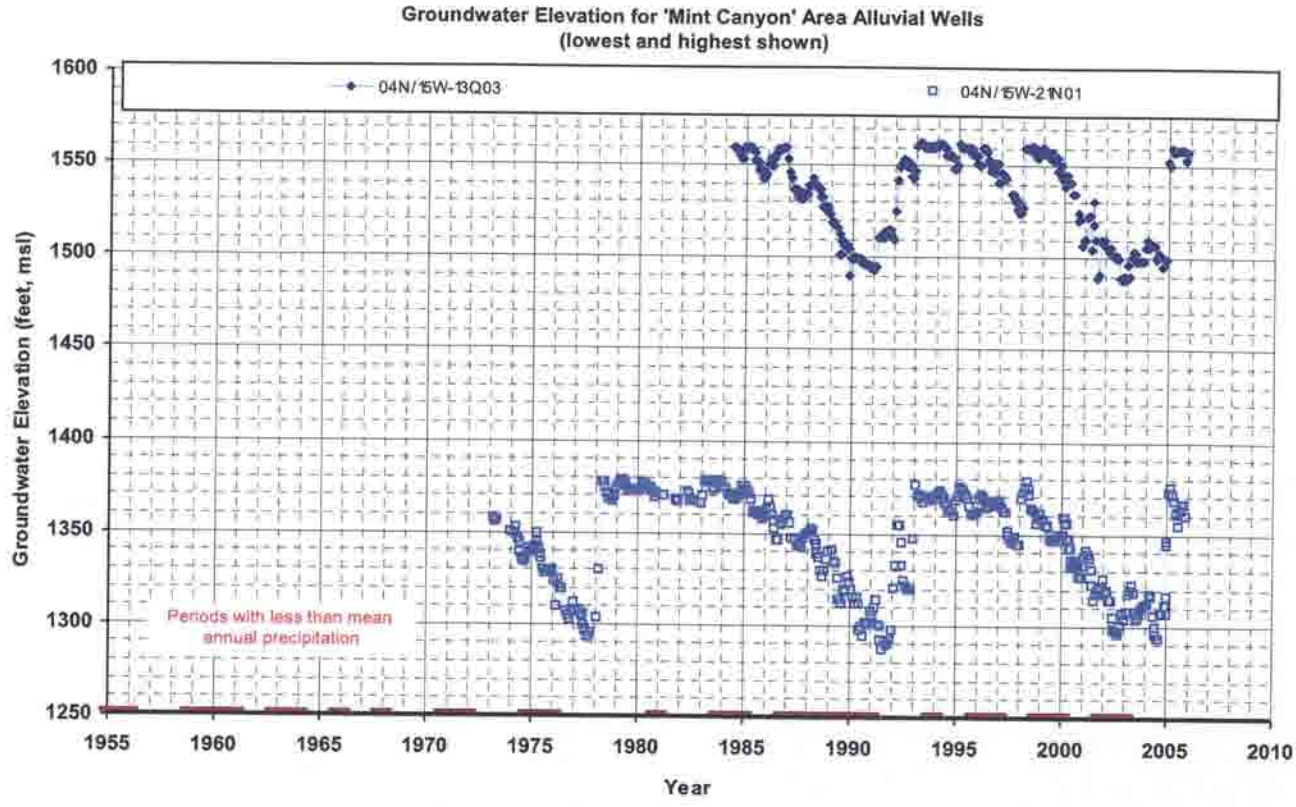
Figure III-3
Alluvial Well Locations By Area
Santa Clara River Valley, East Groundwater Subbasin


Groundwater Elevation for 'Mint Canyon' Area Alluvial Wells
(lowest and highest shown)
04N/15W-13Q03
04N/15W-21N01
Groundwater Elevation (feet, msl)
1600
1550
1500
1450
1400
1350
1300
1250
Periods with less than mean annual precipitation
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year

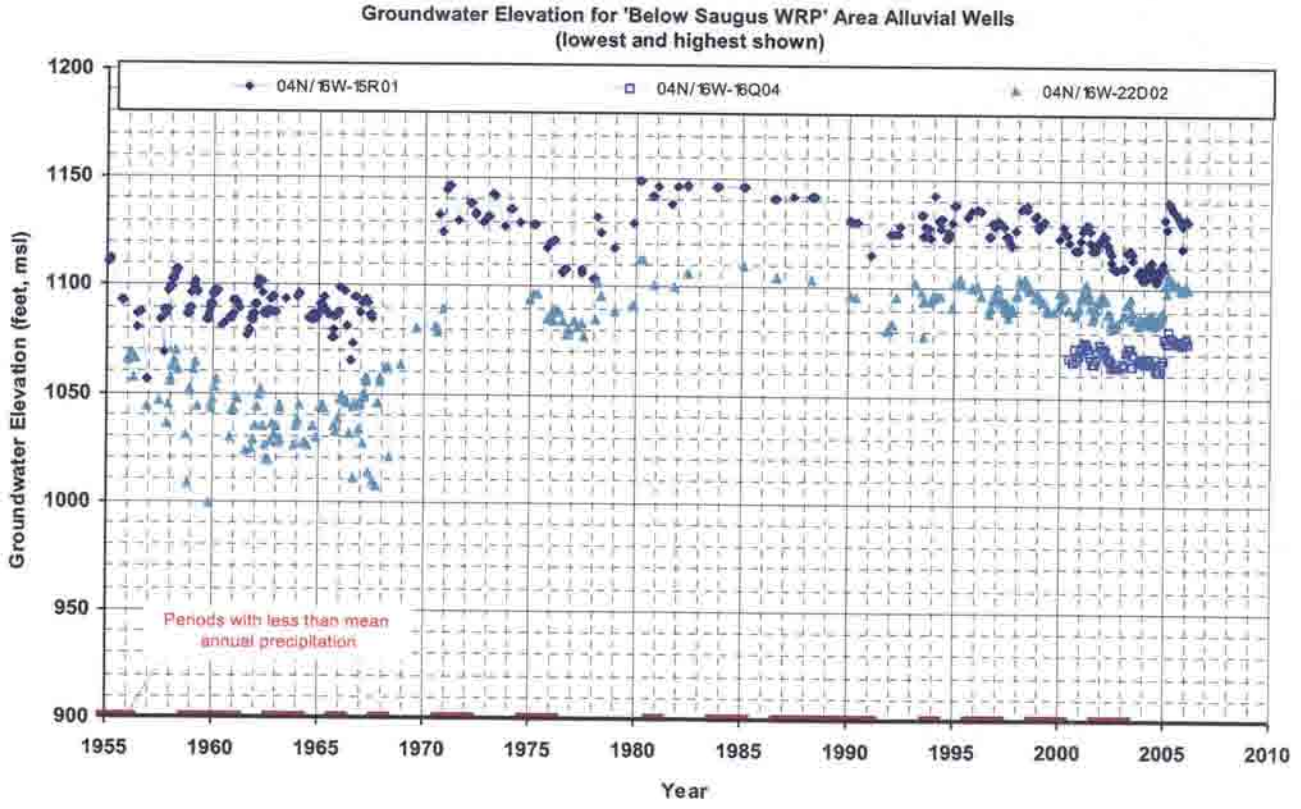
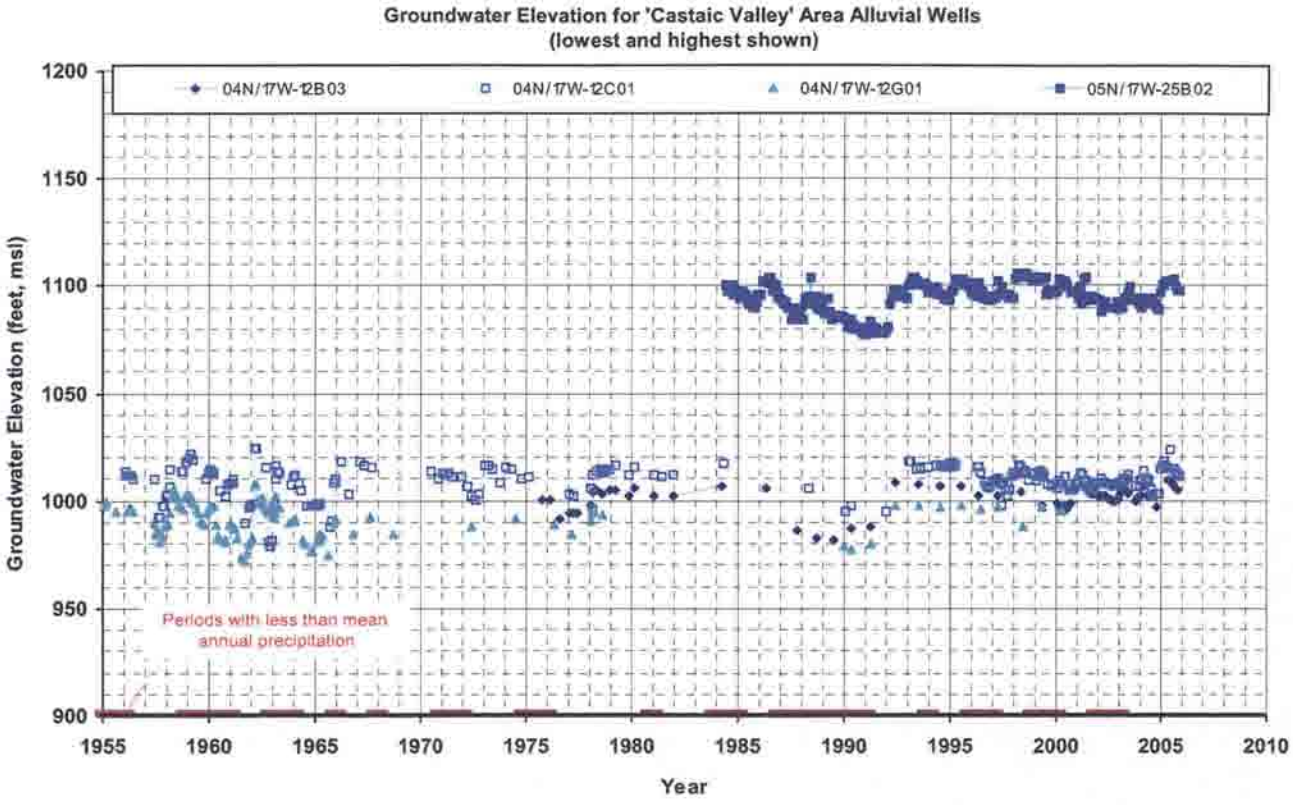

Groundwater Elevation for 'Below Saugus WRP' Area Alluvial Wells
(lowest and highest shown)
04N/16W-15R01
04N/16W-16Q04
04N/16W-22D02
Groundwater Elevation (feet, msl)
1200
1150
1100
1050
1000
950
900
Periods with less than mean annual precipitation
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year

Figure III-4


Groundwater Elevation for 'Castaic Valley' Area Alluvial Wells
(lowest and highest shown)
04N/17W-12B03
04N/17W-12C01
04N/17W-12G01
05N/17W-25B02
Groundwater Elevation (feet, msl)
Periods with less than mean annual precipitation
Year

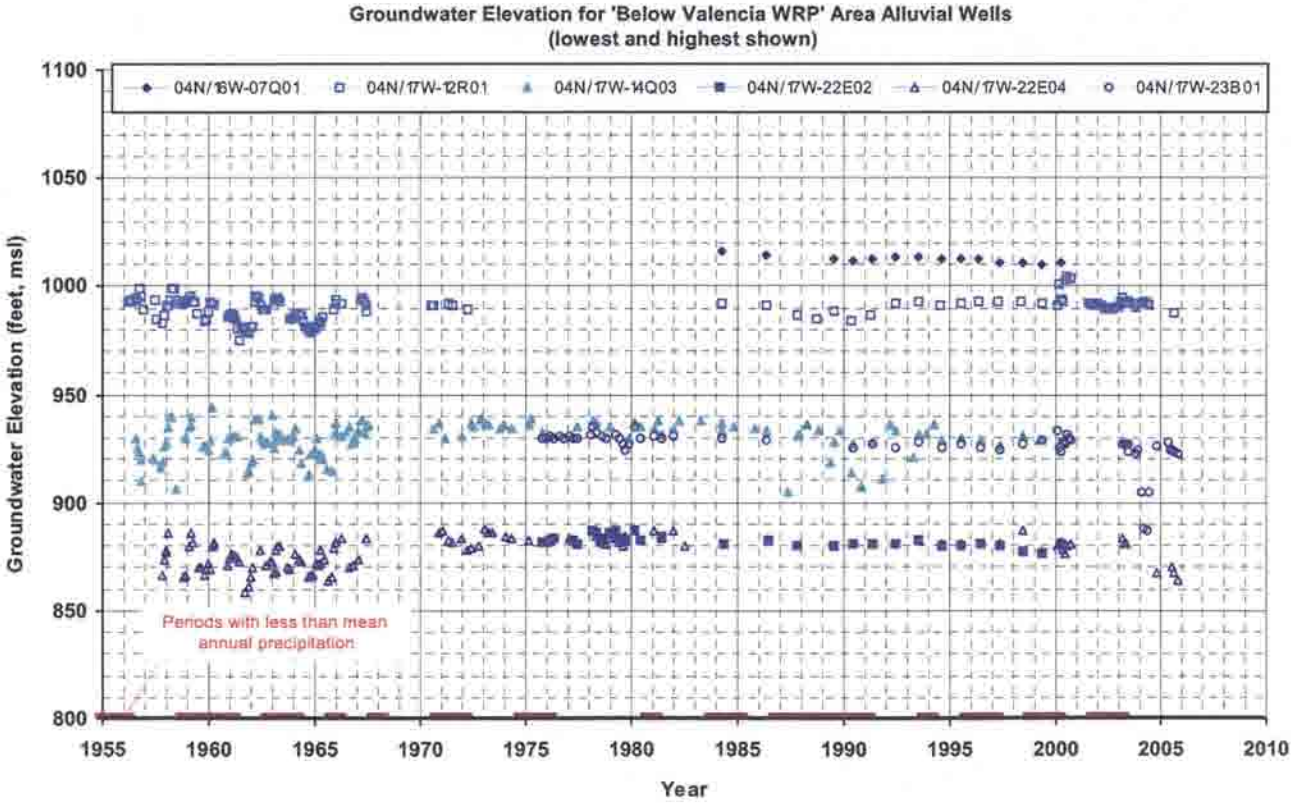

Groundwater Elevation for 'Below Valencia WRP' Area Alluvial Wells
(lowest and highest shown)
04N/16W-07Q01
04N/17W-12R01
04N/17W-14Q03
04N/17W-22E02
04N/17W-22E04
04N/17W-23B01
Groundwater Elevation (feet, msl)
Periods with less than mean annual precipitation
Year

Figure III-5

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Figure III-6
Annual Groundwater Production from Alluvium by Area (Acre-feet)
Santa Clara River Valley, East Groundwater Subbasin

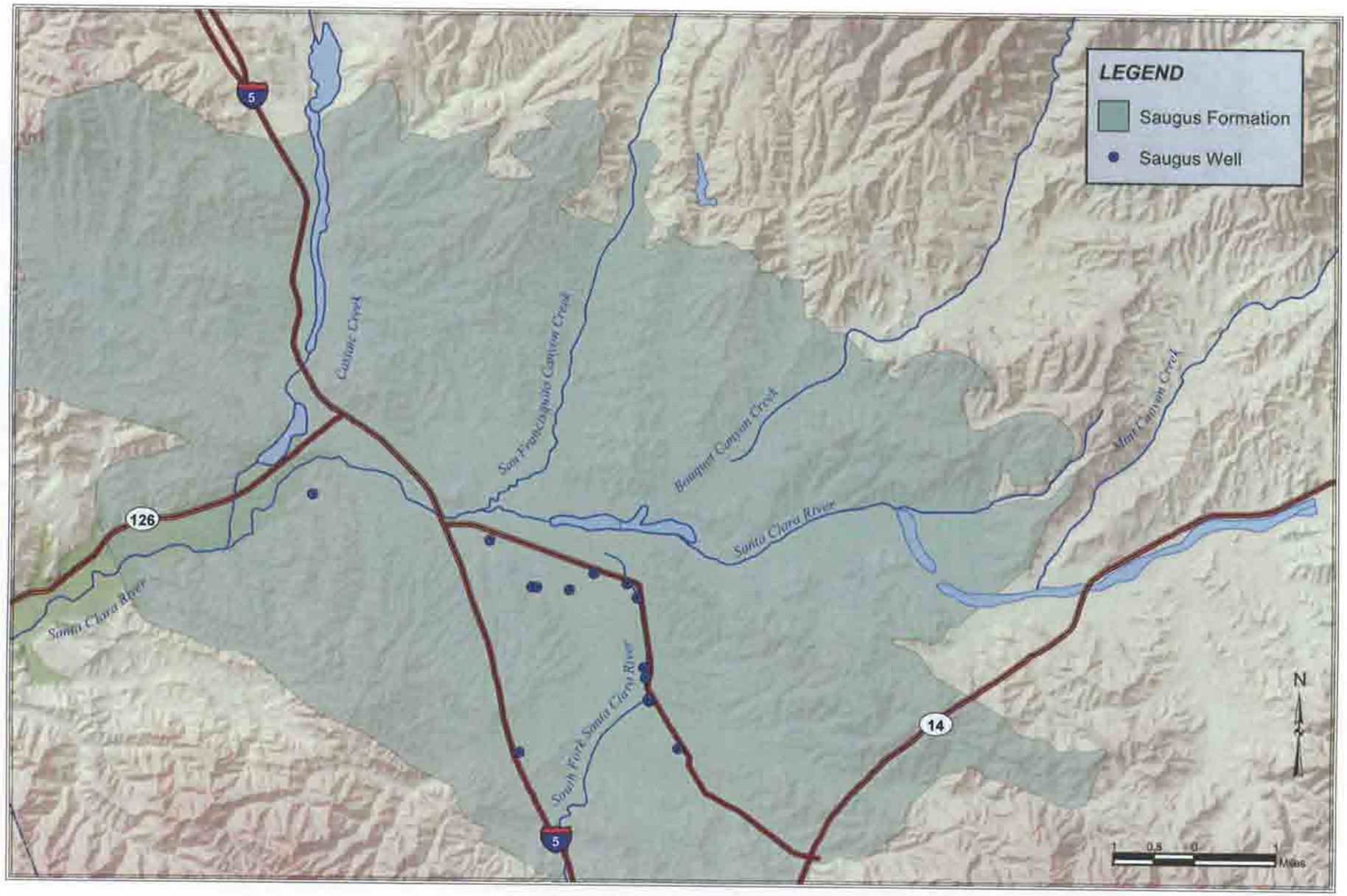

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Figure III-7
Saugus Well Locations
Santa Clara River Valley, East Groundwater Subbasin

Groundwater Production - Saugus Formation
Santa Clara River Valley, East Groundwater Subbasin

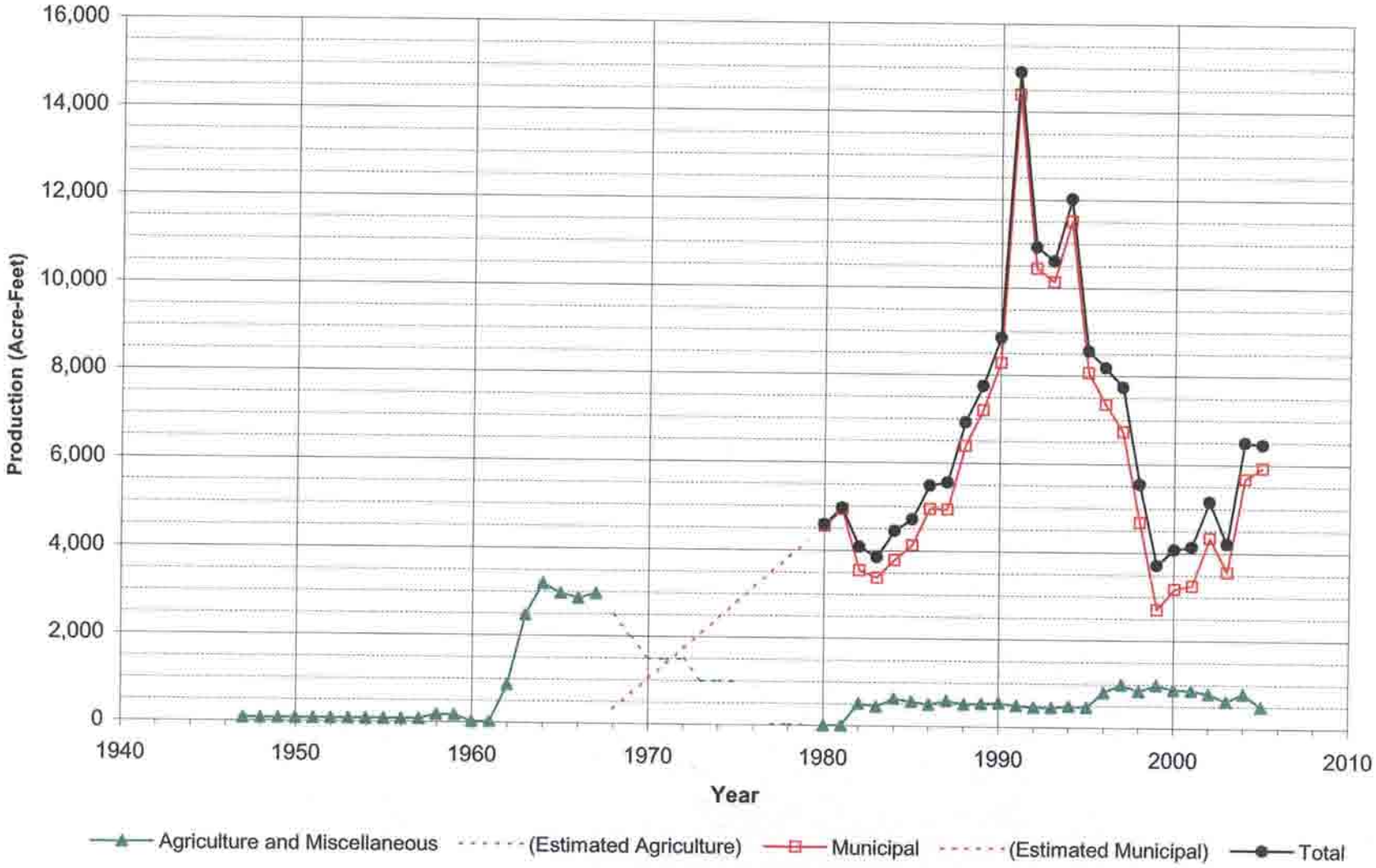
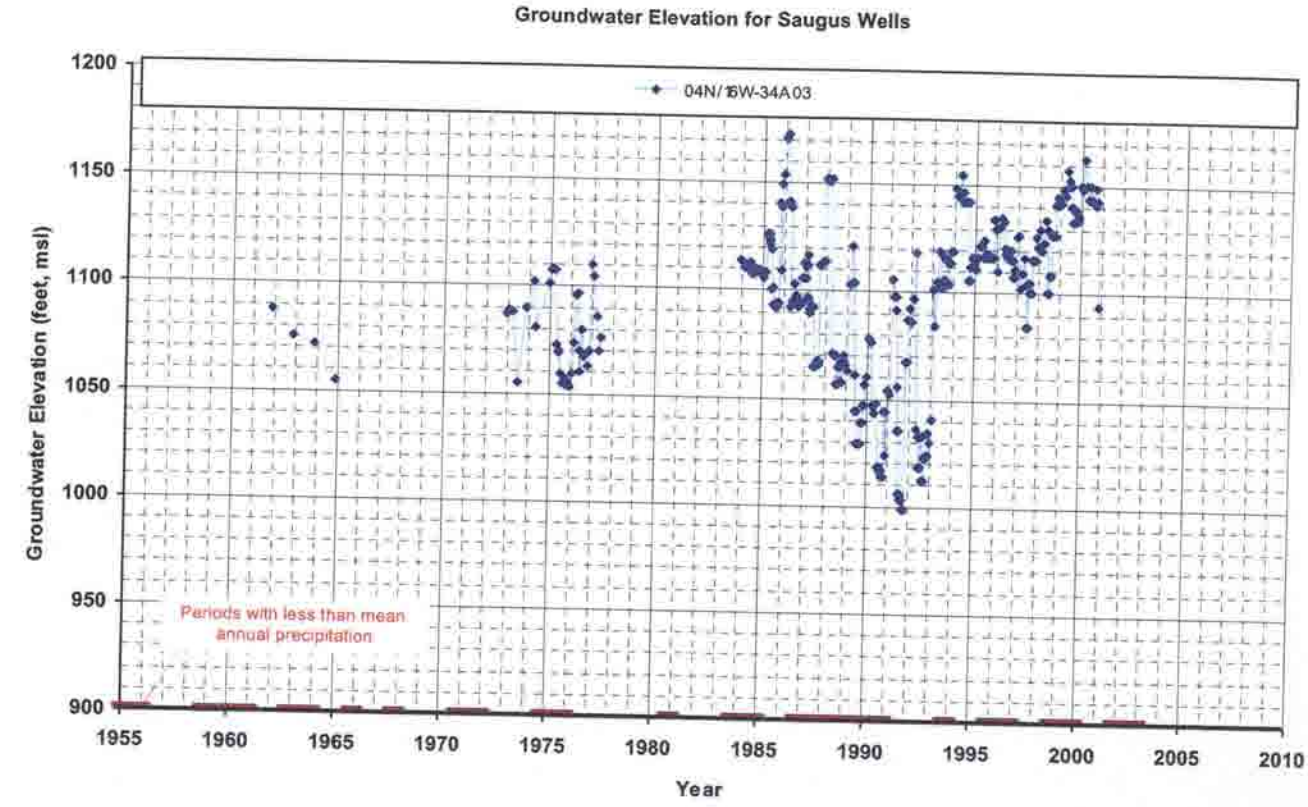


Figure III-8


Groundwater Elevation for Saugus Wells
04N/16W-34A03
Groundwater Elevation (feet, msl)
1200
1150
1100
1050
1000
950
900
Periods with less than mean annual precipitation
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year

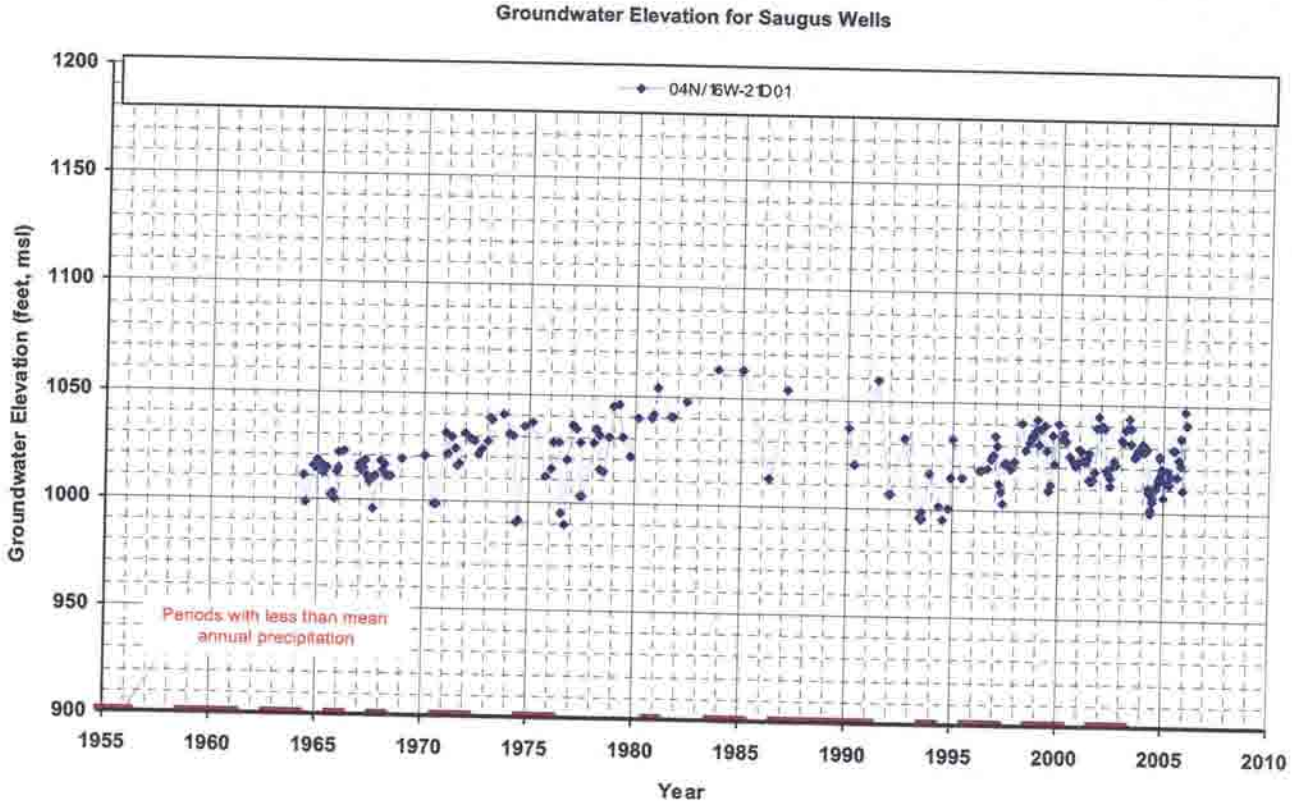
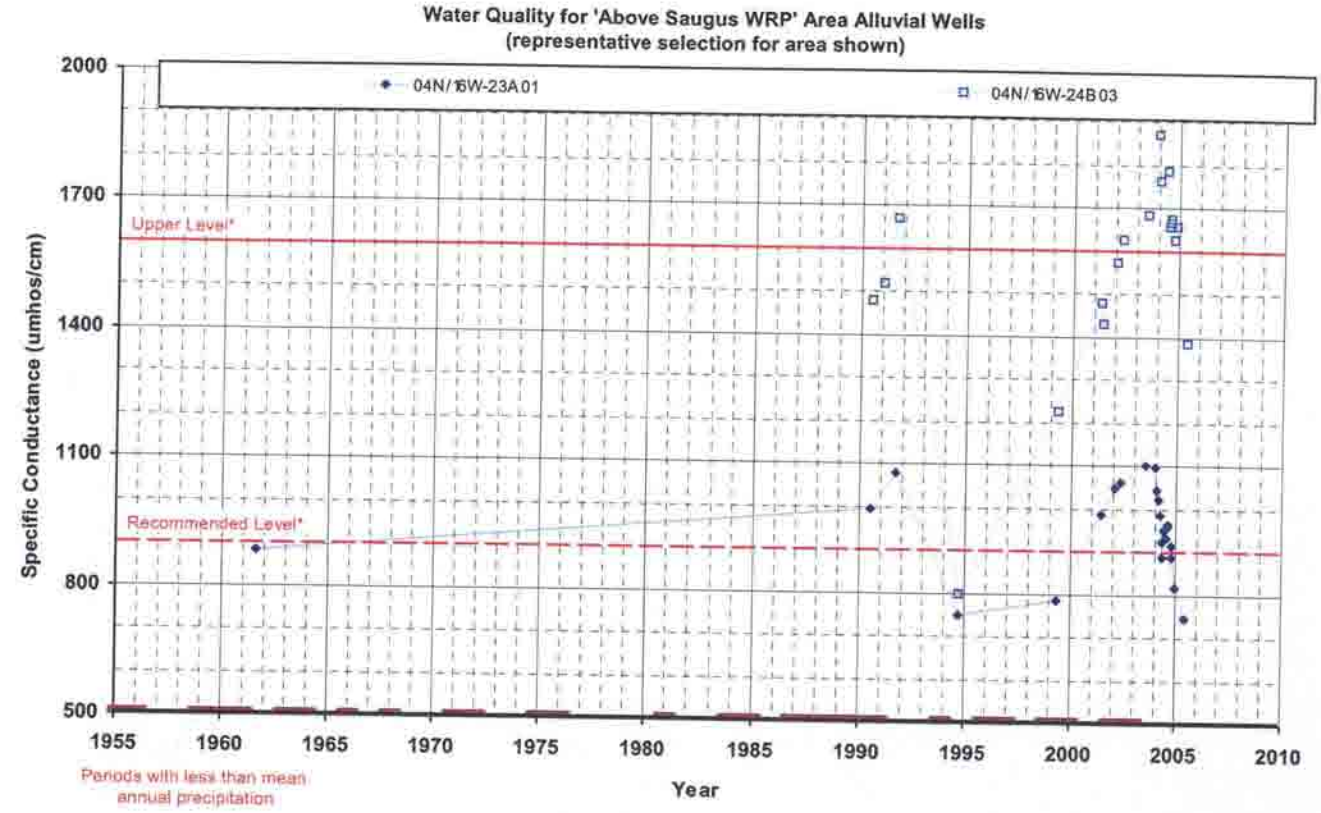
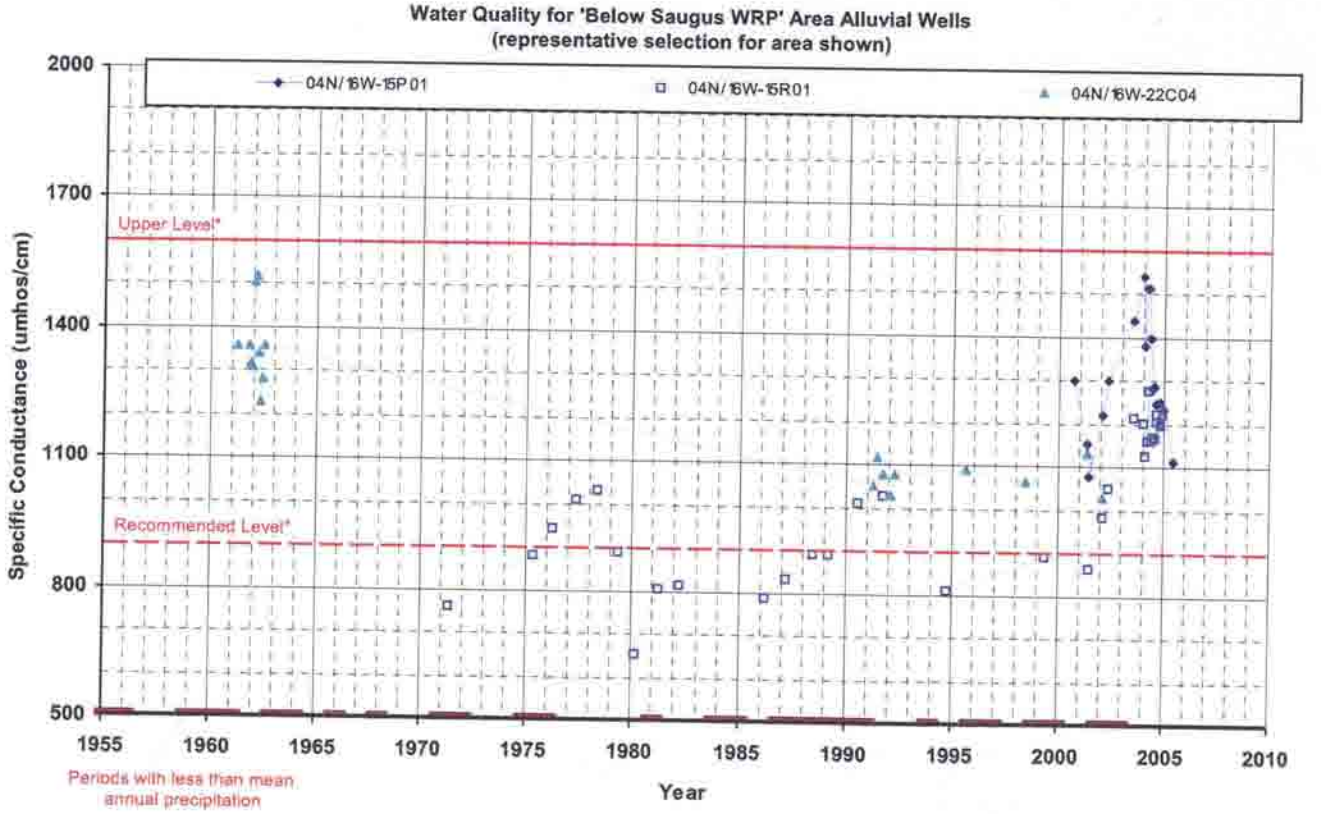

Groundwater Elevation for Saugus Wells
04N/16W-21D01
Groundwater Elevation (feet, msl)
1200
1150
1100
1050
1000
950
900
Periods with less than mean annual precipitation
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year

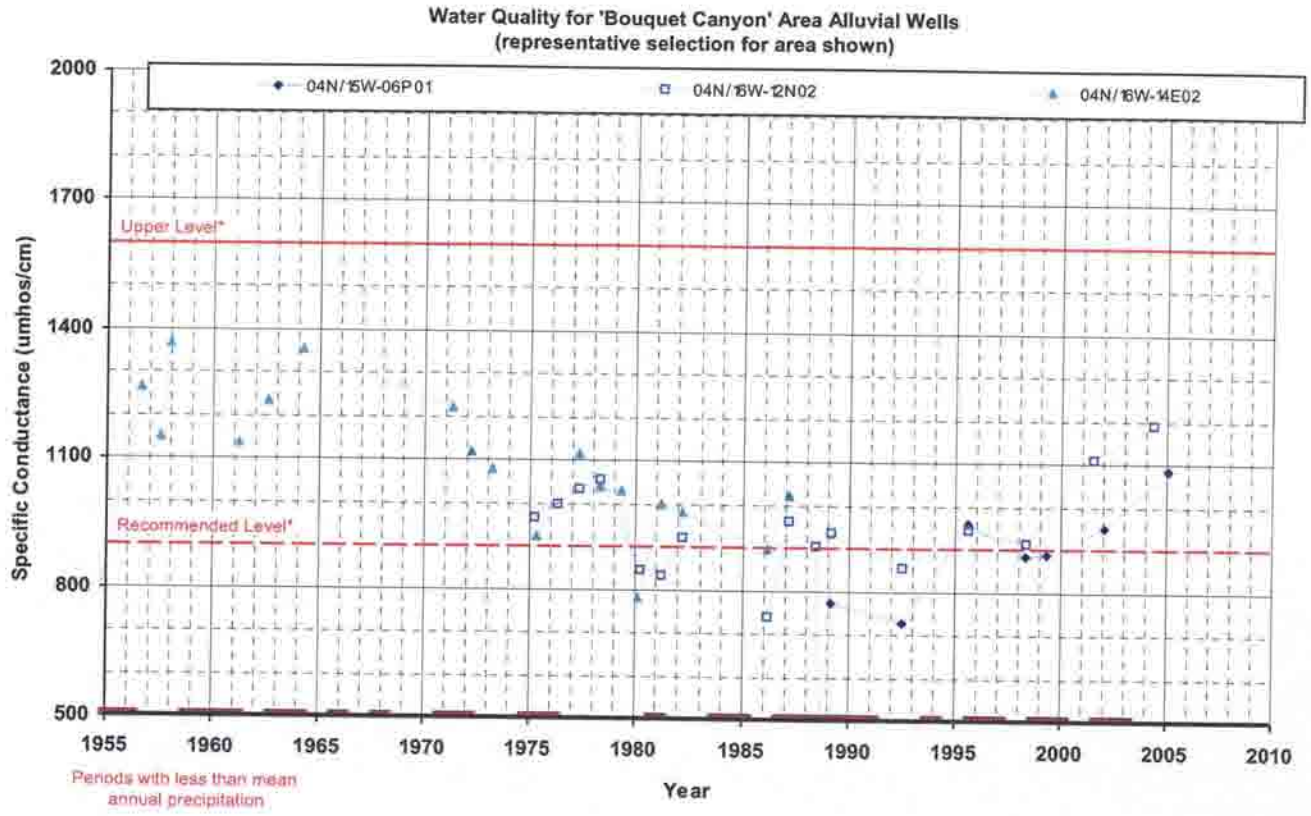
Figure III-9

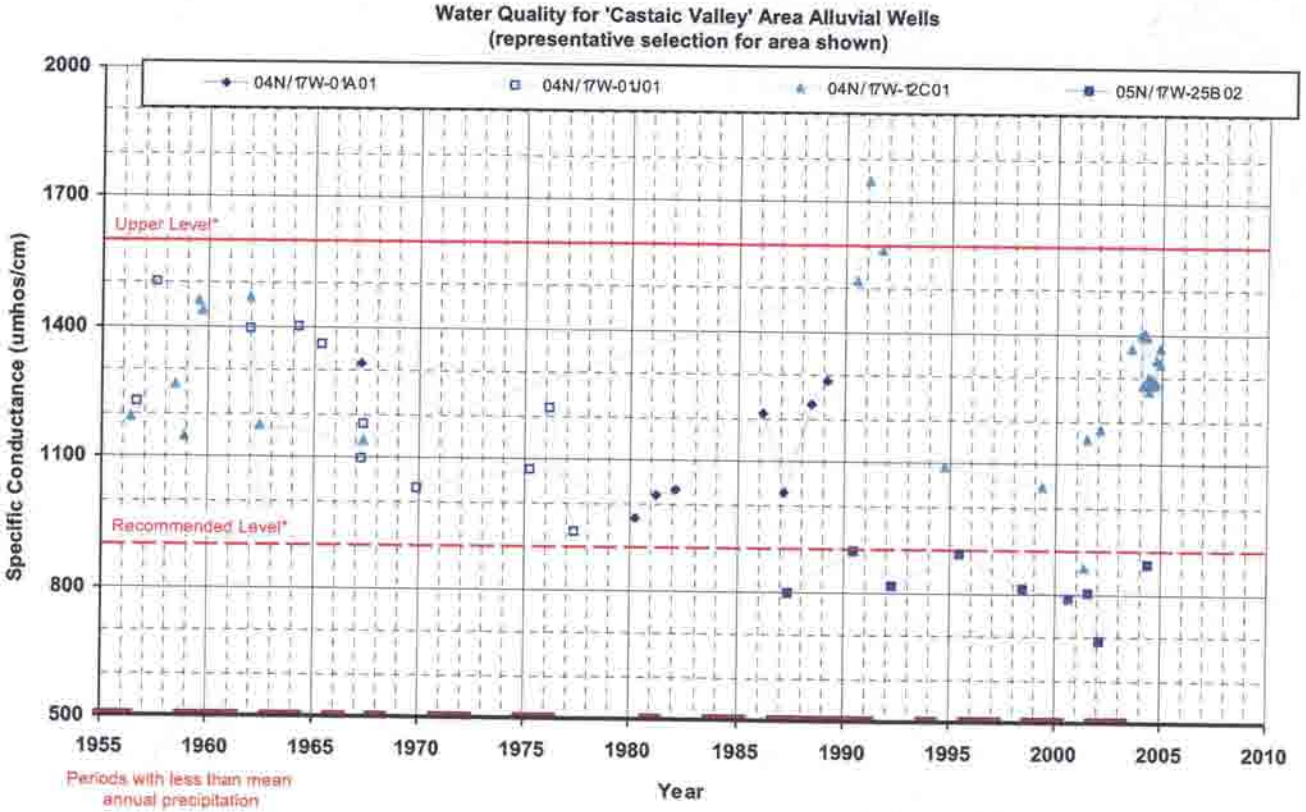




*California Department of Health Services Secondary Maximum Contaminant Level

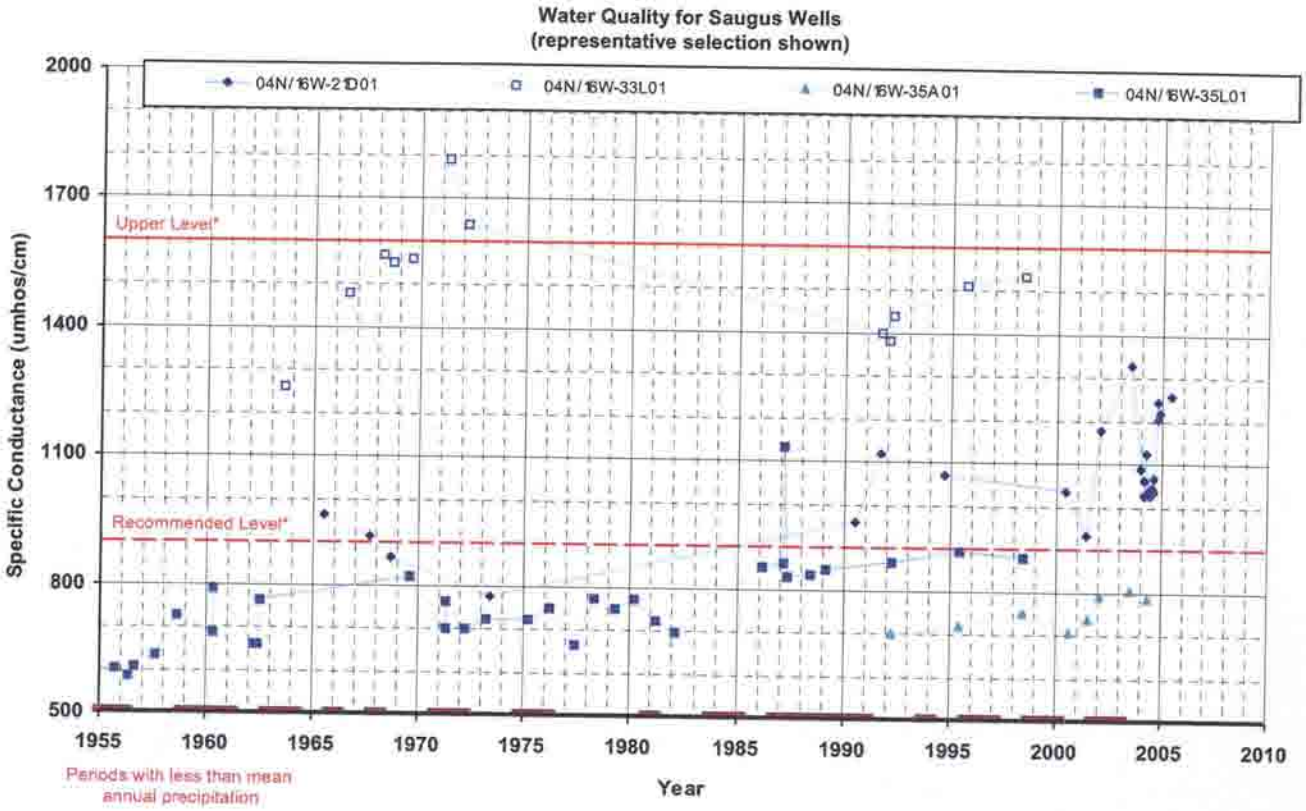
Figure III-10





*California Department of Health Services Secondary Maximum Contaminant Level

Figure III-11



*California Department of Health Services Secondary Maximum Contaminant Level

Figure III-12

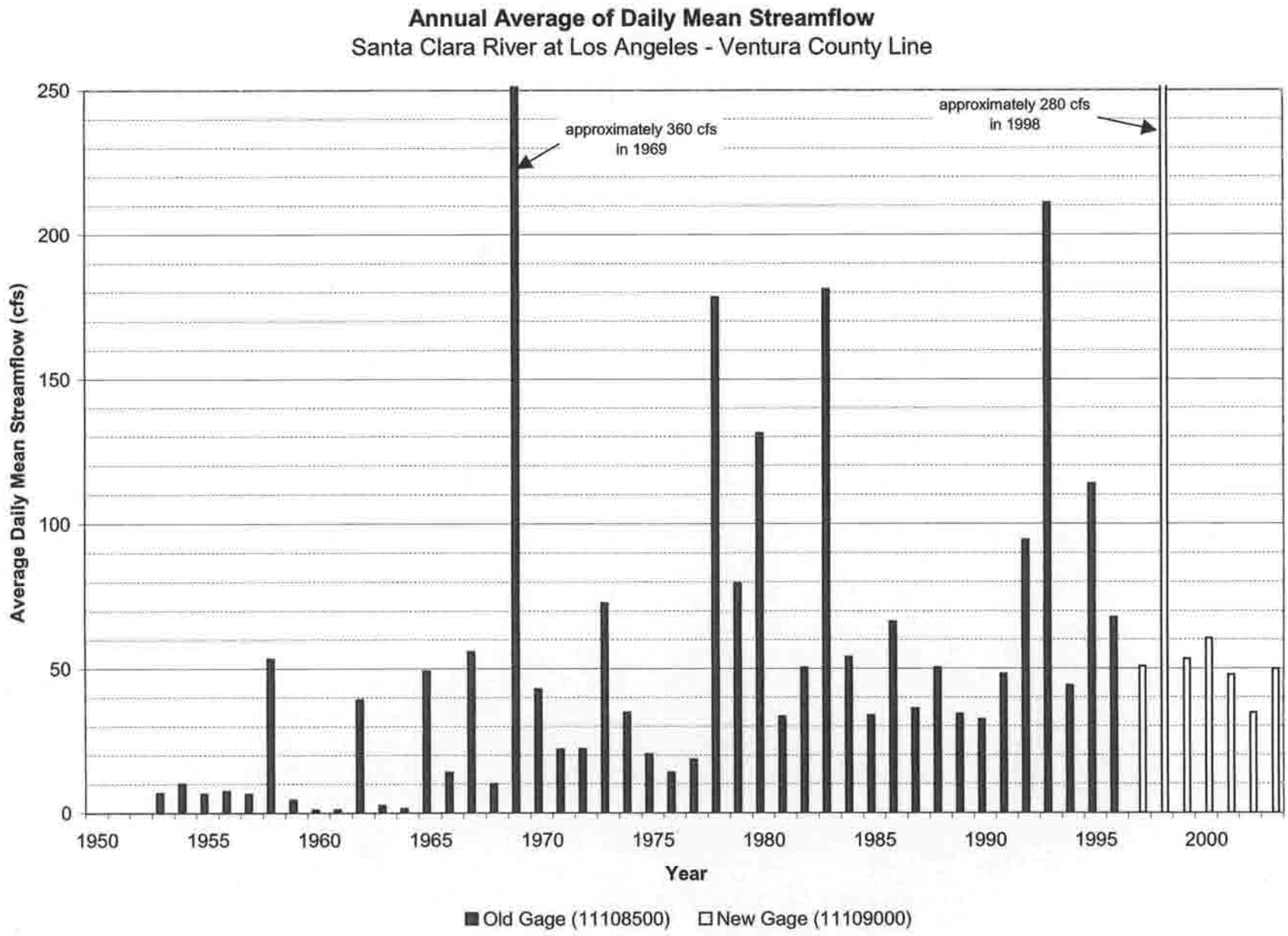


Figure III-13

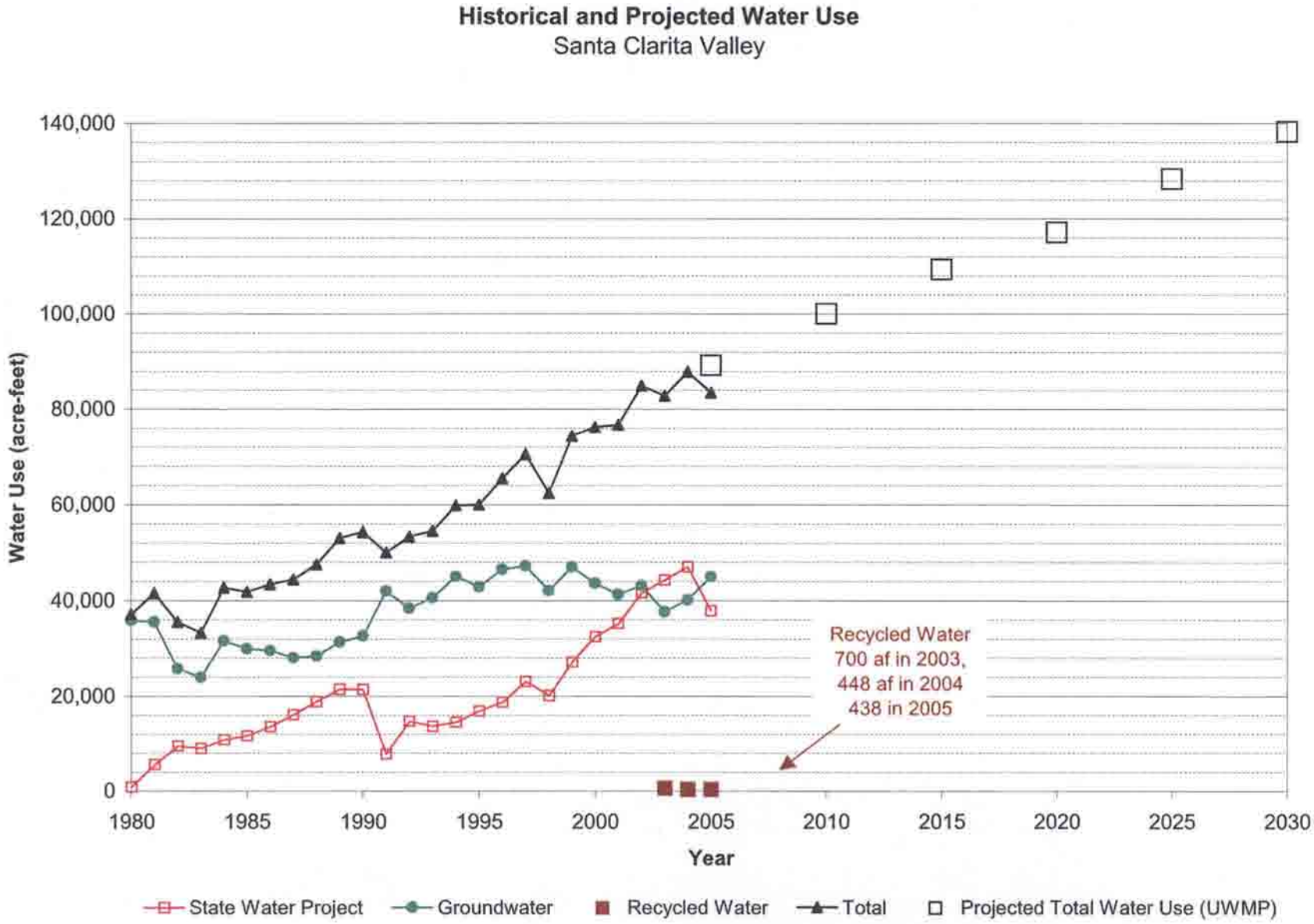

Historical and Projected Water Use
Santa Clarita Valley
Water Use (acre-feet)
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
Year
Recycled Water
700 af in 2003,
448 af in 2004
438 in 2005
State Water Project
Groundwater
Recycled Water
Total
Projected Total Water Use (UWMP)

Figure IV-1

V. Water Conservation

The California Urban Water Conservation Council (CUWCC) was formed in 1991 through the Memorandum of Understanding (MOU) Regarding Urban Water Conservation in California. The urban water conservation Best Management Practices (BMPs) included in the MOU are intended to reduce California's long-term urban water demands. While the BMPs are currently implemented by the MOU signatories on a voluntary basis, they are specified as part of the Demand Management Measures section of the Urban Water Management Planning Act.

Water conservation can achieve a number of goals, such as:

- Meeting legal mandates
- Reducing average annual potable water demands
- Reducing sewer flows
- Reducing demands during peak seasons
- Meeting drought restrictions

CLWA signed the urban MOU in 2001 on behalf of its wholesale service area, and pledged to implement several BMPs at a wholesale support level (listed below). NCWD signed the MOU in 2002 on behalf of its own retail service area. As a separate MOU signatory and due to its role as a retailer, NCWD is committed to implementing all BMPs that are feasible and applicable in its service area. Efforts are made to coordinate with CLWA and the other Purveyors wherever possible to maximize efficiency and ensure the cost effectiveness of NCWD's conservation program.

In coordination with the Purveyors, CLWA has been implementing the following BMPs (which pertain to wholesalers) for several years (some prior to signing the MOU in 2001):

BMP 3	System Water Audits, Leak Detection and Repair
BMP 7	Public Information Programs
BMP 8	School Education Programs
BMP 10	Wholesale Agency Programs
BMP 11	Conservation Pricing
BMP 12	Water Conservation Coordinator
BMP 13	Water Waste Prohibition (implementation during last drought)

CLWA and the Purveyors have been implementing these BMPs valley-wide. Since 2001, CLWA has also instituted implementation of BMP 2 (Residential Plumbing Retrofits) and BMP 14 (Residential ULFT Replacement Programs) on behalf of the Purveyors.

NCWD has initiated implementation of the remaining BMPs that are specific to retail water suppliers:

BMP 1	Water survey programs for single-family residential and multi-family residential customers
BMP 3	System water audits, leak detection and repair

BMP 4	Metering with commodity rates for all new connections and retrofit of existing connections
BMP 5	Large landscape conservation programs and incentives
BMP 6	High-efficiency clothes washing machine financial incentive programs
BMP 9	Conservation programs for commercial, industrial, and institutional (CII) accounts
BMP 11	Conservation pricing
BMP 12	Conservation coordinator
BMP 13	Water waste prohibition

Reports to the CUWCC on BMP implementation by CLWA and the Purveyors were included in the 2005 UWMP.

Additional savings are occurring Valley-wide due to state interior plumbing code requirements that have been in effect since 1992, as well as due to changes in lot size and reduction in exterior square footage of new housing and commercial developments. These have begun to impact overall demand in the Valley. The Valley's water suppliers continue to monitor water demand trends through time to assess those factors that are accounting for the reduction, and to attempt to quantify them.

VI. References

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Results of Laboratory Testing of Valencia Water Company Wells

Valencia Water Company
California Department of Health Services Drinking Water Standards, Title 22
Wells E-14, E-15, E-16, E-17

Primary Standards:
Inorganic Chemicals

Parameter	MCL	DLR	Units	E-14	E-15	E-16	E-17
Aluminum	1000	50	µg/l	ND	ND	ND	ND
Antimony	6	6	µg/l	ND	ND	ND	ND
Arsenic	50	2	µg/l	ND	ND	ND	ND
Barium	1000	100	µg/l	ND	ND	ND	ND
Beryllium	4	1	µg/l	ND	ND	ND	ND
Cadmium	5	1	µg/l	ND	ND	ND	ND
Chromium (Total)	50	10	µg/l	ND	ND	ND	ND
Fluoride	2	0.1	mg/L	0.89	0.9	0.89	0.83
Lead	50	5	µg/l	ND	ND	ND	ND
Mercury	2	1	µg/l	ND	ND	ND	ND
Nickel	100	10	µg/l	ND	ND	ND	ND
Nitrate (as NO3)	45	2	mg/L	11	14.2	16.8	16.8
Nitrite (as N)	1000	400	µg/l	ND	ND	ND	ND
Nitrate + Nitrite (as N)	10000	400	µg/l	2500	3200	3800	3800
Selenium	50	5	µg/l	ND	ND	ND	ND
Thallium	2	1	µg/l	ND	ND	ND	ND

Regulated Organic Chemicals

Parameter	MCL	DLR	Units	E-14	E-15	E-16	E-17
Volatile Organic Chemicals (VOC's)	variable	variable	µg/l	ND	ND	ND	ND
Synthetic Organic Chemicals (SOC's)	variable	variable	µg/l	ND	ND	ND	ND

Secondary Standards:

Parameter	MCL	DLR	Units	E-14	E-15	E-16	E-17
Apparent Color	15	NA	Units	<3	3	3	3
Chloride	250-500-600	NA	mg/L	75	88	89	74
Copper	1000	50	µg/l	ND	ND	ND	ND
Iron	300	100	µg/l	ND	ND	ND	ND
Manganese	50	20	µg/l	ND	ND	ND	ND
MBAS (foaming agents)	0.5	NA	mg/L	ND	ND	ND	ND
Odor	3	1	units (TON)	1	4	3	1
pH	6.5 - 8.5	NA	units	7.5	7.7	7.3	7.4
Silver	100	10	µg/l	ND	ND	ND	ND
Specific Conductance (E.C.)	900-1600-2,200	NA	umho/cm	1240	1290	1390	1360
Sulfate	250-500-600	0.5	mg/L	340	330	340	340
Total Dissolved Solids (TDS)	500-1000-1500	NA	mg/L	900	890	950	960
Turbidity	5	NA	NTU	0.4	0.9	0.2	0.3
Zinc	5000	50	µg/l	ND	ND	ND	ND

Valencia Water Company
California Department of Health Services Drinking Water Standards, Title 22
Wells E-14, E-15, E-16, E-17

Unregulated / Other Chemicals

Parameter	Notification Level	DLR	Units	E-14	E-15	E-16	E-17
Alkalinity	NA	NA	mg/L	230	215	244	254
Bicarbonate (as HCO3)	NA	NA	mg/L	280	262	298	310
Calcium	NA	NA	mg/L	130	120	120	130
Carbonate (as CO3)	NA	NA	mg/L	0.575	0.853	0.386	0.506
Carbon dioxide	NA	NA	µg/l	17700	10500	29900	24700
Hardness (Total as CaCO3)	NA	NA	mg/L	514	481	489	535
Hydroxide	NA	NA	mg/L	0.005	0.009	0.003	0.004
Magnesium	NA	NA	mg/L	46	46	44	51
Potassium	NA	NA	mg/L	4.2	4	3.9	4.4
Sodium	NA	NA	mg/L	100	100	110	110
Total Anions	NA	NA	meq/L	14	13.9	14.8	14.6
Total Cations	NA	NA	meq/L	14.7	14.1	14.7	15.6
Boron	1000	100	µg/l	430	480	460	470
Chromium, hexavalent	NA	1	µg/l	ND	ND	ND	ND
Dichlorodifluoromethane (Freon 12)	100	0.5	µg/l	ND	ND	ND	ND
Ethyl Tert-Butyl Ether (ETBE)	NA	3	µg/l	ND	ND	ND	ND
Langelier Index (25C)	NA	NA	none	0.62	0.75	0.41	0.56
Perchlorate	6	4	µg/l	ND	ND	ND	ND
Tert-Amyl Methyl Ether (TAME)	NA	3	µg/l	ND	ND	ND	ND
Tert-Butyl Alcohol (TBA)	12	2	µg/l	ND	ND	ND	ND
1,2,3-Trichloropropane (1,2,3-TCP)	0.005	0.005	µg/l	ND	ND	ND	ND
Vanadium	50	3	µg/l	ND	ND	ND	ND

Notes: Thiobencarb is listed as both an SOC and a Secondary Standard. The results for thiobencarb are included under SOC results.
MTBE is listed as both a VOC and a Secondary Standard. The results for MTBE are included under VOC results.
Aluminum is considered both a Primary and Secondary Standard. The results for aluminum are listed under Primary Standards.
2,3,7,8 -TCDD is an SOC. The results are attached.
EDB-DBCP are SOC's. They were run separately for E-16. Results are attached to E-16 file.
Alkalinity was run separately for E-14. Results are attached to E-14 file.

CH2MHill Memorandum,
Effect of Urbanization on Aquifer Recharge in the Santa Clarita Valley,
February 22, 2004

Effect of Urbanization on Aquifer Recharge in the Santa Clarita Valley

TO: Tom Worthington/Impact Sciences, Inc.

FROM: John Porcello/CH2M HILL

DATE: February 22, 2004

Introduction

In a groundwater basin, the effect of urbanization on recharge to underlying groundwater is dependent on land uses, water uses, vegetative cover, and geologic conditions. Groundwater recharge from undeveloped lands occurs from precipitation alone, whereas areas that are developed for agricultural or urban land uses receive both precipitation and irrigation of vegetative cover. In an urban area, groundwater recharge occurs directly beneath irrigated lands and in drainages whose bottoms are not paved or cemented. This memorandum discusses the general effects of urbanization on groundwater recharge and the specific effects in the Santa Clarita Valley.

Summary of Findings

In the Santa Clarita Valley, stormwater runoff finds its way to the Santa Clara River and its tributaries, whose channels are predominantly natural and consist of vegetation and coarse-grained sediments (rather than concrete). The stormwater that flows across paved lands in the Santa Clarita Valley is routed to stormwater detention basins and to the river channels, where the porous nature of the sands and gravels forming the streambeds allow for significant infiltration to occur to the underlying groundwater.

Increased urbanization in the Valley has resulted in the irrigation of previously undeveloped lands. The effect of irrigation is to maintain higher soil moisture levels during the summer than would exist if no irrigation were occurring. Consequently, a greater percentage of the fall/winter precipitation recharges groundwater beneath irrigated land parcels than beneath undeveloped land parcels. In addition, urbanization in the Santa Clarita Valley has occurred in part because of the importation of State Water Project (SWP) water, which began in 1980. SWP water use has increased steadily, reaching nearly 44,500 acre-feet (AF) in 2003. Two-thirds of this water is used outdoors, and a portion of this water eventually infiltrates to groundwater. The other one-third is used indoors and is subsequently routed to local water reclamation plants (WRPs) and then to the Santa Clara River (after treatment). A portion of this water flows downstream out of the basin, and a portion infiltrates to groundwater.

Records show that groundwater levels and the amount of groundwater in storage were similar in both the late 1990s and the early 1980s, despite a significant increase in the

urbanized area during these two decades. This long-term stability of groundwater levels is attributed in part to the significant volume of natural recharge that occurs in the streambeds, which do not contain paved, urban land areas. On a long-term historical basis, groundwater pumping volumes have not increased due to urbanization, compared with pumping volumes during the 1950s and 1960s when water was used primarily for agriculture. Also, the importation of SWP water is another process that contributes to recharge in the Valley. In summary, urbanization has been accompanied by long-term stability in pumping and groundwater levels, plus the addition of imported SWP water to the Valley, which together have not reduced recharge to groundwater, nor depleted the amount of groundwater that is in storage within the Valley.

Effect of Pavement on Recharge Beneath Specific Land Parcels

The amount of paved cover on the ground affects the degree to which rainfall and outdoor-applied urban water will be able to infiltrate to groundwater. In heavily industrialized areas with high percentages of paved cover, such as exist in portions of the Los Angeles Basin, less rainfall recharge will occur than if the land is in an undeveloped condition. Furthermore, if the bottoms of rivers and other drainages are paved, then the majority of stormwater generated during a rainfall event will be unable to infiltrate to groundwater. In contrast, the amount of recharge to groundwater will be greater in urbanized areas, such as the Santa Clarita Valley, that have natural soils in the bottoms of rivers and local drainages or that have lower percentages of paved cover on the developed areas lying outside the principal drainages. In these areas, the outdoor use of water for irrigation landscape vegetation or agricultural lands can notably increase the amount of groundwater recharge, particularly if the outdoor water is imported from outside the local groundwater basin. This is discussed further below.

Effect of Vegetative Cover and Water Use

From the 1930s through the 1960s, H.F. Blaney and other researchers at the U.S. Department of Agriculture performed numerous studies to measure the amount of infiltration to groundwater that occurs beneath undeveloped lands and irrigated farmlands, and the differences in recharge rates for different types of native vegetation and crops. In California, these studies included a 1933 study by Blaney in Ventura County, a 1963 study by Blaney and others in the Lompoc Uplands, studies by the U.S. Geological Survey and various consultants in the Montecito and Carpenteria groundwater basins, and a groundwater basin study by Santa Barbara County[1] that incorporated the results of these earlier studies.

Together, these studies concluded that deep percolation to groundwater from undeveloped lands occurs only during years of average or above-average precipitation. This occurs because:

1. Southern California's rainfall is highly seasonal in nature, whereupon most rainfall occurs during the relatively cool period November through March, when plant water

[1] See Santa Barbara County Water Agency, December 15, 1977. *Report on Adequacy of the Groundwater Basins of Santa Barbara County.*

requirements are low, and little, if any, rainfall occurs during the remaining (and warmer months) when plant water requirements increase.

2. During the summer, when little or no rainfall occurs, the native vegetation extracts the residual moisture that is present in the soil, which substantially decreases the soil moisture within the root zone of the vegetation. At the end of the dry season, soil moisture levels on undeveloped lands are below the soil's field capacity, which is the amount of moisture that must be present in the soil before free drainage of water can occur below the rooting zone of the native vegetation.

3. When the seasonal rains arrive, the incident rainfall that is not consumed by plants and does not become stormwater runoff must first raise the soil moisture level to the soil's field capacity before any groundwater recharge will occur. The various studies indicate that about 17 inches/year of rainfall is necessary to raise the soil moisture to the field capacity on an undeveloped parcel of land. This is similar to the average annual rainfall in the Santa Clarita Valley and in other lowland coastal and near-coastal valleys in southern California.

On irrigated lands, irrigation occurs during several months of the year, with the exact duration depending on the amount and timing of rainfall and also the crops or type of urban landscaping being irrigated. The principal effect of converting undeveloped land to land that receives agricultural or urban irrigation is to increase the amount of water that is applied to the land during the low-rainfall months. This application of water to the vegetative cover on the surface of the developed land parcel results in the maintenance of higher soil moisture levels during the warm, dry months than would occur without development. This has three effects:

1. Because irrigation will generally be performed in a manner that maintains the health of the vegetative cover, enough water will be applied to maintain the soil moisture at, or close to, the field capacity of the soil. This in turn will allow some deep percolation to occur from the irrigation water itself.

2. When the rainy season begins, because irrigation has maintained soil moisture at or near field capacity, less of the initial rainfall entering the root zone needs to be stored in the soil (to meet soil moisture deficits) beneath an irrigated parcel than in the case of an undeveloped parcel. Therefore, a greater percentage of the initial rainfall and annual rainfall will be able to infiltrate to groundwater. The southern California studies estimated that irrigated land parcels would allow rainfall infiltration to occur in years when annual rainfall is at least 10.5 inches/year. This threshold rainfall value is 6.5 inches less than the threshold rainfall value that the studies estimated to be necessary for generating groundwater recharge beneath undeveloped land parcels.

3. Because the majority of irrigation occurs during the dry (low-rainfall) months, the total annual recharge to groundwater from irrigated developed lands is the sum of: (a) the deep percolation arising from irrigation (during the low-rainfall months); and (b) rainfall (during the months when less irrigation is occurring). Therefore, groundwater recharge beneath developed lands is greater and occurs for a longer period of time each year than in the case of undeveloped lands where no irrigation is occurring.

Historical Observations of Groundwater Conditions in the Santa Clarita Valley

The findings of the studies described above for other groundwater basins in southern California are consistent with observations that have been made in the Santa Clarita Valley, which are based on long-term water level records, water budget analyses, and groundwater modeling. Based on a month-by-month calibration to a 20-year record of historical water level records (throughout the Valley) and stream gaging records (at the Los Angeles – Ventura County line), the model simulates 10 percent of the applied outdoor water as being available for recharge to groundwater in retail and residential areas, with greater percentages infiltrating beneath golf courses and agricultural lands. This is consistent with a 1980 study by DWR of the groundwater resources of the Santee and El Monte hydrologic subareas of San Diego County. In that study, which was performed to evaluate reclaimed water use plans, DWR concluded that approximately 20 percent of the applied outdoor water in municipal areas infiltrates to the water table, with the remaining 80 percent going to evapotranspiration and direct evaporation. DWR also concluded that there would likely be no significant change in these percentages as urbanization continues.[2]

In the Santa Clarita Valley, as in any urbanized area, urbanization increases the paved area and can increase the magnitude and intensity of stormwater runoff from paved land areas. In the Santa Clarita Valley, this stormwater runoff will find its way to the Santa Clara River and its tributaries, whose channels are predominantly natural and consist of vegetation and coarse-grained sediments (rather than concrete). The stormwater that flows across paved lands in the Santa Clarita Valley is routed to stormwater detention basins and to the river channels, where the porous nature of the sands and gravels forming the streambeds allow for significant infiltration to occur to the underlying groundwater. Consequently, for a developed land parcel, the water that runs off of the paved portion of the land parcel will infiltrate to groundwater from a detention basin or a riverbed, rather than infiltrating onsite.

Riverbed infiltration is a significant percentage of total recharge in the Santa Clarita Valley in any given year. Streamflow records and the model calibration process together demonstrate that year-to-year fluctuations in total recharge in the Valley arise not just from year-to-year variations in incident rainfall within the Valley, but also from year-to-year variations in streamflows in the Santa Clara River and its tributaries. Because the areas contributing flow to the rivers are located both within and outside of the Valley, the recharge that occurs from riverbeds is a significant source of groundwater recharge within the Valley.

Evidence that stormwater infiltration to groundwater is not significantly decreased by urbanization comes from long-term water level records at wells completed in the Alluvial aquifer. These records show that groundwater levels and the amount of groundwater in storage were similar in both the late 1990s and the early 1980s, despite a significant increase in the urbanized area during these two decades. This long-term stability is attributed in part to the significant volume of natural recharge that occurs in the streambeds, which do not contain paved, urban land areas. Also, groundwater pumping volumes have not increased

[2] See State of California, Department of Water Resources, Southern District. August 1984, *San Diego County Cooperative Ground Water Studies: Reclaimed Water Use, Phase II*. Pages 40-41.

due to urbanization, compared with pumping volumes during the 1950s and 1960s when water was used primarily for agriculture. Additionally, beginning in 1980, water was imported into the Santa Clarita Valley from the State Water Project (SWP) for urban use, with SWP water use reaching nearly 30,000 acre-feet per year (AF/yr) by the end of the 1990s, and progressively increasing from about 32,500 AF in 2000 to nearly 44,500 AF in 2003. Because two-thirds of the total urban water demand is used outdoors, a substantial portion of the imported SWP water has been and continues to be applied to urban landscaping, thereby increasing the amount of recharge to groundwater. The remaining urban water is used indoors, and is subsequently routed to local water reclamation plants (WRPs) and then to the Santa Clara River (after treatment). A portion of this water flows downstream out of the basin, and a portion infiltrates to groundwater.

In summary, urbanization has been accompanied by long-term stability in pumping and groundwater levels, plus the addition of imported SWP water to the Valley, which together have not reduced recharge to groundwater, nor depleted the amount of groundwater that is in storage within the Valley.

Final Report

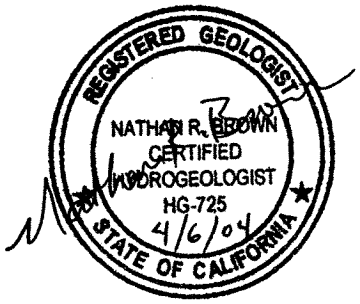
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Model Development and Calibration

Prepared for

Upper Basin Water Purveyors:

Castaic Lake Water Agency (CLWA)
Newhall County Water District
Santa Clarita Water Division of CLWA
Valencia Water District



April 2004

CH2MHILL

Executive Summary

The water purveyors in the Santa Clarita Valley of Southern California have constructed a regional-scale numerical groundwater flow model of the valley. The model, which is called the Santa Clarita Valley Groundwater Model (Regional Model), simulates the occurrence and flow of groundwater, including its interaction with streams in the area. Figure ES-1 shows the study area, including the Regional Model's boundaries. Figure ES-2 shows the extent of the watershed that the valley occupies, and shows the sub-watersheds that drain into the study area covered by the Regional Model.

The Regional Model has been developed as part of the work scope contained in a Memorandum of Understanding (MOU) that was entered into in August 2001 by the Upper Basin Water Purveyors in the Santa Clarita Valley and the United Water Conservation District in Ventura County. This report documents the construction and calibration of the Regional Model, including presenting the conceptual hydrogeologic model on which the Regional Model is based.

ES.1 Model Development Objectives and Approach

The Regional Model is intended to become an evolving tool for managing the local groundwater resource. Specific objectives that are identified for the model are:

a. To be able to evaluate the long-term sustainability (yield) of the two aquifer systems that are present in the valley, the Alluvial Aquifer and the Saugus Formation, under a range of existing and potential future water resource management conditions

b. To be able to evaluate artificial recharge to increase the long-term sustainability of the aquifer system, particularly in conjunction with the availability of imported surface water supplies

c. To evaluate the influences of future water management plans and alternatives on groundwater conditions within the valley and on the flows of water into the downstream basins in Ventura County

d. To facilitate general management of water quantity and water quality issues

The approach to developing the Regional Model included the following steps:

1. Compiling information on the geology and hydrogeology of the valley and developing a conceptual understanding of the groundwater flow system

2. Creating a variety of data sets to conduct steady-state and transient calibrations

3. Constructing the Regional Model using the MicroFEM® finite-element groundwater flow code, and also using the available database and geographic information system (GIS) for the Santa Clarita Valley

4. Calibrating the Regional Model
5. Performing sensitivity tests on the Regional Model

ES.2 Hydrogeology of the Santa Clarita Valley

Section 2 of the report describes the hydrogeology of the Santa Clarita Valley, including the geologic system; groundwater occurrence; groundwater recharge and discharge mechanisms; the relationship of surface hydrology to the valley's groundwater resources; historical trends in the valley's hydrology; the role of the State Water Project (SWP) in the valley's water resources and water supply; and key findings from prior studies conducted in the valley. This section of the report focuses particularly on information of specific relevance to development of the Regional Model. Figure ES-3 is a schematic representation of the regional-scale geology and hydrologic cycle in the Santa Clarita Valley. Figure ES-4 is a geologic map.

ES.2.1 Geology

The geology of the valley is defined in part by the non-water-bearing bedrock that underlies and surrounds the valley's aquifer systems. This bedrock forms a bowl-shaped aquifer system, which is thickest at the center of the valley and progressively thins outwards towards the margins of the valley. The deeper of the two aquifer systems is contained in the Saugus Formation, which consists of lenticular and interfingered beds of poorly- to well-consolidated sandstone, conglomerate, and siltstone that are at least 7,500 feet thick in the deepest part of the basin. The most productive portion of the Saugus Formation is thought to be the area southwest of the San Gabriel Fault. The deeper and older portion of the Saugus Formation, the Sunshine Ranch Member, was deposited in a marine environment and consists of fine-grained, low-permeability siltstone and sandstone that preclude development of municipal water supplies. Evidence from geophysical logs also indicates that the groundwater in much of the Sunshine Ranch Member may be somewhat brackish in quality.

Overlying the Saugus Formation is the Alluvial Aquifer, which consists of extensively interlayered and interfingered mixtures of gravel, sand, silt, and clay, with variable amounts of cobbles and boulders. In general, alluvium in the main river valley ranges from medium-grained sand to sandy gravel and cobbles. Due to its unconsolidated to poorly consolidated condition, and its lack of cementation, the alluvium has relatively high permeability and porosity.

ES.2.2 Groundwater Recharge

Average annual rainfall in the Santa Clarita Valley is approximately 18 inches per year, and higher (up to 30 inches per year or more) in the surrounding mountains. Natural groundwater recharge occurs from direct precipitation and from stormwater flowing in the Santa Clara River and its tributaries. Each of these streams have their headwaters in areas lying upstream of the Alluvial Aquifer and Saugus Formation. Consequently, stormwater that is generated in these upstream watersheds flows into the valley and is an important source of groundwater recharge. Because the climate is semi-arid, rainfall and stormwater runoff occur primarily between November and March and can vary considerably in

magnitude from year to year. The direct precipitation in the valley and the recharge of stormwater generated in upstream watersheds together provide approximately 94 percent of the total groundwater recharge to the valley's groundwater resources. Irrigation on agricultural and urban lands represents another 4 percent, and underflow beneath Castaic Dam into the adjoining Alluvial Aquifer is estimated to represent approximately 2 percent of the total basinwide groundwater recharge.

ES.2.3 Groundwater Discharge

Groundwater discharge from the Alluvial Aquifer occurs primarily as discharge to the Santa Clara River and evapotranspiration (ET) by the riparian vegetation growing along the river corridor. The Alluvial Aquifer also discharges as subsurface outflow into the Piru Basin at Blue Cut, which is located just downstream of the Los Angeles-Ventura County line. Groundwater pumping occurs from both the Alluvial Aquifer and the Saugus Formation, and Saugus Formation groundwater also discharges to the Alluvial Aquifer.

ES.2.4 Aquifer Physical Properties

Specific capacity data from Alluvial Aquifer production wells indicates that the horizontal hydraulic conductivity is approximately 300 to 700 feet per day, and possibly higher, along the Santa Clara River. In the tributaries, the horizontal hydraulic conductivity is approximately 100 to 600 feet per day. The horizontal hydraulic conductivity in the Saugus Formation has been estimated to be approximately 6.5 feet per day, based on pumping and injection tests conducted on production wells with long screen intervals.

ES.2.5 Basin Hydrology

Long-term records of groundwater elevations and pumping exist for the Alluvial Aquifer throughout the valley. These records indicate that groundwater elevations can fluctuate significantly from year to year in the eastern part of the valley, in response to patterns of droughts and above-normal rainfall. In the western part of the valley, groundwater levels are stable, as this is the regional groundwater discharge area. Despite the variations in groundwater elevations in the eastern valley and the variations in pumping throughout the valley during the past five decades, groundwater elevations in the Alluvial Aquifer have shown no permanent long-term declines. In addition, the availability of SWP water has allowed the valley to become increasingly urbanized, and the resulting gradual increase in urbanization and SWP water imports have resulted in a gradual increase in flows in the Santa Clara River.

Similar conditions are seen in the Saugus Formation. From the late 1980s through the early to mid-1990s, groundwater elevations declined in response to drought conditions and increased pumping. However, starting in the mid-1990s, Saugus groundwater elevations increased notably as pumping decreased and rainfall increased. As with the Alluvial Aquifer, the Saugus Formation showed groundwater elevation recovery to levels seen prior to the drought.

ES.2.6 Water Supply

The Santa Clarita Valley obtains its water supply from local groundwater sources and from SWP water that is delivered to the Castaic Lake Water Agency by the California Department

of Water Resources (DWR) via the California Aqueduct. Water use includes municipal and agricultural uses.

Before 1970, agriculture was the predominant land use in the valley. Agricultural water was supplied by production wells, most of which were completed in the Alluvial Aquifer. Pumping from the Alluvial Aquifer during the 1950s and early 1960s ranged from 35,000 to 44,000 acre-feet per year (AF/yr). Pumping from the Alluvial Aquifer dropped gradually from 40,000 AF/yr in 1967 to less than 30,000 AF/yr by 1983, and did not rise above 30,000 AF/yr until 1993. In the Saugus Formation, very little pumping occurred before 1960. From 1960 through 1990, total pumping from the Saugus Formation ranged from approximately 2,500 AF/yr to approximately 8,500 AF/yr. In response to statewide drought conditions, pumping from the Saugus Formation ranged between 10,000 and 15,000 AF/yr from 1991 through 1994. Saugus pumping was reduced beginning in 1995, as the drought ended and additional water supplies became available. The water management practices of the purveyors call for maximizing the use of Alluvial Aquifer and SWP water. Groundwater pumping is minimized from the Saugus Formation, except during years when SWP water allocations are below normal. Consequently, since 1995, Saugus pumping has ranged between approximately 4,000 and 8,500 AF/yr.

The Castaic Lake Water Agency (CLWA) has a contract amount of SWP Table A water of 95,200 AF/yr. Modeling by DWR has indicated that actual SWP water imports, based on the current CLWA Table A contract amount, will be 66,300 AF/yr in wet years, 56,800 AF/yr in average years, and 37,900 AF/yr in multiple dry years. The occurrences of drought years in the SWP system is based on the hydrology of Northern California, and hence only occasionally coincides with the occurrence of drought locally. In addition to the above entitlements, DWR occasionally releases flood flows into Castaic Creek from Castaic Dam. These flows averaged 15,700 AF/yr during the 24-year period of water years 1977 through 2000. However, no flood flows were stored or delivered in five of those years, and the median flow was 2,800 AF/yr (only 18 percent of the average flow).

ES.3 Model Construction

The Regional Model was constructed using the three-dimensional finite-element groundwater modeling software called MicroFEM® (Hemker and de Boer, 2003). The Regional Model covers the entire area underlain by the Saugus Formation, plus the portions of the Alluvial Aquifer that lie beyond the limits of the Saugus Formation. The model area largely coincides with the Santa Clara River Valley East Groundwater Subbasin, extending from the Lang stream gage at the eastern end of the valley to the County Line gage area in the west. The Regional Model is based on a finite-element mesh consisting of 7 layers, with 17,103 nodes and 32,496 elements in each layer. The upper model layer simulates the Alluvial Aquifer, or the upper portion of the Saugus Formation wherever the Alluvial Aquifer is not present. The underlying layers simulate the underlying freshwater Saugus Formation and the Sunshine Ranch Member.

The boundary conditions in the model consist of specified flux boundaries for precipitation; irrigation; recharge from ephemeral streams; pumping; and underflow from beneath Castaic Dam. Head-dependent flux boundaries are used in the perennial reach of the Santa Clara River, and to model any residual drainage of groundwater that might occur in the

ephemeral reach under high water table conditions. A head-dependent flux boundary is also used for ET. A constant-head boundary was used in the Alluvial Aquifer at the downgradient (western) end of the valley, at the County Line gage.

Groundwater recharge rates were estimated using precipitation records; streamflow records; watershed maps; topographic maps; and aerial photography. These recharge rates were calculated using a detailed Surface Water Routing Model that was written specifically for the construction and calibration of the Regional Model. Pumping rates and pumping depths were defined from groundwater pumping and well construction records.

ES.4 Model Calibration Process

Calibration of the Regional Model involved matching both steady-state and transient conditions in the Alluvial Aquifer and the Saugus Formation. The steady-state calibration was performed for calendar years 1980 through 1985, and the transient calibration was performed for calendar years 1980 through 1999. The goals of the calibration process were generally to match groundwater flow directions, groundwater gradients, and groundwater elevations that were measured throughout the 20-year simulation period at wells across the valley. Figures ES-5 and ES-6 show the locations of wells that were used to evaluate calibration in the Alluvial Aquifer and the Saugus Formation, respectively. The figures also show how each aquifer was subdivided into zones to facilitate parameter selection and model calibration. An additional calibration goal was to match the patterns of total flow in the Santa Clara River and estimated groundwater discharge rates to the river. Model variables were adjusted in a manner that sought to honor independent estimates of parameter values while resulting in the best possible calibration.

ES.5 Model Calibration and Sensitivity

The Regional Model meets most of the qualitative and quantitative goals that were established for the calibration process. For the steady-state model, statistical goals for the head residuals, which are equal to the modeled minus measured groundwater elevations, were easily met for the Alluvial Aquifer and adequately met for the Saugus Formation. For the transient model, trends in groundwater elevations were generally well matched. However, during the mid- and late 1990s, the model tended to simulate too much decline in Alluvial Aquifer groundwater elevations in the eastern-most portion of the valley and water level fluctuations that were too variable in Castaic Creek. Groundwater discharges to the river were simulated well for both the steady-state and transient models.

The groundwater budget for the 20-year transient calibration period showed that recharge from precipitation and streamflows varied considerably from year to year, ranging from less than 15,000 AF/yr in the driest years to as much as 270,000 AF/yr in the wettest years (see Figure ES-7). In contrast, total groundwater discharges were less variable, ranging from approximately 61,000 AF/yr at the end of the late 1980s/early 1990s drought to 116,000 AF/yr during 1998 (see Figure ES-8). This variability in groundwater discharge did not follow the year-to-year pumping patterns, but instead was caused by year-to-year fluctuations in ET and groundwater discharges to the river. These fluctuations, in turn, correlated well with groundwater recharge patterns. During the 20-year transient

calibration period, changes in the volume of groundwater stored in the combined Alluvial-Saugus aquifer system varied primarily according to year-to-year variations in regional rainfall. No long-term decline in groundwater storage was observed in the field or simulated by the model (see Figure ES-9) during this period. As Section 2.6.2 of this report will discuss, available data dating back to the 1950s also show that no long-term water level declines have occurred in the valley, despite past periods of significant pumping (particularly during the 1950s) and drought cycles.

Sensitivity analyses were performed to evaluate whether further changes in the values of key model parameters would improve the calibration quality of the Regional Model. Variables that were tested were the hydraulic properties (horizontal and vertical hydraulic conductivities and storage coefficients) for the Alluvial Aquifer and the Saugus Formation; the riverbed leakage terms for the Santa Clara River and Castaic Creek; and the ET parameters. The sensitivity analysis indicated that the model is calibrated well and that it is sensitive to the choices of horizontal hydraulic conductivity in both aquifers and vertical hydraulic conductivity in the Saugus Formation. The Regional Model was also sensitive to the riverbed leakage terms in both groundwater recharge and groundwater discharge areas. However, the model was insensitive to the choice of ET parameters.

The process of calibrating the Regional Model to a 20-year period of groundwater elevation and streamflow data has resulted in a model that is suitable for its intended applications, which are evaluating groundwater management strategies, groundwater sustainability, artificial recharge options, and restoration of contaminated water supplies. The primary attributes of the model's calibration that makes this tool appropriate for its intended uses are:

a. Its ability to simulate historical trends in groundwater elevations and river flows during a 2-decade period that reflects increased urbanization, increased SWP water imports (from outside the valley), and associated changes in land use and water use

b. Its ability to simulate trends in smaller geographic areas of interest within the valley (for example, near the Whittaker-Bermite property)

c. Its use of an integrated model of the watershed, the Surface Water Routing Model, to define the amount of rainfall and stormwater that is potentially available to recharge the groundwater system

The calibration process has resulted in a Regional Model that closely simulates, on a monthly basis, total flows in the river and estimated volumes of groundwater discharging to the river. The calibration process has also resulted in a Regional Model that closely simulates the short-term and long-term time-varying trends in groundwater elevations throughout the valley, which is necessary for evaluating groundwater management strategies. The close calibration of the groundwater elevation trends and absolute groundwater elevations in both the Alluvial Aquifer and the Saugus Formation near the Whittaker-Bermite property also renders the Regional Model suitable for particle-tracking analyses, to support the design of a long-term pumping and groundwater treatment plan that will restore impaired water supplies while also preventing contamination in unimpacted portions of the aquifer.

ES.6 Model Use and Recommendations

The Regional Model is generally well-calibrated and therefore can be applied to meet the objectives for which it was developed. Nonetheless, because no model is perfect, it should be used with care, and all model results should be examined by qualified and experienced hydrogeologists and water resource managers. It is recommended that future applications of the model include sensitivity analyses on key variables and that the Regional Model and the Surface Water Routing Model be updated as water use conditions change in the future. Additionally, data gathering efforts should continue or resume, to facilitate updates of the Regional Model. In particular, controlled pumping tests should be conducted to provide quantitative estimates of aquifer properties at the locations of new Saugus Formation wells and streamflow monitoring should resume at the Lang gage, in order to better understand the magnitudes and timing of Santa Clara River flows into the valley.

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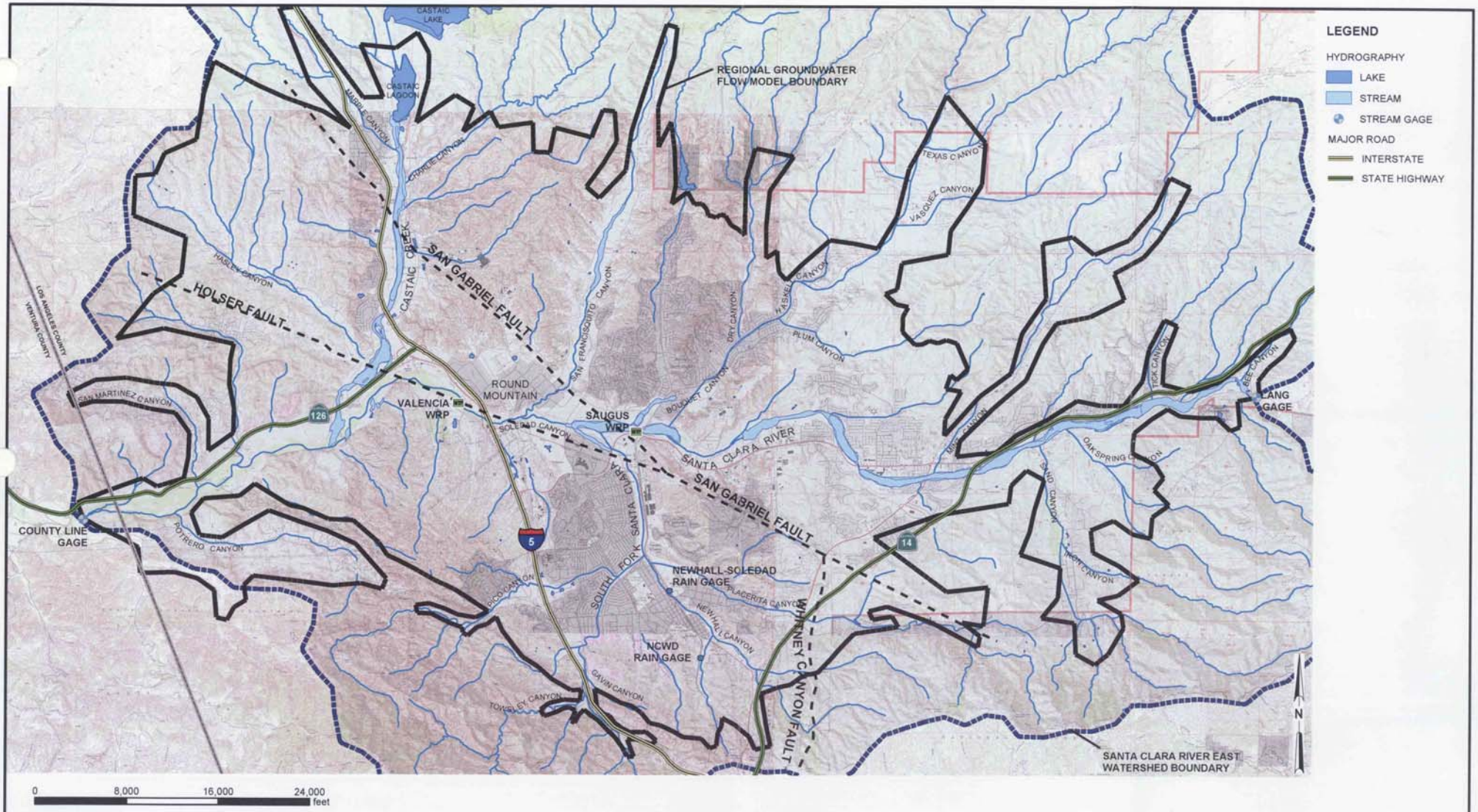

FIGURE ES-1
MAP OF STUDY AREA
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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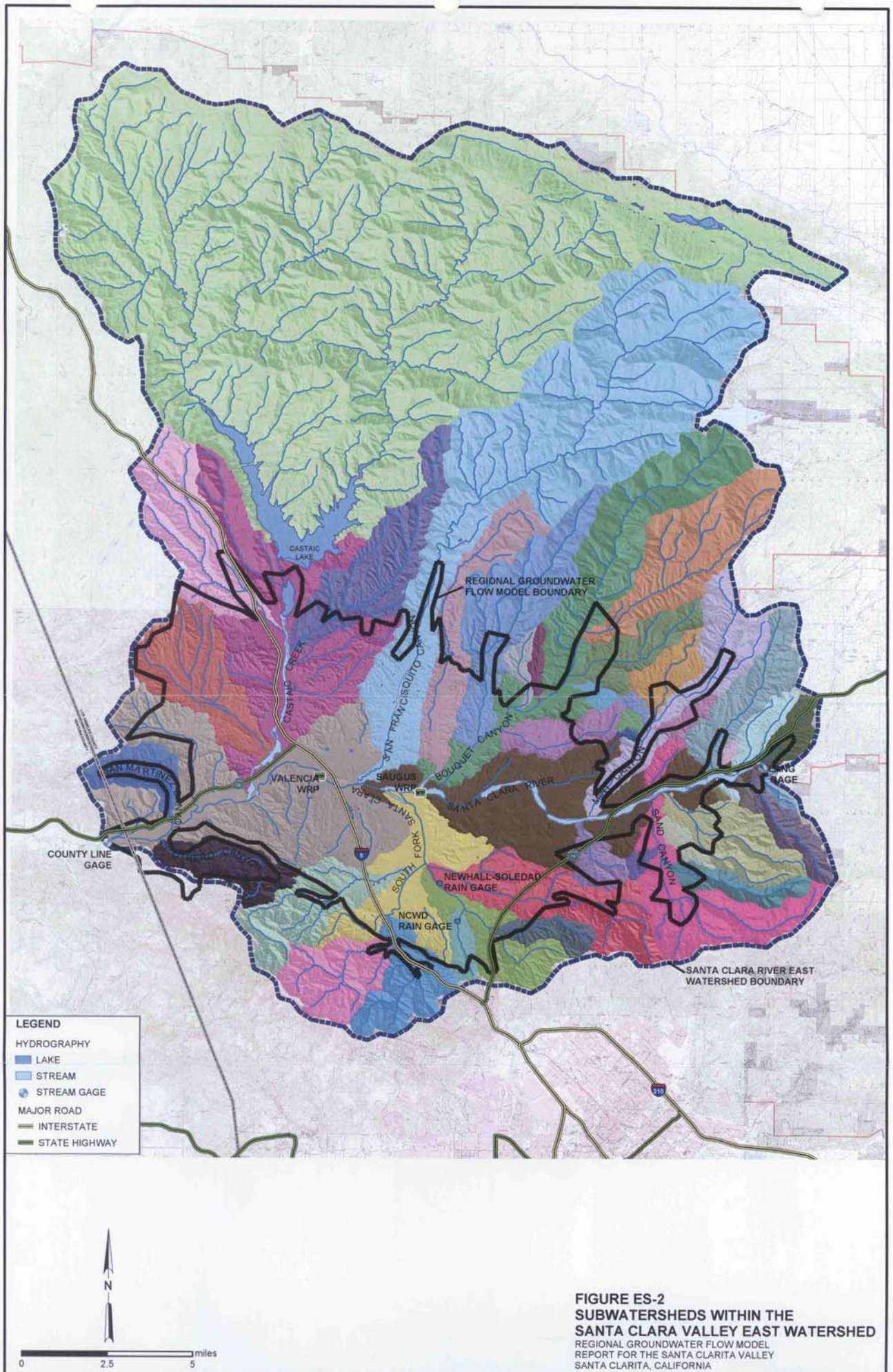

FIGURE ES-2
SUBWATERSHEDS WITHIN THE SANTA CLARA VALLEY EAST WATERSHED
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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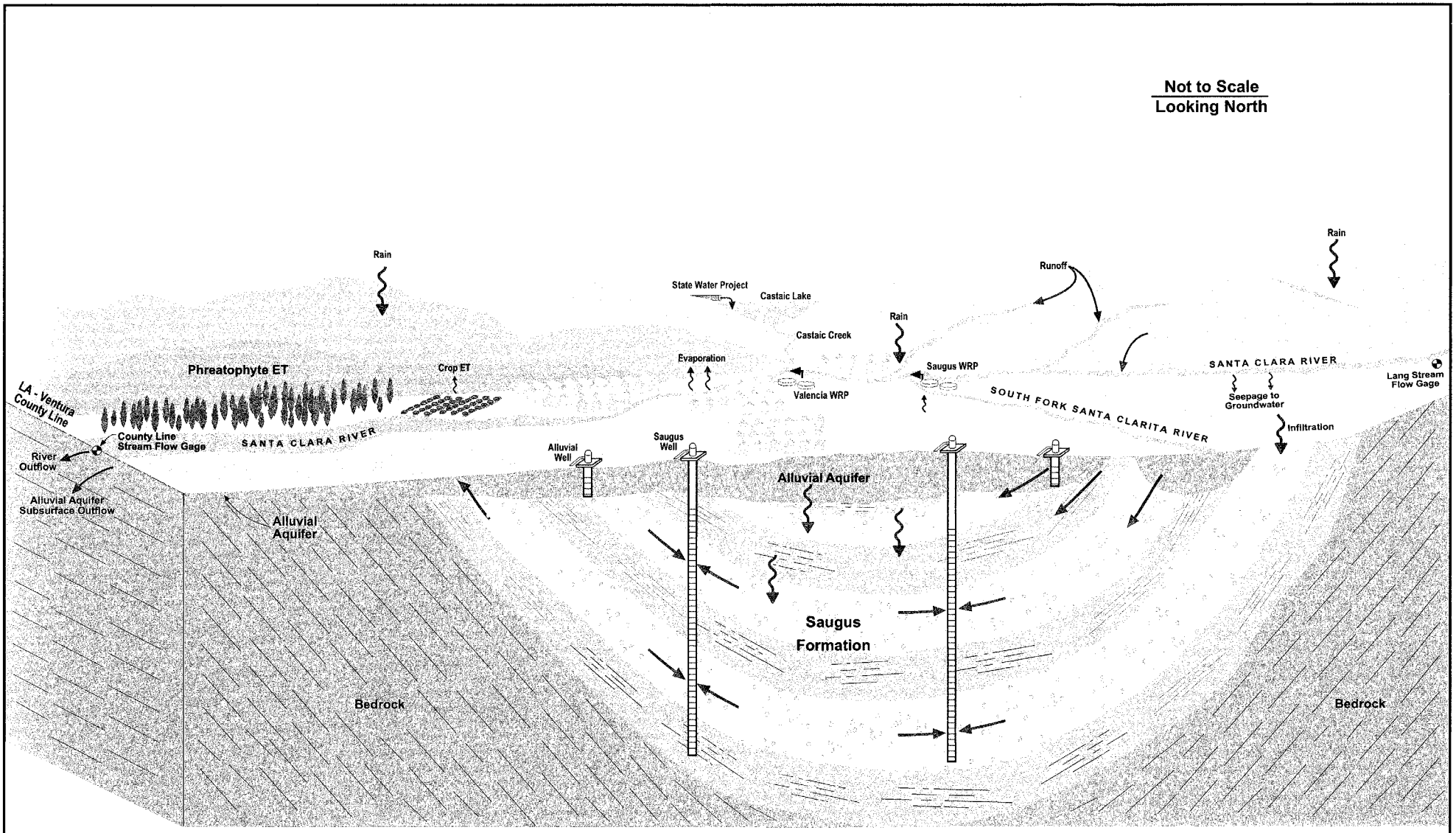

FIGURE ES-3
SANTA CLARITA VALLEY HYDROLOGY
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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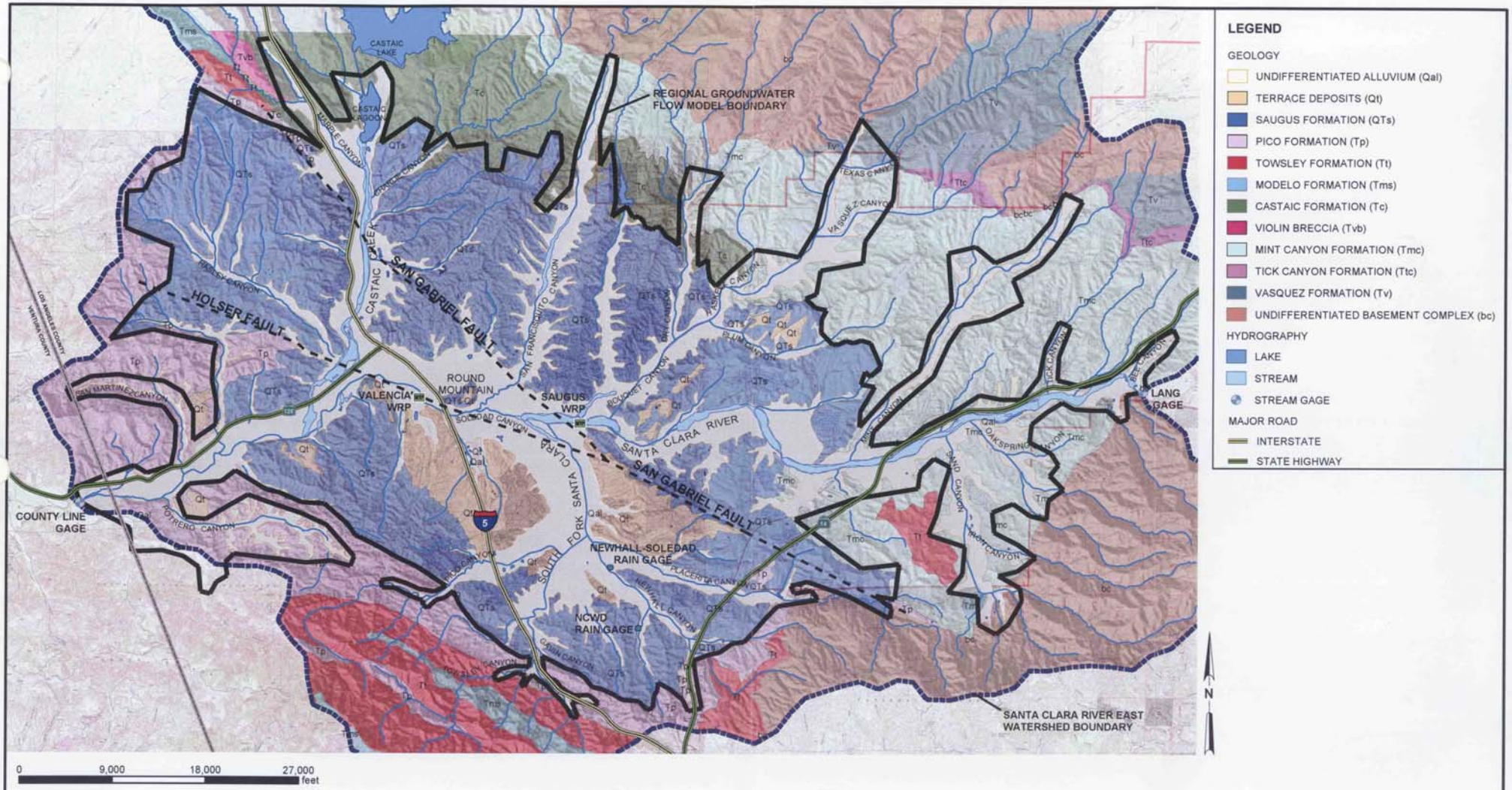

FIGURE ES-4
BASIN GEOLOGIC MAP
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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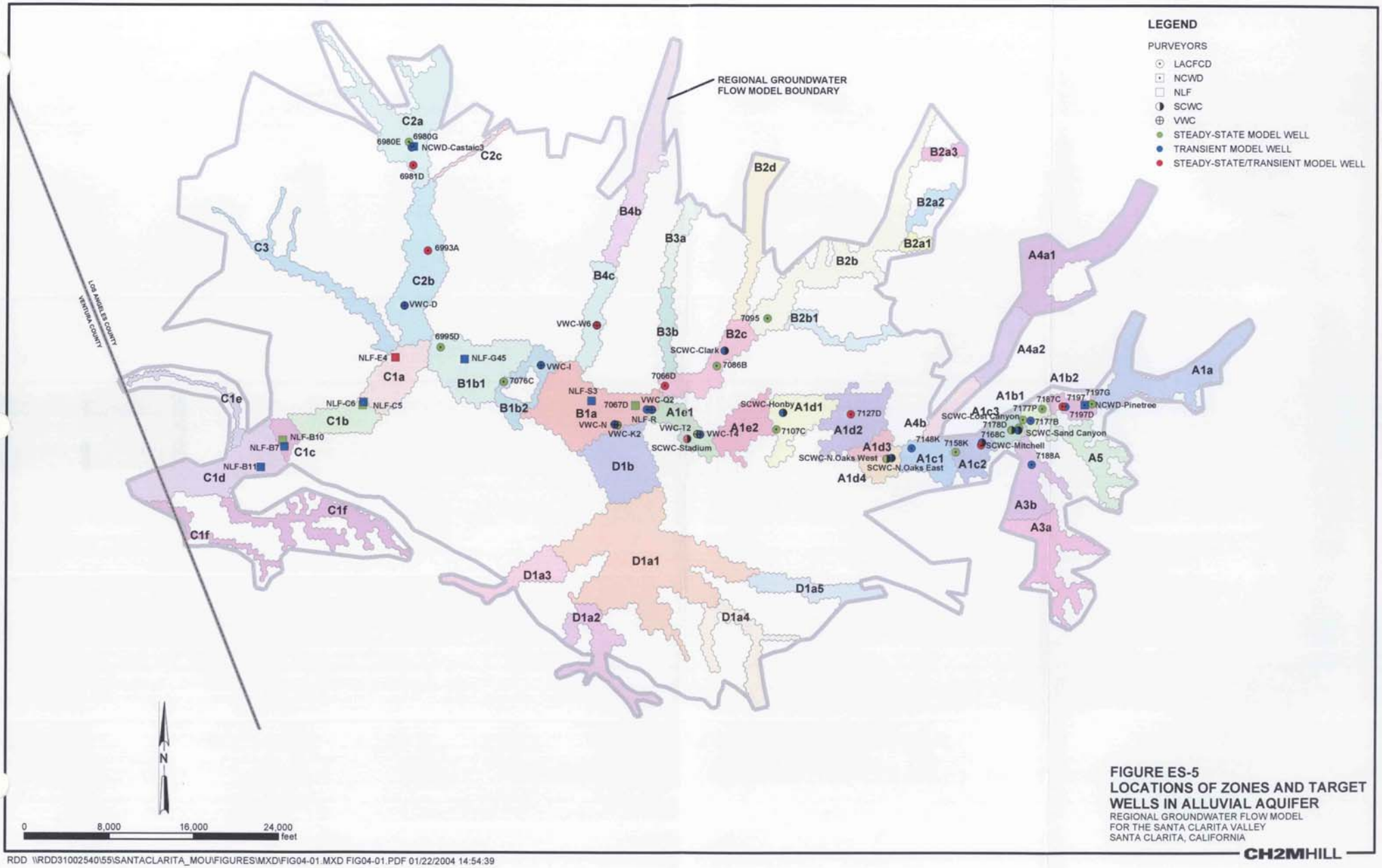

FIGURE ES-5
LOCATIONS OF ZONES AND TARGET WELLS IN ALLUVIAL AQUIFER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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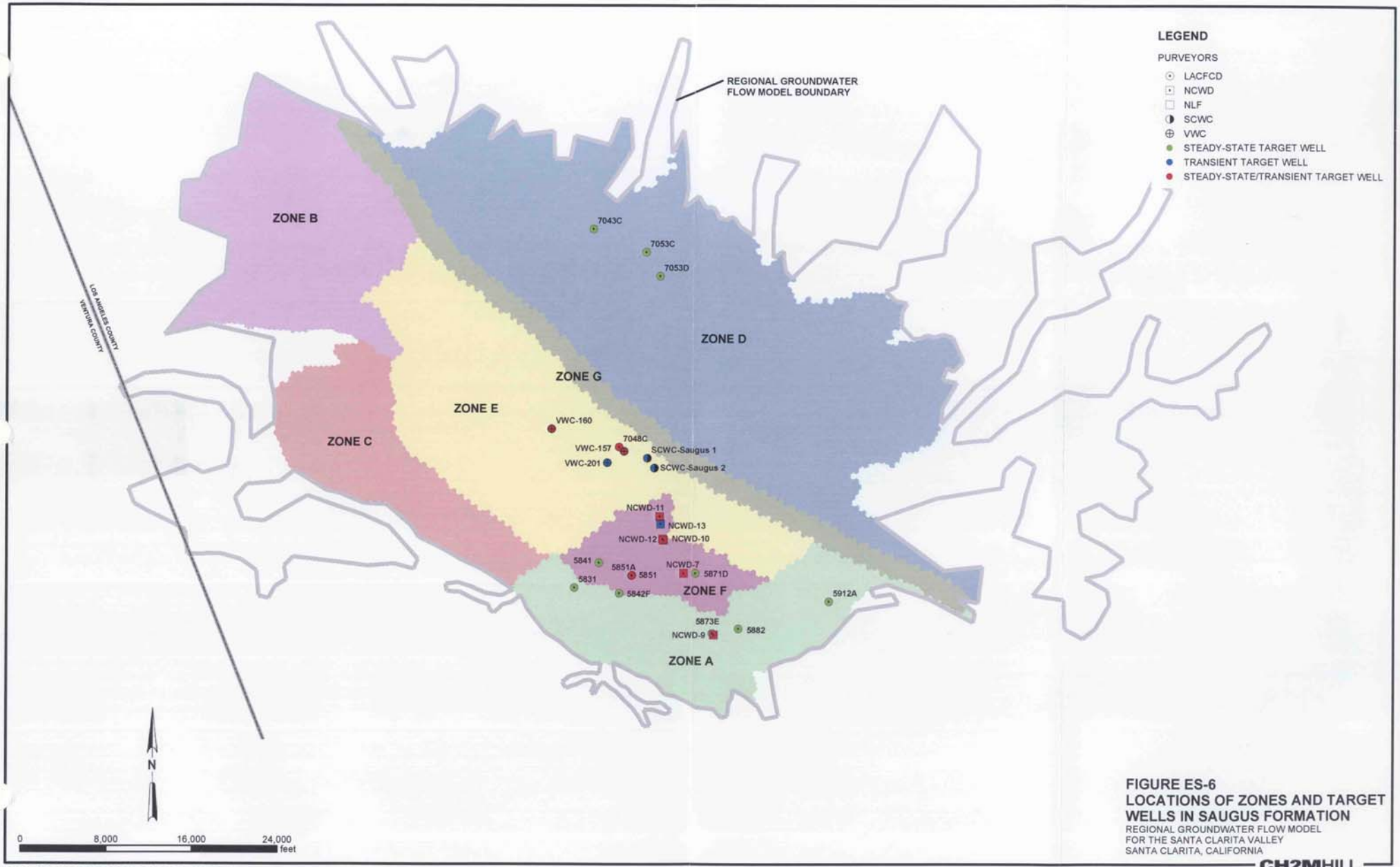

FIGURE ES-6
LOCATIONS OF ZONES AND TARGET WELLS IN SAUGUS FORMATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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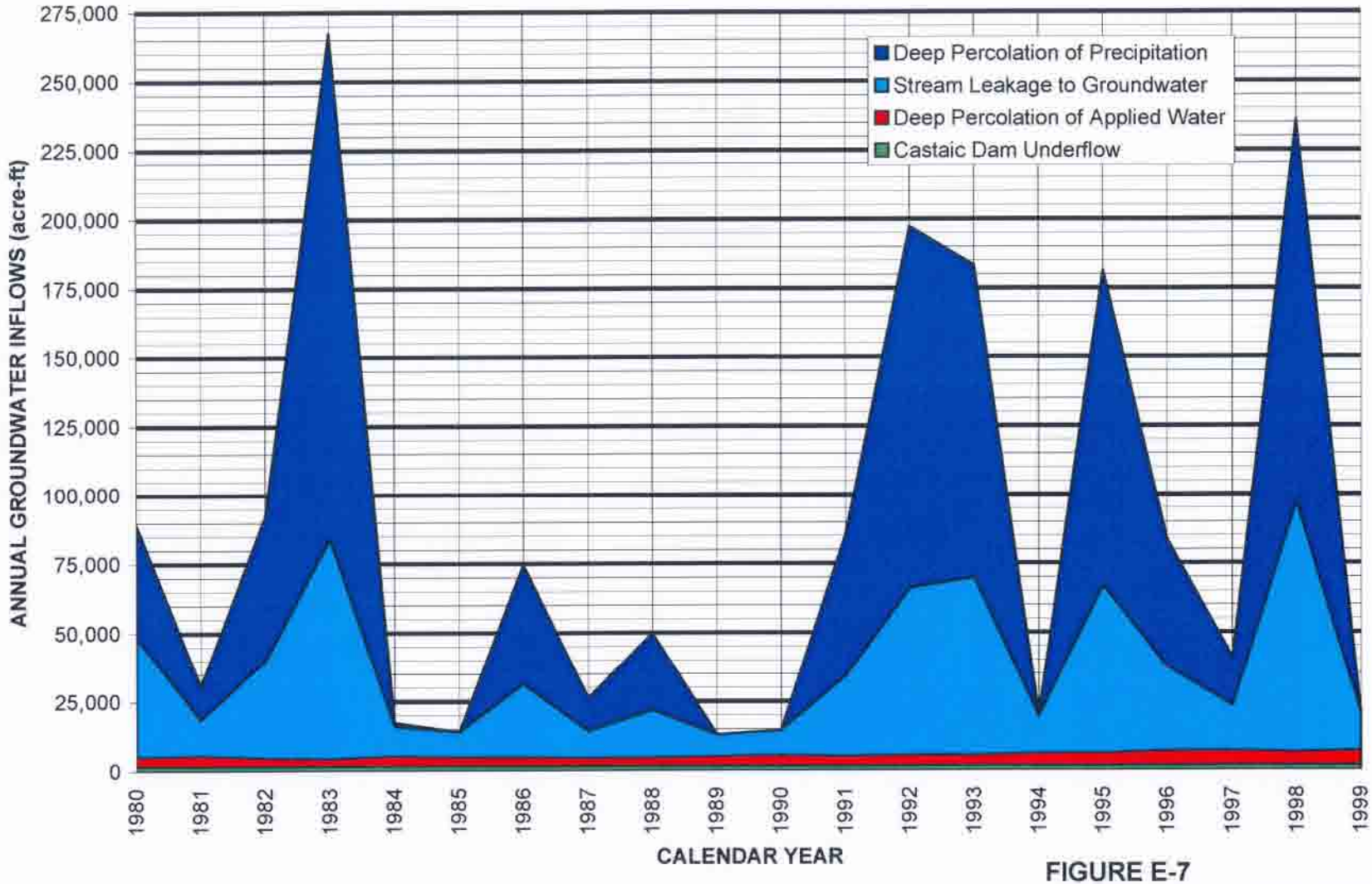

FIGURE E-7
ANNUAL GROUNDWATER INFLOWS
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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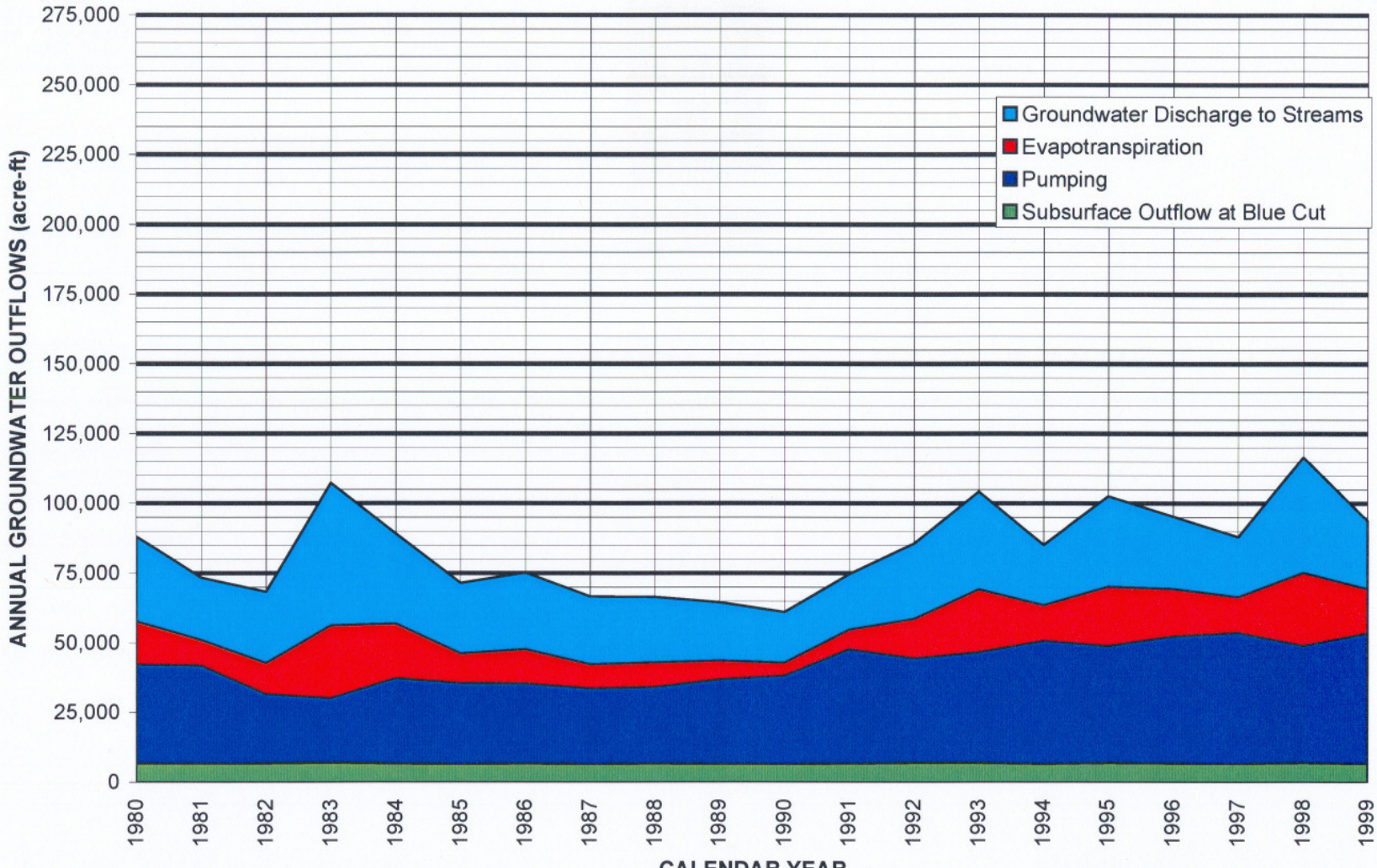

FIGURE E-8
ANNUAL GROUNDWATER OUTFLOWS
REGIONAL GROUNDWATER FLOW MODEL
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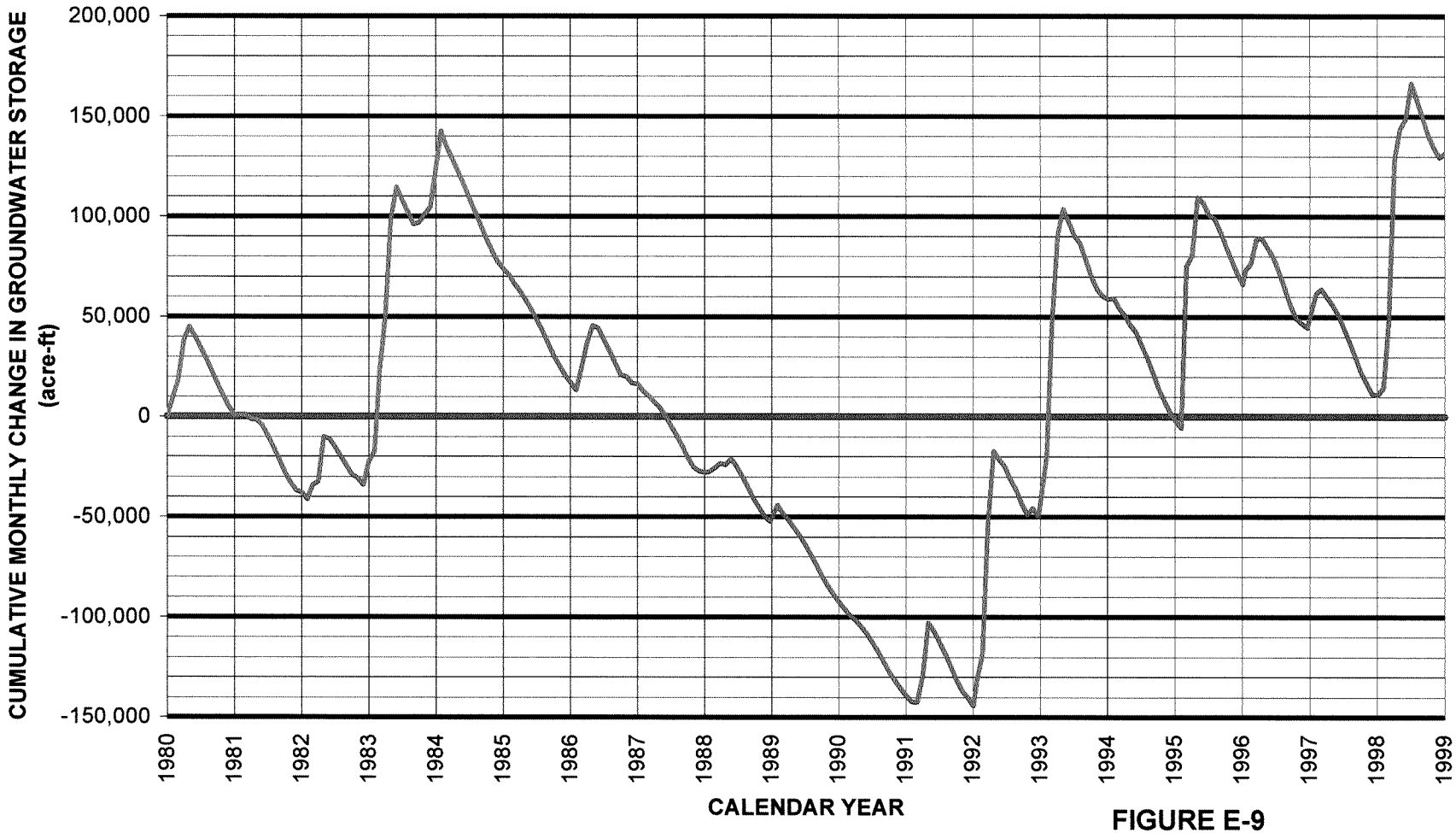

FIGURE E-9
CUMULATIVE CHANGE IN GROUNDWATER STORAGE
REGIONAL GROUNDWATER FLOW MODEL
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Acronyms and Abbreviations

°F	degrees Fahrenheit
AF	acre-feet
AF/yr	acre-feet per year
ASR	aquifer storage and recovery
bgs	below ground surface
cfs	cubic feet per second
CLWA	Castaic Lake Water Agency
cm/sec	centimeters per second
county line	Los Angeles-Ventura County line
Downstream Water Users	Los Angeles County Waterworks District, Newhall Land & Farming Company, Newhall County Water District, and United Water Conservation District
DWR	California Department of Water Resources
ET	evapotranspiration
ft/day	feet per day
ft^2/day	square feet per day
ft/yr	feet per year
GIS	geographic information system
gpd	gallons per day
gpd/ft	gallons per day per foot
gpm	gallons per minute
gpm/ft	gallons per minute per foot
GPS	global positioning system
I-5	Interstate 5
in/yr	inches per year
K	hydraulic conductivity
Kh	horizontal hydraulic conductivity
Kv	vertical hydraulic conductivity
LACFCD	Los Angeles County Flood Control District
LACSD	Los Angeles County Sanitation District

LACWWD	Los Angeles County Waterworks District
LADPW	Los Angeles County Department of Public Works
MOU	Memorandum of Understanding
NCDC	National Climate Data Center
NCWD	Newhall County Water District
NLF	Newhall Land & Farming Company
Purveyors	Upper Basin Water Purveyors
R	vertical anisotropy ratio (Kh:Kv)
RCS	Richard C. Slade and Associates, LLC
Regional Model	Santa Clarita Valley Groundwater Model
residual	residual error
RMS	root-mean-square
SCWC	Santa Clarita Water Company
SWP	State Water Project
SWRM	Surface Water Routing Model
Sy	aquifer specific yield
T	transmissivity
UWCD	United Water Conservation District
USGS	U.S. Geological Survey
VWC	Valencia Water Company
WHR	Wayside Honor Rancho
WRP	water reclamation plant
WY	water year

SECTION 1

Introduction

This report describes the development of a regional groundwater flow model for the Santa Clarita Valley, located in northwestern Los Angeles County, California. The model, called the Santa Clarita Valley Groundwater Model (Regional Model), simulates the occurrence and flow of groundwater, including its interaction with streams in the area. It has been developed for the water purveyors in the valley as a tool for the analysis of groundwater management options in the context of future water demands and water supply conditions in the valley. Figure 1-1 is a map showing the study area.

1.1 Model Use Objectives

The Regional Model has been developed as part of the work scope contained in a Memorandum of Understanding (MOU) that was entered into in August 2001 by the water purveyors in the Santa Clarita Valley (the Purveyors) and the United Water Conservation District (UWCD), located downstream in Ventura County. The MOU, which is contained in Appendix A, is a commitment by the Purveyors to expand the analysis of groundwater conditions such that the adequacy of the local water supply is well understood and questions about surface water and groundwater resources can be more readily addressed. The MOU contained a number of technical components, including the development and calibration of a regional-scale groundwater flow model and the preparation of technical reports on topics such as groundwater model development. This report and the model described herein reflect the accomplishment of two of the MOU technical components.

The Regional Model is intended to become a tool for managing the local groundwater resource, including the relationship of surface water to groundwater in the valley. The model has been designed to be an evolving tool that will analyze groundwater development, natural and artificial recharge (particularly in conjunction with the availability of imported surface water supplies), and the resultant impacts of these activities on groundwater conditions within the valley and on the flows of water into the downstream basins in Ventura County. As discussed in the MOU, one use will be to evaluate the long-term sustainability, or operational yield, of the shallow Alluvial Aquifer and the deeper groundwater resources that are present in the underlying Saugus Formation. Specifically, this assessment will look at basin operations over a multi-year wet/dry cycle, with operational yield defined as a basin operating plan that allows continued pumping from these aquifers while assuring that groundwater supplies are adequately replenished from one wet/dry cycle to the next. The parties to the MOU agreed to use the Regional Model for this assessment because (1) data show no long-term lowering of the water table or degradation of water quality has occurred during the 50 to 60 years of historical groundwater development in the valley, and (2) current planning places future pumping of the Alluvial Aquifer in the same range as historical pumping. At this time, the primary question of interest to the MOU parties is the effect of pumping the Saugus Formation during short-term dry periods at rates that are higher than have been historically pumped from that formation. An additional

planned application of the model will be to evaluate the restoration of pumping capacity that has been impacted by perchlorate contamination in the vicinity of the Whittaker-Bermite property in the central part of the valley.

Based on these objectives, the MOU specified that a model would be constructed that covers the entire area within the Santa Clarita Valley where Alluvial and Saugus groundwater resources are present, and that the model should be subjected to a transient calibration.

1.2 Model Development

The approach to developing the model included:

a. Compiling information on the geology and hydrogeology of the valley and developing a conceptual understanding of the groundwater flow system.

b. Creating a variety of data sets to conduct steady-state and transient calibrations.

c. Constructing the groundwater flow model using the MicroFEM® finite-element groundwater flow code, and also using the available database and geographic information system (GIS) for the Santa Clarita Valley.

d. Calibrating the flow model.

e. Performing sensitivity tests on the flow model.

This project was conducted for the parties to the MOU, who are the United Water Conservation District (UCWD) in Ventura County and the Upper Basin Water Purveyors, the water providers in the Santa Clarita Valley. The Upper Basin Water Purveyors consist of four retail purveyors of municipal water and the Castaic Lake Water Agency (CLWA), which has a contract with the State of California to obtain water from the State Water Project (SWP), and which furnishes SWP water to the four retail purveyors. The four retail purveyors are Los Angeles County Waterworks District (LACWWD) No. 36, the Newhall County Water District (NCWD), Santa Clarita Water Company (SCWC, a division of CLWA), and the Valencia Water Company (VWC).

1.3 Previous Studies

There are several previous studies of the groundwater system in the Santa Clarita Valley that were used to help develop the conceptual and numerical models of the hydrogeologic system. These studies include reports on the regional geology and hydrogeology, and a previous modeling analysis of the feasibility of constructing an aquifer storage and recovery (ASR) system. These studies are listed below and are described in more detail in Section 2.7 of this report.

a. *Hydrogeologic Investigation: Perennial Yield and Artificial Recharge Potential of the Alluvial Sediments in the Santa Clarita River Valley of Los Angeles County, California* (Richard C. Slade and Associates, LLC [RCS], 1986). This report was the first comprehensive study of the geology and hydrology of the Alluvial Aquifer.

b. *Hydrogeologic Assessment of the Saugus Formation in the Santa Clara Valley of Los Angeles County, California* (RCS, 1988). This report was the first comprehensive study of the geology and hydrology of the Saugus Formation.

c. *Assessment of the Hydrogeologic Feasibility of Aquifer Storage and Recovery, Saugus Formation, Santa Clarita Valley, California* (RCS, 2001). This report documented the results of ASR field tests in the Saugus Formation that evaluated the feasibility of injecting water into, and recovering water from, deep Saugus Formation wells.

d. *2001 Update Report: Hydrogeologic Conditions in the Alluvial and Saugus Formation Aquifer Systems* (RCS, 2002). This report was a summary and update of the 1986 and 1988 RCS reports.

e. *Newhall Ranch ASR Impact Evaluation* (CH2M HILL, 2001). This document evaluated the longer-term basinwide influences that would occur for an ASR program that was proposed as part of the water supply for the planned Newhall Ranch community.

f. *Newhall Ranch Updated Water Resources Impact Evaluation* (CH2M HILL, 2002). This document updated the ASR impact evaluation, including analyzing the effects of all aspects of the Newhall Ranch community (not just ASR) on the valley's water resources.

1.4 Report Organization

The remainder of this report is organized as follows:

Section 2 describes the hydrogeology of the Santa Clarita Valley, including the geologic system; groundwater occurrence; groundwater recharge and discharge mechanisms; the relationship of surface hydrology to the valley's groundwater resources; historical trends in the valley's hydrology; the role of the SWP on the valley's water resources and water supply; and key findings from prior studies conducted in the valley. This section of the report (along with Appendix B) focuses on information of specific relevance to development of the regional flow model.

Section 3 discusses the construction of the model, including the modeling software; the grid design; the layer-by-layer representation of the aquifers; the boundary conditions; the estimation of groundwater recharge rates; and the assignment of pumping rates in the model. Appendix C describes the design, operation, and data for a surface water routing model that was developed to provide the Regional Model with recharge rates from urban irrigation, agricultural irrigation, direct precipitation, streamflows entering the model domain, and discharges from water reclamation plants (WRP).

Section 4 describes the calibration conditions; the calibration goals; the model variables that were adjusted during calibration; the calibration procedure; and the measured (target) data that were used to evaluate calibration quality.

Section 5 presents quantitative and semi-quantitative evaluations of the calibration results, with a focus on the assessment of the model's calibration quality compared with the calibration goals presented in Section 4. Section 5 then concludes with a sensitivity analysis that further evaluates calibration quality and demonstrates the sensitivity of simulated groundwater elevations and water budget terms to changes in model parameter values.

Section 6 summarizes the applicability of the model for use in managing local groundwater resources, including the key attributes of the model and recommendations for further data collection and future model updates.

Section 7 is the reference list.

Figures

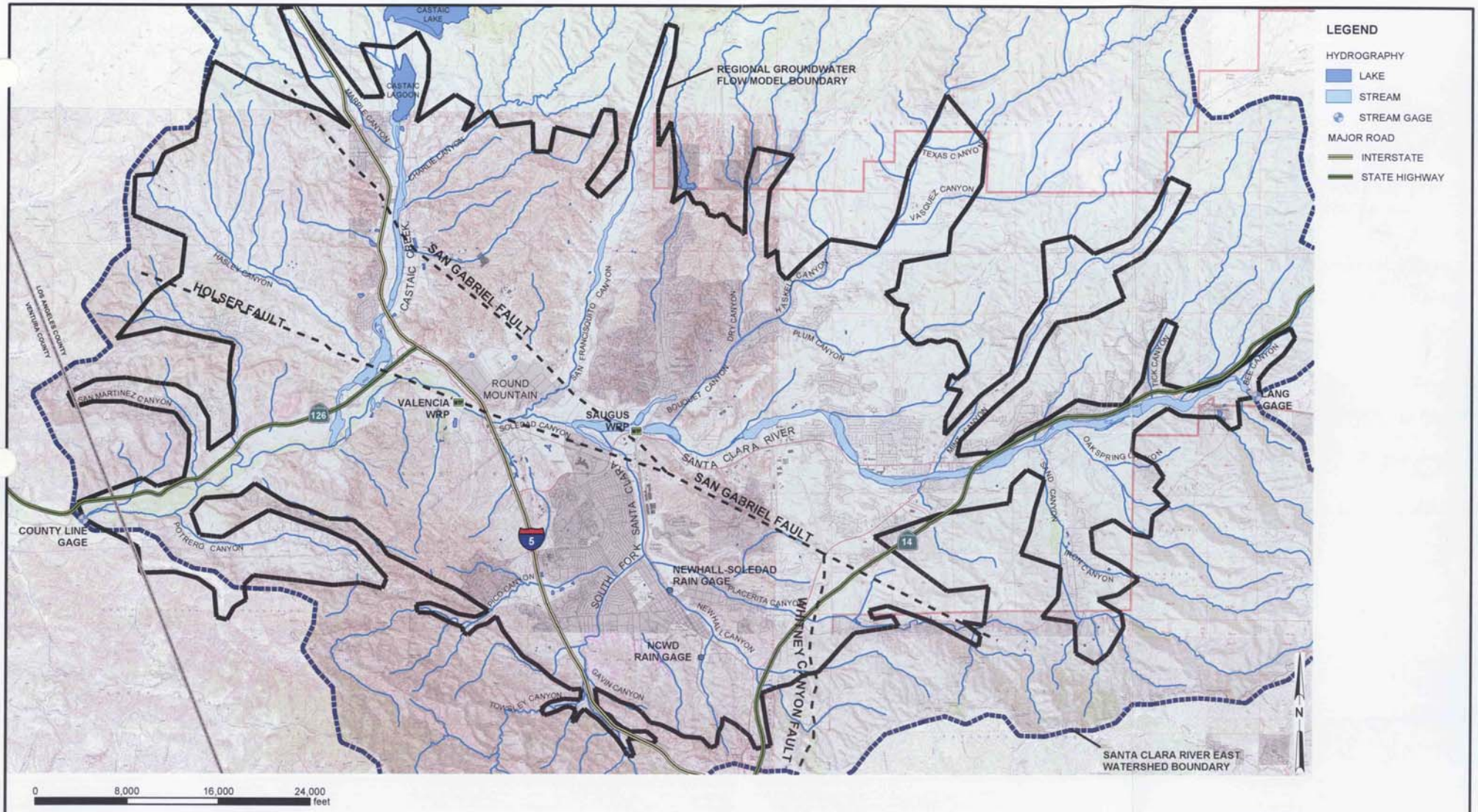

FIGURE 1-1
MAP OF STUDY AREA
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

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SECTION 2

Hydrogeology of the Santa Clarita Valley

The geology and hydrogeology of the Santa Clarita Valley are described in this section, which is derived primarily from the reports described in Section 1.3 and Section 2.7. Figure 2-1 is a schematic representation of the regional scale geology and hydrologic cycle in the Santa Clarita Valley. As shown on Figure 2-1, the two aquifer systems in the Santa Clarita Valley are the Alluvial Aquifer and the Saugus Formation. Groundwater is exchanged between these two units. Additionally, the aquifer systems are affected by direct rainfall; streamflows in the Santa Clara River and its tributaries; evapotranspiration (ET) by riparian vegetation along portions of the river; and human influences which consist of pumping, agricultural and urban irrigation, discharge of treated water into the Santa Clara River from two water reclamation plants, and occasional releases of water into Castaic Creek from Castaic Lake and Castaic Lagoon.

Figure 2-2 shows the location of the Santa Clarita Valley groundwater basin. This groundwater basin is identified by the California Department of Water Resources (DWR) as the Santa Clara River Valley East Groundwater Subbasin and lies within the DWR-designated Upper Santa Clara River Hydrologic Area. Figure 2-3 is a map of the Santa Clarita Valley, showing the locations of production wells completed in the Alluvial Aquifer and Saugus Formation.

2.1 Setting

The study area comprises the relatively flat-lying Santa Clarita Valley and portions of the surrounding hills and mountains. The study area extends from approximately the Los Angeles-Ventura County line (county line) on the west to the community of Lang on the east, and from the southern end of Castaic Lake on the north to the intersection of the Golden State Freeway (Interstate 5 [I-5]) and the Antelope Valley Freeway (State Highway 14) on the south. The mountains that surround the Santa Clarita Valley include the Santa Susana and San Gabriel Mountains to the south and the Sierra Pelona and Leibre-Sawmill Mountains to the north. Elevations range from approximately 800 feet on the valley floor to approximately 6,500 feet in the San Gabriel Mountains. The headwaters of the Santa Clara River are at an elevation of approximately 3,200 feet at the topographic divide separating the Upper Santa Clara River Hydrologic Area from the Mojave Desert.

The largest community in the study area is the City of Santa Clarita, which was formed in 1987 through the amalgamation of the communities of Newhall, Valencia, Saugus, and Canyon Country. Other smaller unincorporated communities in the study area include Stevenson Ranch and Val Verde in the west, Castaic in the northwest, and Lang in the east. The population of the City of Santa Clarita was estimated to be approximately 151,260 in the 2000 U.S. Census. In 2001, the Southern California Association of Governments estimated the population of the surrounding unincorporated Santa Clarita Valley at 48,237. Hence, the total current population of the Santa Clarita Valley is approximately 200,000 (RCS, 2002).

Prior to the 1960s, the predominant land use in the Santa Clarita Valley was agricultural, with much of the valley undeveloped. Urbanization began gradually in the 1960s, with a rapid increase beginning in the late 1970s and early 1980s and continuing to the present. Accompanying the rapid population increase has been a gradual change in valley land use patterns, from largely agricultural to urban and suburban developments. Nevertheless, a considerable portion of the hills and low mountains bordering the main river valley remain in a natural, undeveloped condition (RCS, 2002).

2.2 Climate

The study area has a semi-arid Mediterranean-type climate, characterized by long, dry summers and relatively short, wet winters. Temperatures in the Santa Clarita Valley range from a minimum of 20 degrees Fahrenheit (°F) to 30°F in the winter to a maximum of approximately 100 to 110°F during the summer. Mean monthly temperatures range between approximately 48°F in the winter and 77°F in the summer.

Rainfall data have been recorded since 1883 at the Newhall-Soledad gage (Station No. FC32CE), located at the Los Angeles County Department of Public Works (LADPW) Newhall-Soledad Division Headquarters office, on San Fernando Road in the community of Newhall. The average rainfall at this gage was 17.95 inches from 1883 through 2000 and 17.84 inches from 1950 through 2000.[1] A second rain gage is located approximately 1.3 miles to the south, at the NCWD office. Figure 2-4 shows the annual rainfall at the Newhall-Soledad and NCWD gages for calendar years 1950 through 2000. As shown in the figure, annual rainfall is highly variable from year to year. During this period, the highest calendar-year rainfall was 42.17 inches in 1978 at the Newhall-Soledad gage, and 48.33 inches in 1983 at the NCWD gage. The lowest amount of annual rainfall from 1950 through 2000 was 4.15 inches in 1972 at the Newhall-Soledad gage, and 8.47 inches in 1989 at the NCWD gage. Average annual rainfall from 1979 through 2000 was 18.67 inches at the Newhall-Soledad gage and 22.88 inches at the NCWD gage. Rainfall at the NCWD gage is usually greater than at the Newhall-Soledad gage, because the NCWD gage is located closer to the hills that form the southern boundary of the watershed and receive a greater amount of orographic precipitation.

Rainfall is not only variable on an annual basis, but is also highly seasonal. Approximately 80 percent of the annual precipitation in the Santa Clarita Valley falls between November and March. Most of the precipitation comes from winter storms that last only a few days and are separated by relatively long periods of clear weather.

As shown by the difference in rainfall values between the Newhall-Soledad and NCWD rain gages, rainfall varies across the basin according to elevation differences and the locations of surrounding mountain ranges. Figure 2-5 shows lines of equal precipitation (rainfall isohyets), based on long-term mean annual precipitation data compiled from the U.S. Geological Survey (USGS), DWR, and California Division of Mines maps and data. The source maps consist primarily of U.S. Weather Service data for approximately 800 precipitation stations, but in the Los Angeles and San Francisco Bay areas the

[1] Annual rainfall values for the Newhall-Soledad gage are based on monthly records reported by the National Climate Data Center (NCDC) and LADPW.

U.S. Weather Service data have been supplemented by county and local agency precipitation data. The precipitation isohyets shown on Figure 2-5 display the average annual rainfall during the period from 1900 through 1960. (See the internet site http://gis.ca.gov/meta.epl?oid=286 for more information.)

2.3 Geology

Figure 2-6 presents a geologic map of the Santa Clarita Valley, as reported by RCS (2002). The geologic units shown on the map include water-bearing sediments and non-water-bearing bedrock.

The Santa Clarita Valley is underlain and bounded by non-water-bearing bedrock units that are Miocene, Oligocene, and pre-Tertiary in geologic age. These units yield little water and are not considered viable for groundwater development.

Where the bedrock units are not exposed at the ground surface, they are overlain by younger geologic units. The Pliocene-age to Pleistocene-age Saugus Formation (map symbol, QTs) overlies the bedrock in much of the basin. At the far western and eastern ends of the basin, and in the upper reaches of some of the canyons, the Saugus Formation is absent and the bedrock units are overlain by a blanket of unconsolidated alluvium of Quaternary geologic age (map symbol, Qal). Where present, the alluvium overlies the Saugus Formation within much of the Santa Clarita Valley. In some areas where the alluvium is absent, the Saugus Formation is overlain by scattered outcrops of Quaternary-age Terrace deposits (map symbol, Qt). Groundwater is present in much of the alluvium and the Saugus Formation. However, the terrace deposits do not contain significant water resources because they are typically situated at elevations above the regional water table.

2.3.1 Non-Water-Bearing Bedrock

Underlying the water-bearing sediments in the Santa Clarita Valley are a series of consolidated, older, cemented sedimentary and crystalline rocks of Tertiary geologic age or older. For the most part, the sedimentary rocks are exposed along the flanks of the hills and mountains that border the Santa Clarita Valley, while the geologically older crystalline metamorphic and igneous rocks crop out in the upper watershed areas of the Sierra Pelona and San Gabriel Mountains.

Geologically older sedimentary rocks underlie the base of the Saugus Formation and are exposed in the hills beyond the exterior boundary line for the mapped surface limits of the Saugus Formation. The older rocks lying immediately below the Saugus Formation are: (1) the Pico Formation, composed of siltstone and shale, which underlies the Saugus Formation in the region southwest of the San Gabriel fault; and (2) the Castaic Formation and the Mint Canyon Formation, mainly siltstone and shale, which underlie the Saugus Formation in areas northeast of the San Gabriel fault. These sedimentary rock formations are generally fine grained, have low permeability, and do not yield substantial quantities of water to wells. In the project area, these rocks are considered barriers to groundwater flow.

2.3.2 Water-Bearing Sediments

Water-bearing sediments in the Santa Clarita Valley consist of:

a. Alluvial and valley fill deposits that underlie the Santa Clara River and its tributaries

b. Partially consolidated, older sediments of the Saugus Formation, including the Sunshine Ranch Member, that underlie the alluvium and are also exposed in the hillsides surrounding the main portion of the valley

2.3.2.1 Alluvium

The alluvial sediments are composed of extensively interlayered and interfingered mixtures of gravel, sand, silt, and clay, with variable amounts of cobbles and boulders. In general, alluvium in the main river valley ranges from medium-grained sand to sandy gravel and cobbles. Drillers' logs indicate the presence of discrete sand zones and discrete gravel zones in many areas of the alluvium. Due to its unconsolidated to poorly consolidated condition, and its lack of cementation, the alluvium has relatively high permeability and porosity.

The alluvial sediments lie within and along the course of the Santa Clara River and its main tributaries. The maximum thickness of the alluvium varies along the Santa Clara River, but generally is considered to be 200 feet. Typically, the alluvium tends to be thickest near the central portion of the river, and thins or pinches out near the flanks of the adjoining hills.

The alluvium overlies the Saugus Formation in much of the valley. However, in the eastern part of Soledad Canyon, the Saugus Formation is absent, and instead the alluvium overlies Miocene-age terrestrial sediments of the Tick Canyon and Mint Canyon Formations. In the upper reaches of some tributaries to the Santa Clara River, the alluvium overlies these or other Miocene-age sediments, such as the Pico and Castaic Formations. At the west end of the valley, the alluvium overlies the Pico Formation.

2.3.2.2 Saugus Formation

The Saugus Formation is present throughout the main portion of the Santa Clarita Valley and extends to the surrounding foothills. The Saugus Formation contains lenticular and interfingered beds of poorly- to well-consolidated sandstone, conglomerate, and siltstone that are at least 7,500 feet thick in the deepest part of the basin. These terrestrial sediments were deposited in stream channels, floodplains, and alluvial fans by the ancestral drainage system in the valley. The coarser-grained materials in the Saugus Formation were deposited in the main channels of the ancestral drainage system, and the locations of these channels changed throughout the approximately 3-million-year period of deposition of the Saugus Formation. Recent interpretations of geophysical electric log data indicate that the coarse-grained channel deposits (the primary water-bearing strata) are thicker and more numerous in some areas than in other locations in the valley. Although the Saugus Formation displays a considerable amount of lateral variability in lithology and grain size, some thicker stratigraphic packages can be traced through portions of the valley, primarily on the west (downthrown) side of the San Gabriel Fault (RCS, 2002).

The deeper and older portion of the Saugus Formation, the Sunshine Ranch Member, was deposited in a marine environment and consists of fine-grained, low-permeability siltstone and sandstone. The Sunshine Ranch Member has a maximum thickness of approximately 3,500 feet in the central part of the valley. It is present at or very close to ground surface at the margins of the valley. Geophysical (electric) logging indicates that the groundwater in

much of the Sunshine Ranch Member may be somewhat brackish in quality and is not useful for municipal water supply purposes.

2.3.3 Geologic Structure

Faulting and folding of the rocks in the region have caused the sedimentary rocks, including the Saugus Formation, to form a bowl-shaped structure. The Saugus Formation and the underlying bedrock dip generally toward the center of the "bowl" from all locations along the bottom (basal) contact of the Saugus Formation.

Dominating the geologic structure in the valley is the southeast-northwest-trending San Gabriel fault. The fault is a northeast-dipping reverse fault. The vertical displacement of the Saugus Formation on each side of the fault varies along the length of the fault and ranges from 100 feet to 2,600 feet within the valley (RCS, 1988). The Saugus Formation is thickest south of the fault, and this is the area where all significant Saugus production wells are located. North of the San Gabriel fault, the Saugus Formation is older, thinner, and finer grained than south of the fault. Little groundwater development has occurred north of the San Gabriel Fault.

A spur from this fault, referred to as the Holser fault, trends west through the valley. Cross sections prepared by RCS (1988, 2002) show that marker beds are offset by approximately 100 to 200 feet across the Holser Fault, which is substantially less than the offset across the San Gabriel Fault. Another spur fault called the Whitney Canyon fault extends south from the San Gabriel Fault in the southeastern corner of the valley.

2.4 Groundwater Occurrence, Recharge, and Discharge

Groundwater is present in the alluvium under generally unconfined conditions. Saugus Formation groundwater is thought to be present under unconfined conditions in the shallowest water-bearing zones where the Alluvial Aquifer is absent, and under semi-confined and confined conditions at greater depths. Figure 2-1 is a schematic cross-sectional representation of the groundwater flow patterns in the Santa Clarita Valley, including the predominant recharge and discharge mechanisms for the two aquifer systems. These are discussed in detail below.

2.4.1 Alluvium

Natural sources of recharge to the alluvium include deep percolation (infiltration) of direct precipitation within the valley; percolation of stream runoff flowing into the valley along the Santa Clara River and its tributaries; subsurface inflow from the adjoining (upgradient) portions of the Alluvial Aquifer to the north and east of the valley; and discharge of groundwater from the Saugus Formation to the Alluvial Aquifer, primarily on the west side of the Santa Clarita Valley.

Manmade sources of recharge to the Alluvial Aquifer include infiltration of irrigation water; infiltration of stormwater runoff from urban areas; infiltration of surface flow and underflow from Castaic Dam within the Castaic Creek area; infiltration of water released by the Los Angeles Department of Water and Power from its reservoir facilities in upper San Francisquito Canyon and upper Bouquet Canyon; and infiltration of water reclamation

plant (WRP) discharges to the Santa Clara River from two Los Angeles County Sanitation District (LACSD) WRPs in the valley (Plant No. 26 near Bouquet Canyon and Plant No. 32 near Valencia).

Groundwater discharge is significant in the western portion of the Alluvial Aquifer, where it occurs primarily as discharge to the Santa Clara River and ET by the riparian vegetation growing along the river corridor. Groundwater discharge from the west end of the basin also occurs as subsurface outflow through the Alluvial Aquifer to the downstream Piru Basin. Other groundwater discharge mechanisms in the Santa Clarita Valley are pumping for agricultural and municipal uses and seepage to underlying permeable portions of the Saugus Formation, particularly in the eastern portion of the basin.

According to RCS (1986), groundwater present within the Alluvial Aquifer flows from east to west roughly coincident with the direction of surface water flow. Figure 2-7 displays a groundwater elevation contour map for the Alluvial Aquifer, using water level data collected during the spring of 2000.

RCS (2002) estimated that the amount of groundwater in storage in the Alluvial Aquifer has historically fluctuated between approximately 100,000 and 200,000 acre-feet. Table 2-1 summarizes the well-by-well historical annual groundwater pumping from the Alluvial Aquifer from 1980 through 2000. Historical groundwater production rates during this period averaged 29,700 acre-feet per year (AF/yr) and ranged from approximately 20,300 to 43,500 AF/yr. As discussed later in Section 2.6.2, these pumping rates are at or below pumping rates during the 1950s and 1960s, when groundwater was used primarily for agricultural purposes.

2.4.2 Saugus Formation

The Saugus Formation is recharged by two principal sources: (1) infiltration of precipitation in the exposed portions of the Saugus in the highlands surrounding the valley, and (2) seepage from the Alluvial Aquifer along the Santa Clara River and its tributaries, particularly in the eastern and central portions of the Santa Clarita Valley. Minor recharge may also occur in limited areas through irrigation seepage, where the land overlying the Saugus is cultivated. In the eastern part of the Santa Clarita Valley, the Saugus Formation is underlain by older rocks of the Castaic Formation and Mint Canyon Formation, which surround the bowl-shaped Saugus structure. Little, if any, groundwater exchange occurs between these formations and the Saugus Formation.

Discharge from the Saugus Formation occurs in part as groundwater pumping from wells as deep as 2,000 feet. Discharge from the Saugus Formation also occurs at the west end of the valley, west of the I-5 bridge, where Saugus groundwater is thought to discharge to the Alluvial Aquifer. The older and relatively impermeable rocks of the Pico Formation, that underlie and form the western boundary of the Saugus Formation, form a barrier to groundwater flow and force Saugus groundwater to discharge upwards into the Alluvial Aquifer in the area extending between two miles and six miles upstream of the county line (refer to Figure 2-1). The Saugus is not present at Blue Cut, which is approximately three miles downstream of the Saugus/Pico Formation contact and approximately one mile downstream of the county line.

Because the Saugus Formation and underlying bedrock units tilt downward from the edges of the valley to the center of the valley, the permeable sand layers within the Saugus Formation near the margins of the valley are thought to be oriented so that they are in direct connection with the overlying Alluvial Aquifer. Consequently, recharge to the Saugus Formation from the Alluvial Aquifer is thought to be greatest in these areas, particularly on the east side of the valley. Also, discharge from the Saugus Formation to the Alluvial Aquifer is thought to be enhanced where permeable sand layers of the Saugus are contacting the Alluvial Aquifer on the western end of the valley where the Saugus Formation discharges.

The available water level data, which are concentrated in localized areas, indicate that the direction of groundwater flow in the Saugus is toward the center of the valley from the highlands. The data indicate that Saugus groundwater flows toward the western end of the Santa Clara Valley where it discharges naturally into the Alluvial Aquifer. Figure 2-8 displays a groundwater elevation contour map for the Saugus Formation, using water level data collected during the fall of 2000 (RCS, 2002).

Although few wells have been drilled into the Saugus Formation at or north/northeast of the San Gabriel fault, there is evidence of limited Saugus groundwater flow across the fault. Data that suggest this limited hydraulic connection between the two fault blocks are as follows:

a. Geologic and geophysical logging of former exploratory oil wells indicates that the Saugus Formation is much thinner north of the San Gabriel Fault than south of it (see geologic cross section E-E' in RCS, 1988). Preliminary interpretations of recent geologic and geophysical logging at multi-port monitoring wells on the Whittaker-Bermite property also suggest the Sunshine Ranch Member is present at much shallower depths on the upthrown fault block, north/northeast of the fault, than on the downthrown block, south/southwest of the fault. Together, these data indicate that the older and fine-grained Sunshine Ranch Member of the Saugus Formation predominates in the area north of the fault.

b. Water level monitoring on the Whittaker-Bermite property shows groundwater elevations in multi-port monitoring well MP-3, on the upthrown side of the fault, are approximately 100 to 150 feet higher than in the other multi-port wells, which are on the downthrown side of the fault. Additionally, the three monitoring wells on the downthrown side (MP-1, MP-2, and MP-4) that have been monitored since January 2003, show responses to seasonal pumping of nearby water supply wells, whereas the monitoring well on the upthrown side (MP-3) shows no such response. (See Figure 2-3 for the locations of these wells, and Figure 2-9 for plots of groundwater elevations over time at each of these wells.)

In contrast, recent drilling, well construction, and pump testing work has indicated that the Holser Fault does not act as a barrier to groundwater flow. In early 2003, well MP-5 was installed in the Saugus Formation, located just north of the fault. This is a multi-port monitoring well that measures water levels at four discrete depths as great as 965 feet in the Saugus Formation. During March 2004, a deep Saugus production well south of the Holser Fault (VWC-205, located 4,700 feet away) was pumped for 72 hours under controlled conditions that included allowing no pumping to occur from other Saugus wells in the area.

The test was performed in part to evaluate the Holser Fault's hydraulic influence in the Saugus Formation. During pumping at VWC-205, measurable drawdown was observed at the two deepest ports at MP-5, which are situated at depths (795 feet and 965 feet) that correspond with the depths of the upper portion of the screen of VWC-205. Water level recovery monitoring conducted when VWC-205 was shut down showed rising water levels in these same two ports at MP-5. These observations are consistent with previous indications that the Holser Fault is not a significant barrier to groundwater flow in the Saugus Formation.

RCS (2002) estimated that the amount of groundwater in storage in the freshwater-portion of the Saugus Formation is approximately 1.65 million acre-feet. Historical groundwater production rates since 1980 have ranged from approximately 3,000 to nearly 15,000 AF/yr. Table 2-2 summarizes the well-by-well historical annual groundwater pumping from the Saugus Formation from 1980 through 2000.

2.5 Aquifer Physical Properties

2.5.1 Alluvium

Available groundwater elevation data and aquifer test data from Alluvial wells indicate that the Alluvial Aquifer is unconfined (i.e., is under water table conditions). Transmissivity values range from 4,700 square feet per day (ft^2/day), or 35,000 gallons per day (gpd) per foot (gpd/ft) to over 100,000 ft^2/day, or 750,000 gpd/ft. Specific yield values range from approximately 0.09 to 0.16 (RCS, 1986, 2002).

The transmissivity values are estimated (indirectly calculated) from pumping plant efficiency (specific capacity) tests conducted on a number of alluvial water wells over the years by the Southern California Edison Company. The transmissivity estimates that are calculated from these tests vary widely over short distances, and in some cases they vary substantially over time at individual wells. This is because the drawdown data that are collected during these tests are solely from the pumping wells themselves. Consequently, the use of water level drawdown data from pumping wells may provide transmissivity estimates that are strongly influenced (potentially biased low) by the condition of the well's screen or perforations and the gravel pack, particularly in the case of older wells. Nonetheless, these estimates can be useful for identifying substantial spatial variations in aquifer permeability if one selects the highest transmissivity values that are calculated for each given well (those values least impacted by well structure or well-related issues). Table 2-3 summarizes the results of the interpretations of the specific capacity data. Appendix B contains detailed tables of the testing data and the calculations of transmissivity and hydraulic conductivity, along with a comparison of these values to parameter values used in the regional model.

2.5.2 Saugus Formation

Available aquifer test data from Saugus wells located near the center of the valley where the Saugus is thickest indicate that the Saugus is semi-confined to confined (under pressure). In areas where the Saugus crops out, the uppermost saturated zones are partially unconfined because the permeable beds are folded upwards. In the highlands, the Saugus beds are

exposed at the ground surface, and in the valley the Saugus beds are in contact with the Alluvial Aquifer.

Transmissivity values range from approximately 400 to 25,000 ft^2/day (3,000 to 180,000 gpd/ft), but are typically between 5,500 and 11,000 ft^2/day (40,000 and 80,000 gpd/ft). Storativity values are on the order of 10^{-3} to 10^{-4}. These aquifer parameter values have been estimated from well performance tests and from the Saugus Formation ASR study conducted in 2000 (RCS, 2001, 2002). Table 2-4 summarizes this parameter data.

The ASR study consisted of a three-phase field test:

a. Phase 1: Injection of approximately 24 million gallons of treated drinking water into well VWC-205 at three injection rates (500, 800, and 1,100 gallons per minute [gpm]). Injection at each rate was performed for 7 days, for a total injection period of 21 days.

b. Phase 2: Recovery of 33 million gallons of water by pumping well VWC-205 at an average rate of 2,300 gpm for a period of 10 days. This pumping began 13 days after injection had ended.

c. Phase 3: Pumping 35 million gallons of water from nearby well VWC-201 at an average rate of 2,400 gpm for a period of 10 days. This pumping began 24 days after pumping had stopped at well VWC-205.

Water levels were monitored in nearby non-pumping Saugus Formation wells, including a Saugus monitoring well located 35 feet from well VWC-205, and in a newly installed Alluvial Aquifer monitoring well located 40 feet from well VWC-201. Monitoring began 22 days prior to Phase 1 and continued 3 days beyond the completion of Phase 3. Testing and monitoring details are provided in the report titled *Assessment of the Hydrogeologic Feasibility of Aquifer Storage and Recovery, Saugus Formation, Santa Clarita Valley, California* (RCS, 2001). The ASR test indicated that it is hydrogeologically feasible to inject and recover significant volumes of water from a well completed in the Saugus Formation. The data also indicated that there was no measurable effect on water levels at the alluvial monitoring well during the monitoring period.

The ASR testing data also indicated that wells VWC-201 and VWC-205 have specific capacities between 10 and 20 gpm per foot (gpm/ft), which is intermediate in value between those of nearby wells. NCWD's wells to the south have specific capacities ranging from approximately 2 to 10 gpm/ft. To the north, wells that are owned by VWC and SCWC show specific capacities ranging from approximately 25 to 50 gpm/ft. Although these data suggest the possible existence of slightly more permeable zones in the center of the basin than along the southern edge, the apparent difference may also be caused by differences in well construction and well efficiency. Analyses of the ASR test data, including numerical model calibration runs, indicate that the bulk permeability of the Saugus Formation at wells VWC-201 and VWC-205 is approximately 6.5 feet per day (ft/day) (CH2M HILL, 2001).

2.6 General Hydrology and Hydrologic Cycle

The major sources of surface water in the Santa Clarita Valley include precipitation, return flows of urban and agricultural irrigation water, and treatment plant discharges to the Santa Clara River from two WRPs which were built in 1962 and 1967. Another significant source

of surface water is the increased importing of SWP water, which is stored in Castaic Lake and Castaic Lagoon, then treated and delivered by CLWA to the retail water purveyors in the Santa Clarita Valley. In some years, DWR releases flood flows from Castaic Dam/ Lagoon into Castaic Creek during the winter or spring months. Further details regarding the operation of the SWP system and its effect on the valley's hydrology and water supply are provided in Section 2.6.3 below.

Before 1970, agriculture was the predominant land use in the valley. Agricultural water was supplied by production wells, most of which were completed in the Alluvial Aquifer. Pumping from the Alluvial Aquifer during the 1950s and early 1960s ranged from 35,000 to 44,000 AF/yr. Pumping from the Alluvial Aquifer dropped gradually from 40,000 AF/yr in 1967 to less than 30,000 AF/yr by 1983, and did not rise above 30,000 AF/yr until 1993. In the Saugus Formation, very little pumping occurred before 1960. From 1960 through 1990, total pumping from the Saugus Formation ranged from approximately 2,500 AF/yr to approximately 8,500 AF/yr. In response to statewide drought conditions, pumping from the Saugus Formation ranged between 10,000 and 15,000 AF/yr from 1991 through 1994. Saugus pumping was reduced beginning in 1995, as the drought ended and additional water supplies became available. The water management practices of the purveyors call for maximizing the use of Alluvial Aquifer and SWP water. Groundwater pumping is minimized from the Saugus Formation, except during years when SWP water allocations are below normal. Consequently, since 1995, Saugus pumping has ranged between approximately 4,000 and 8,500 AF/yr.

The remainder of this section describes the hydrology of the Santa Clarita Valley, historical hydrologic trends, and the operation of the SWP system and its influence on local hydrology and water supplies.

2.6.1 Basin Hydrology

The natural surface water features in the basin are the Santa Clara River and the tributaries that flow into it from canyons lying north and south of the river (Figure 2-10). Flows in the tributary canyons, and in the reach of the Santa Clara River that lies upstream of San Francisquito Canyon, are ephemeral, or intermittent. In these ephemeral streams, flow is limited to short-term runoff periods during storm events. The reach of the Santa Clara River west of San Francisquito Canyon is a perennially flowing river that obtains its flow from natural discharge of Alluvial Aquifer groundwater and from discharge of treated water from two WRPs. The other significant surface water feature is Castaic Lake, an SWP reservoir that lies at the north end of Castaic Creek in the northwestern portion of the valley. Like other tributaries to the Santa Clara River, the flows in Castaic Creek are ephemeral.

Figure 2-1 is a schematic diagram showing the hydrologic cycle for the Santa Clarita Valley. Table 2-5 lists the components of the hydrologic cycle for the basin. The components are classified in the table as one or more of the following:

a. Surface water recharge
b. Surface water discharge

c. Groundwater recharge
d. Groundwater discharge

These four elements of the hydrologic cycle have an important influence on the availability of surface water and groundwater resources in the basin. Time-series plots were constructed to show the relative magnitudes and trends of the various components of the hydrologic cycle in recent years. The time-series plots also illustrate the interrelationships of the hydrologic system components and their relationships to trends in groundwater levels in the Alluvial Aquifer and the Saugus Formation. The time-series analyses are discussed below.

2.6.2 Historical Hydrologic Trends

Long-term water level data have been collected over the years at purveyor-owned wells in the City of Santa Clarita and along the South Fork Santa Clara River. The data have been collected in pumping wells, and the hydrographs of these wells are steep at certain times, suggesting that some water levels are influenced by pumping at the well. Nonetheless, the data show some general trends over time and are useful for assessing general relationships between groundwater elevation trends and changes in groundwater recharge and pumping over time. Following are discussions of the observed hydrologic trends in the basin during the 50-year period from 1950 through 1999, as well as a comparison of hydrologic trends locally and in the SWP system.

2.6.2.1 Historical Trends in Rainfall

Figure 2-11 shows the annual precipitation along with the cumulative departure from the average annual precipitation since 1950. Cumulative departure refers to the cumulative amount of rainfall that is greater than or less than the long-term average rainfall. The slope of the cumulative departure plot shows the temporal trends in rainfall over successive years. The figure shows the following trends in precipitation within the Santa Clarita Valley:

a. 1950 through 1964: Dry conditions except for single wet years in 1952, 1957, 1958, and 1962 (a nearly continual decrease in cumulative departure values)

b. 1965 through 1970: Wet conditions (increase in cumulative departure values)

c. 1971 through 1977: Average to dry conditions (flat or declining cumulative departure values)

d. 1978 through 1983: Wet conditions (increase in cumulative departure values)

e. 1984 through 1991: Dry conditions (decrease in cumulative departure values)

f. 1992 through 1999: Highly variable conditions from year to year, but overall increase in cumulative departure values

2.6.2.2 Historical Trends in Alluvial Groundwater Elevations

Figure 2-12 shows trends in groundwater elevations in two Alluvial Aquifer wells located near the mouth of the South Fork Santa Clara River (VWC-N and NLF-S) and two Alluvial Aquifer wells near the western end of the basin (NLF-C5 and NLF-C7). The figure also shows trends in the following other components of the hydrologic cycle:

a. Precipitation at the Newhall-Soledad rain gage (plotted as the cumulative departure from the average precipitation)

b. Annual pumping volumes from the Alluvial Aquifer and the Saugus Formation

c. Total discharges from the WRPs to the Santa Clara River

d. Measured flow volume in the Santa Clara River during the lowest flow month of each year

Observations from Figure 2-12 are as follows:

a. Alluvial Aquifer groundwater elevations show greater variability over time within the basin interior (wells VWC-N and NLF-S) than near the basin outlet (wells NLF-C5 and NLF-C7). The range in water levels during the 50-year period of record is approximately 100 feet at the interior wells but only 20 to 30 feet in the two wells near the basin outlet.

b. The effect of reduced pumping from the Alluvial Aquifer from 1967 through 1989 was to minimize seasonal fluctuations in Alluvial Aquifer water levels near the aquifer's regional discharge zone at the western end of the valley. In this area, fluctuations in Alluvial pumping over time affected Alluvial groundwater elevations only seasonally; year-to-year variations in groundwater elevations were small. This indicates that water levels in this area are controlled less by pumping than by the discharge of Alluvial Aquifer groundwater to the Santa Clara River in the area downstream of I-5.

c. As with the western portion of the Alluvial Aquifer, the central portion of the Alluvial Aquifer has not shown long-term water level declines. During the 1950s and early 1960s, total pumping from the Alluvial Aquifer ranged between 35,000 AF/yr and 44,000 AF/yr during all but one year, and long-term (year-to-year) groundwater elevations were relatively stable (see the hydrographs for wells VWC-N, and NLF-S). When pumping from the Alluvial Aquifer decreased beginning in 1967, Alluvial groundwater elevations in this area quickly rose and have been relatively stable since about 1970, despite an increase in Alluvial Aquifer pumping during the 1990s. The hydrographs indicate that after an extended drought and high rates of pumping, Alluvial Aquifer groundwater elevations recover very quickly when normal or above normal rainfall patterns return.

d. The seasonal low flow in the Santa Clara River at the County Line gage has shown a long-term increase since the mid-1970s and, to some degree, during the late 1960s. The figure shows that this increase in flow coincides with increases in the annual discharges of treated water to the Santa Clara River from the two WRPs. Although Alluvial Aquifer pumping increased during the 1980s and 1990s, the seasonal low river flow did not show a long-term decrease during this period. The increases in WRP and Santa Clara River flows and the fluctuations in Alluvial Aquifer pumping have not caused long-term changes in Alluvial Aquifer groundwater elevations at the two wells near the basin outlet.

2.6.2.3 Historical Trends in Saugus Groundwater Elevations

Figures 2-13 and 2-14 compare groundwater elevation trends in the Saugus near the Santa Clara River, below the mouth of the South Fork Santa Clara River, with the same hydrologic

components displayed on Figure 2-12. Figure 2-13 shows this information for the period 1950 through 1999, and Figure 2-14 shows this information during the 1990s, when groundwater levels rose in the Saugus Formation. Figures 2-15 and 2-16 show the same information, but for groundwater elevations at Saugus Formation wells located farther away from the Santa Clara River, along the tributary valley containing the South Fork Santa Clara River.

In examining the four Saugus figures, it is difficult to distinguish between the influences of precipitation and pumping trends on changes in Saugus water levels. Although a slight rise in water levels may have occurred at VWC-157 and VWC-160 during the late 1960s and early 1970s, it appears to follow the trends in Saugus pumping volumes more closely than the precipitation trends. The data at VWC-157 also suggest that a succession of above-normal precipitation years (e.g., 1978 through 1983) or a year of precipitation that is substantially above normal (e.g., 1983) may have some influence on Saugus water levels. However, the data are limited, and the periods of increased precipitation tend to coincide with periods of decreased pumping, making it difficult to identify the effect of precipitation or pumping on Saugus water levels.

Another observation is that the rise in Saugus water levels in the late 1960s and early 1970s occurred despite an increase in annual pumping volumes from the Alluvial Aquifer. This indicates that Saugus water levels are controlled by precipitation and/or Saugus pumping trends, and not by Alluvial pumping trends.

2.6.2.4 Comparison of Historical Trends in Alluvial and Saugus Groundwater Elevations

Figure 2-17 compares groundwater elevations at Alluvial and Saugus wells located near each other along the Santa Clara River, just below the mouth of the South Fork Santa Clara River. At this location, the trends in Alluvial groundwater elevations show no clear relationship with the trends in Saugus groundwater elevations. A moderate overall increase in groundwater elevations is observed in both the Alluvial Aquifer and the Saugus Formation during the late 1960s. However, this similarity in the water level trends may be a coincidence arising from reduced pumping in both aquifers. During the early 1970s, water levels in Saugus well VWC-157 decreased while water levels in the nearby Alluvial Aquifer well (VWC-N) generally increased. During the 1990s, the Alluvial Aquifer groundwater elevations at well VWC-N were generally stable despite (1) increased basinwide alluvial pumping and (2) a sharp decrease, then increase, in Saugus groundwater elevations, which correlated with the trends in Saugus pumping. In summary, although there may be a relationship between Alluvial and Saugus groundwater elevations near the margins of the Santa Clara Valley, where folding of Saugus beds has brought permeable zones in contact with the alluvium, Figure 2-17 indicates that there is general independence between the Alluvial and Saugus water level trends at this location, which is near the center of the bowl-shaped Saugus Formation structure discussed in Section 2.3.3.

2.6.2.5 Historical Trends in Santa Clara River Baseflow

Hydrograph separation techniques were applied to the daily streamflow data for the County Line gage to estimate historical groundwater discharges (baseflow) to the Santa Clara River within the Santa Clarita Valley. The hydrograph separation was performed for calendar years 1953 through 1999 using the following five steps:

1. For each day, the average daily flow at the County Line gage in cubic feet per second (cfs) was converted to acre-feet of volumetric flow for the day.

2. The daily flows from Castaic Dam and at the Castaic Creek South gage (located near the mouth of Castaic Creek) were subtracted from the flow at the County Line gage. These data reflect surface water flow from tributaries. Data from the Castaic Creek South gage were used through June 1977. Beginning in July 1977, operational data for Castaic Lagoon, presented in annual reports by DWR, were used to estimate surface flow contributions from Castaic Creek.

3. The discharges of treated effluent from WRPs owned by LACSD were subtracted. This was performed for calendar years 1975 and later, as 1975 was the first year that such records were available.

4. The resulting day-to-day trends in streamflows were scrutinized for days when notably elevated flows occurred suddenly. These days were assumed to be dominated by storm flow. In some cases, the elevated flows lasted for only 2 to 5 days. In other cases, flows remained elevated for several days but showed steady declines, indicating that only the beginning of the elevated-flow period was dominated by surface runoff.

5. On all other days, storm flow was considered to be minimal or zero, and the flow values calculated for days not dominated by storm flow were assumed to represent river base-flow (that is, groundwater discharge to the river). For each month, an average flow was calculated for these non-storm days. The average flow was then converted to a total flow for the month, and the monthly flow volumes were summed to come up with the total flow for each year.

Table 2-6 presents the annual calculations from the hydrograph separation analysis. Table 2-7 presents summary statistics for the entire 47-year period that was analyzed, as well as for shorter time frames. Tables 2-8 and 2-9 show dry-year, normal-year, and wet-year statistics for the entire period of record and the shorter time frames. The shorter time frames are:

a. Calendar years 1953 through 1965, which were years of primarily agricultural water use prior to urbanization and construction of WRPs. This 13-year period was also characterized by 5 years of below-normal rainfall.

b. Calendar years 1975 through 1999, which represent 25 years of significant urbanization, including SWP water importation and WRP operations. This 25-year period was characterized by 6 years of below-normal rainfall, though rainfall volumes in general were somewhat higher (19.4 inches per year [in/yr] average, versus 15.5 in/yr average for 1953 through 1965).

c. Calendar years 1953 through 1999, but excluding 8 years (1966 through 1974) when WRP discharges occurred but were not recorded.

The daily streamflow data and the hydrograph separation technique indicate the following:

a. Summary statistics in Table 2-7 for all types of rainfall years (dry, normal, and wet) show that average groundwater discharges to the river from 1953 through 1965 were approximately 2,500 AF/yr (3.5 cfs). Groundwater discharges to the river were typically

14,000 to 22,000 AF/yr (19 to 31 cfs) from 1975 through 1999 because of more rainfall, increasing urbanization, and increasing importation of water from outside the valley.

b. For normal rainfall years only, median and average groundwater discharges to the river were approximately 12,500 and 14,300 AF/yr (17 and 20 cfs), respectively, during 1975 through 1999 (Table 2-8); approximately 8,600 and 10,000 AF/yr (12 and 14 cfs), respectively, for the entire historical record (Table 2-9); and approximately 4,000 and 3,600 AF/yr (5.5 and 5.0 cfs), respectively, from 1953 through 1965 (Table 2-8).

c. For drought years only, Table 2-8 shows that groundwater discharges to the river ranged from 400 to 4,900 AF/yr (0.5 to 7 cfs) between 1953 and 1965, and from 5,200 to 14,500 AF/yr (7 to 20 cfs) between 1975 and 1999. Table 2-8 also shows that median and average groundwater discharges to the river during drought years were 600 and 1,700 AF/yr (1 and 2 cfs), respectively, from 1953 through 1965, and typically 9,600 and 10,200 AF/yr (13 and 14 cfs), respectively, from 1975 through 1999.

2.6.3 State Water Project Operations and Hydrology

The import of SWP water is an important aspect of the local hydrologic system, particularly for water supplies. Following is a summary of the SWP system's operations and history in the Santa Clarita Valley, the amount of SWP water available to the valley, and a comparison of the timing of wet-dry rainfall cycles in the SWP system and in the Santa Clarita Valley.

2.6.3.1 State Water Project Operations and History

SWP water is transported to the Santa Clarita Valley by the California Aqueduct and is stored in Castaic Lake prior to use. Castaic Lake is one of several facilities that store SWP water that is transported to Southern California by the California Aqueduct and other aqueducts. The designated uses of Castaic Lake are recreation and storage of SWP water intended for eventual municipal use.

The stored SWP water is delivered by CLWA, which was formed in 1962 to provide a supplemental supply of imported water to the retail water purveyors in the valley. CLWA treats this water at two facilities, the Earl Schmidt Filtration Plant and the Rio Vista Water Treatment Plant, then wholesales this water to each of the retail water purveyors through an extensive transmission pipeline system. The CLWA service area covers approximately 195 square miles (124,800 acres), including the City of Santa Clarita and the surrounding unincorporated communities.

In 1966, CLWA signed a contract with DWR that established a contract amount of 41,500 acre-feet of SWP water. CLWA subsequently purchased 12,700 AF/yr from a Kern County water district during the 1980s, and recently purchased an additional 41,000 AF/yr from a member agency of the Kern County Water Agency, for a current total of 95,200 AF/yr of Table A SWP water. From 1980, when SWP water was first imported into the Santa Clarita Valley, through 1999, the total amount of SWP water delivered to the CLWA service area was approximately 298,972 acre-feet.

The SWP water is combined with local groundwater to meet both residential and non-residential interior and exterior water demands. Ultimately, a substantial portion of the municipal water supply reaches the local existing WRPs in the valley. Historically, the

treated water has been discharged from these WRPs to the Santa Clara River, where it contributes significantly to the natural surface water and groundwater flows reaching Ventura County. As discussed previously, stream gage data at the county line (USGS Gage No. 11108500)[2] demonstrate an increase in annual flow since the import of SWP water and the operation of the WRPs began, even during dry years. This is expected to continue in the future because increased urbanization will increase CLWA water deliveries, which in turn will increase inflows and outflows at LACSD's two WRPs (LACSD, 1998; CH2M HILL, 2002). However, over time, a portion (up to 17,000 AF/yr) of the future increases in flows into the WRPs will become reclaimed water that is used for outdoor irrigation, rather than being discharged into the river.

2.6.3.2 State Water Project Water Availability

The current CLWA Table A contract amount of 95,200 AF/yr of SWP water is affected by a number of factors, including hydrologic conditions; the status of SWP facilities construction; environmental requirements; and evolving policies for water resources management in the San Francisco Bay and Sacramento Delta system, which help route SWP water. While several programs may improve the reliability of SWP water imports to Southern California, such as Interim Delta Improvements and future improvements called the Full Delta Fix and South of Delta Storage, water planning efforts in the Santa Clarita Valley have conservatively assumed that future SWP water supplies will be equal to the SWP supply available under existing conditions. (See the Urban Water Management Plan 2000 [S.A. Associates et al., 2000] for details.)

The DWR has created a model of the SWP system and its allocations. The results from the model, called the DWRSIM model, are used by water agencies in the Santa Clarita Valley as planning numbers for SWP deliveries. The planning numbers for annual SWP water imports to the Santa Clarita Valley, based on CLWA's current Table A contract amount, are as follows:

a. Average years = 56,800 AF/yr (59.7 percent of the 95,200 AF/yr Table A contract amount)

b. Wet years = 66,300 AF/yr (69.6 percent of the 95,200 AF/yr Table A contract amount)

c. Multiple dry years = 37,900 AF/yr (39.8 percent of the 95,200 AF/yr Table A contract amount)

d. Multiple critical years = 19,000 AF/yr (20.0 percent of the 95,200 AF/yr Table A contract amount)

The DWRSIM model also indicates that a dry year allocation occurs, on average, once every 10 years, and that 3 consecutive years of drought occur, on average, once every 20 years. A separate DWR study (Roos, 1992) also concluded that droughts in excess of 3 years are rare in Northern California. Consequently, because of the availability of storage in the SWP

[2] Until October 1996, this gage was located just downstream of the county line at Blue Cut, an area where the valley becomes substantially narrower in width and the river begins to bend toward the southern side of the valley. See Figure 1-1 for this location. This gage continued operation through October 21, 1996, at which time it was permanently taken out of service. A new gage (USGS Gage No. 11109000) was put into service beginning on October 1, 1996 approximately 2.5 miles downstream, near Piru Junction, at the Las Brisas Bridge.

system, DWR and the water agencies in the Santa Clarita Valley use the dry year allocation of 37,900 AF/yr to plan for single dry years, and also for droughts lasting up to 3 years.

2.6.3.3 Local and State Water Project Historical Hydrology

Table 2-10 compares the historical hydrologic pattern for the SWP system with the local basin hydrology since 1944. The SWP hydrologic pattern is affected by the hydrology of Northern and Central California and is specifically mentioned in the Sacramento Four Rivers Unimpaired Runoff Index in Volume 1 of *Bulletin 160-98: The California Water Plan Update* (DWR, 1998). This index provides a general indication of SWP water delivery patterns, though it only describes runoff into the SWP system and does not account for system storage and other factors that affect actual SWP deliveries. The local hydrologic pattern shown in Table 2-10 is based on the long-term rainfall record at the Newhall-Soledad rain gage. Table 2-10 shows the following:

a. Critically low runoff years occurred in the SWP system during the 2-year period 1976 through 1977; during 1988; during the 3-year period 1990 through 1992; and again during 1994.

b. The period 1980 through 1999 shows primarily extreme hydrologic conditions (wet, dry, or critical), with moderate hydrologic conditions occurring only twice, above-normal years in 1980 and 1993.

c. Hydrologic conditions in the SWP system are often different from local hydrologic conditions. Below-normal years in the SWP system often do not coincide with local droughts, and only some critical SWP years, 1990 and 1994, coincide with local drought. Likewise, historical SWP hydrology has varied considerably during years of local droughts.

The Regional Model was calibrated to time-varying hydrologic conditions for the historical time period 1980 through 1999 (see Section 4 for more details on Regional Model calibration). Table 2-11 compares SWP hydrology, SWP allocations, and local hydrology for the period 1980 through 1999. Based on the historical cycle and the goals listed above, the hydrologic cycle relating to the availability of SWP water during that period was as follows:

a. Years 1 through 5 (water years [WY] 1980 through 1984): normal or above-normal availability

b. Year 6 (WY 1985): 1-year drought (below-normal availability)

c. Years 7 through 10 (WYs 1986 through 1989): normal or above-normal availability

d. Years 11 through 13 (WYs 1990 through 1992): 3-year drought (below-normal availability)

e. Year 14 (WY 1993): normal or above-normal availability

f. Year 15 (WY 1994): 1-year drought (below-normal availability)

g. Years 16 through 20 (WYs 1995 through 1999): normal or above-normal availability

Although SWP hydrology was dry or critical during water years 1987 through 1989, the DWRSIM model indicates that the storage volume in the SWP would have provided normal water deliveries to the Santa Clarita Valley (S.A. Associates et al., 2000).

2.6.3.4 Availability of Castaic Creek Flood Flows

As provided through agreement with DWR, CLWA has access to approximately 4,700 acre-feet of storage in Castaic Lake. This water is stormwater that flows into Castaic Lake from its upstream watersheds. Prior to completion of Castaic Dam in 1972, the LACWWD, Newhall Land & Farming Company (NLF), NCWD, and UWCD, which together constitute the Downstream Water Users, had certain rights to the stormwater flowing in Castaic Creek. On October 24, 1978, DWR entered into agreements with the Downstream Water Users regarding their rights to this water. Under the terms of the agreement, DWR would release the first 100 cfs of inflow. At the time of the agreement, flows in excess of 100 cfs were believed to be wasted to the ocean. When the local inflow to Castaic Reservoir exceeds 100 cfs, the excess of 100 cfs inflow is retained in the reservoir. Until May 1 of each year, the Downstream Water Users can receive 75 percent of this retained water by paying specified storage charges. If the Downstream Water Users request this water, it is delivered by releasing water into Castaic Lagoon, and then Castaic Creek. These releases are called Castaic Creek Flood Flows. If the Downstream Water Users do not request this water on or before May 1, any retained water becomes the property of DWR.

The allocation of stored water among the Downstream Water Users is specified in a separate agreement. Under that agreement, UWCD receives 48 percent of the delivered flood flows, while the three Santa Clarita Valley entities, NLF, NCWD, and LACWWD, together receive 52 percent.

The Castaic Creek flood flows available to the group of four Downstream Water Users averaged 15,700 AF/yr during water years 1977 through 2000. (See Table 2-12.) However, the magnitudes of these flows varied greatly from year to year, as shown on Figure 2-18. No flood flows were stored or delivered in 5 of these years, and the median flow was 2,800 AF/yr (only 18 percent of the average flow). The highest flood flow was 67,400 AF/yr, in water year 1978, and the flood flow exceeded the average flow in only 7 of these 24 years. The Regional Model simulated these historical flows, as described in Appendix C.

2.7 Previous Studies

Several prior studies have been important in developing a general understanding of the valley's geology and hydrology and in developing and calibrating the Regional Model.

2.7.1 1986 Alluvial Aquifer Study

In 1986, RCS studied the alluvial sediments in the Santa Clarita Valley to estimate the amount of groundwater in storage and the amount of recharge that occurs over the long-term, and also to evaluate the feasibility of artificially recharging these sediments (RCS, 1986). This was the first published report detailing the hydrogeologic characteristics of the Alluvial Aquifer system, water well construction and testing information, and magnitudes and changes in groundwater elevation and groundwater quality. Prior studies in the Santa Clarita Valley focused on oil development, and therefore evaluated the regional geology

with an emphasis on the subsurface geologic conditions in the hills and mountains surrounding the valley.

The 1986 study identified 650 water wells that had been drilled in the valley up to that time, all but 22 of which were drilled in the alluvium to depths less than 250 feet. The study examined geologic logs, well testing (specific capacity) records, long-term water level data, and water quality records. The study concluded that the coarse-grained, permeable sediments comprising this aquifer system are subjected to seasonal and year-to-year variations in water levels and groundwater in storage due to highly variable rainfall and streamflow patterns. In addition to describing the hydrogeology of the Alluvial Aquifer, the study mapped and identified the watersheds contributing to streamflows in the Santa Clara River and its tributaries, and estimated the amount of runoff from these watersheds that is potentially available as recharge to the Alluvial Aquifer. The study also concluded that it would be feasible to artificially recharge portions of the Alluvial Aquifer using spreading basins, primarily along the Santa Clara River in the area east of the mouth of Bouquet Canyon.

2.7.2 1988 Saugus Aquifer Study

In 1988, RCS conducted a study of the Saugus Formation that was similar in scope to the 1986 study of the Alluvial Aquifer (RCS, 1988). The scope of work included conducting 24-hour, constant discharge aquifer tests in five different Saugus Formation wells, including monitoring water level recovery rates. Six regional geologic cross-sections were also constructed from geologic and geophysical logs that had been compiled prior to this study at water wells and numerous oil wells within and around the Santa Clarita Valley.

The study concluded that the Saugus Formation is discretely layered, with groundwater production occurring from discrete sand and gravel zones that exist throughout much of the total thickness of the formation. The study also concluded that it is hydrogeologically feasible to develop additional groundwater supplies from the Saugus Formation as long as wells are properly sited and constructed, and that the groundwater-yielding capability of the Saugus Formation is likely greater south of the San Gabriel fault than north of the fault.

2.7.3 2002 Aquifer Study Update

In 2002, RCS updated the 1986 and 1988 studies with more recent data and prepared a report for both the Alluvial and Saugus Formation aquifers (RCS, 2002). As part of this work, a GIS and digital database were constructed. Field activities conducted during the study included surveying water well locations and elevations using a global positioning system (GPS) survey and water level data collected at Alluvial and Saugus wells.

The report concluded that groundwater levels in the Alluvial Aquifer and Saugus Formation have fluctuated over time, but have shown no long-term progressive declines in the amount of groundwater storage that could be considered indicative of overdraft conditions. From the long-term pumping and water level data, the report concluded that the Alluvial Aquifer can be pumped at rates between 30,000 and 40,000 AF/yr over the long-term, and suggested that pumping be between 30,000 and 35,000 AF/yr during dry years. For the Saugus Formation, the study concluded that pumping can occur at rates between 7,500 and 15,000 AF/yr on a long-term basis, with short-term increases to as much as

35,000 AF/yr during the end of a multi-year drought period. These pumping rates for the Alluvial and Saugus aquifer systems were referred to in the 2002 study as the operational yields of both aquifers.[3]

2.7.4 Newhall Ranch ASR Impact Evaluation

The Newhall Ranch Company performed analyses of potential impacts resulting from development of the proposed Newhall Ranch Specific Plan, including implementation of an ASR program. Findings were documented in the following reports:

a. *Assessment of the Hydrogeologic Feasibility of Aquifer Storage and Recovery, Saugus Formation, Santa Clarita Valley, California* (RCS, 2001).

b. *Newhall Ranch ASR Impact Evaluation* (CH2M HILL, 2001).

c. *Newhall Ranch Updated Water Resources Impact Evaluation* (CH2M HILL, 2002).

The study consisted of the following work:

a. An ASR field test was conducted by RCS in the Saugus Formation at VWC-205 in July 2000. The objective of the test was to determine the feasibility of injecting water into the Saugus Formation and later extracting the stored water. Approximately 24 million gallons of treated drinking water were injected into the well at a rate of up to 1,100 gpm for 21 days (RCS, 2001). The stored water was then recovered at a rate of 2,300 gpm for 10 days. Water levels were monitored in nearby Saugus Formation wells and in a newly installed Alluvial Aquifer monitoring well. This test demonstrated that ASR is indeed feasible in the Saugus Formation. Also, there was no measurable effect on water levels during the injection or pumping phase at the Alluvial monitoring well.

b. A pumping test was conducted by RCS in the Saugus Formation at VWC-201 to further demonstrate the limited hydraulic connection between the Saugus Formation and the Alluvial Aquifer. Well VWC-201 was pumped at 2,400 gpm for 10 days and water levels were monitored at an Alluvial Aquifer well located less than 50 feet away. Again, no response to Saugus Formation pumping was discernible at the Alluvial monitoring well.

While the ASR field test demonstrated that ASR is feasible in the Saugus Formation and that there is limited effect on the Alluvial Aquifer, it was necessary to conduct additional

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[3] The concept of operational yield was described in the RCS report as follows (RCS, 2002):

"One of the disadvantages of utilizing perennial yield as a basis for managing the pumpage from an aquifer system is that it represents a long-term average value for annual yield. There is a potential for the perennial yield value to be interpreted as a "not-to-exceed" volume, with a related potential for pumping above the perennial yield value in any give year to be incorrectly interpreted as "overdraft." A recently advanced concept intended to deal with such misinterpretations is that of operational yield. Operational yield can be defined as a fluctuating value of pumpage that may be above or below the perennial (or average) yield in any given year, and that varies as a function of the availability of other water supplies. The basic intent of the operational yield value is that it should not exceed the perennial yield of the groundwater basin over multi-year wet and dry cycles."

"The operational yield concept includes flexibility of groundwater use by allowing increased pumping during dry periods and increased recharge (direct or in-lieu) with supplemental water when it is available in wet/normal rainfall periods. The operational yield protects the aquifer by helping to assure that groundwater supplies are adequately replenished on a long-term basis from one wet/dry cycle to the next. In the Valley, historical groundwater data demonstrate that the alluvium has been, and continues to be, developed within its long-term sustainability (i.e., no continuous lowering of water levels, no notable trend toward degradation of groundwater quality, etc.)"

analysis to extrapolate the results of RCS's well field testing to a full-scale, long-term ASR operation. This additional analysis was designed to address the following questions:

a. Can 4,500 AF/yr of water be stored in the Saugus Formation for withdrawal during drought years?

b. Will storage of water in the Saugus Formation increase the rate of natural groundwater discharge to the Alluvial Aquifer and to the Santa Clara River, and, if so, by how much?

c. Will pumping Saugus Formation ASR wells during a drought period reduce groundwater elevations in the Alluvial Aquifer and, subsequently, flows in the Santa Clara River?

d. Will the ASR program result in water quality changes within the Saugus Formation, the Alluvial Aquifer, and the Santa Clara River?

e. Will the ASR program cause spreading of perchlorate that is present in the Saugus Formation?

To answer these questions, CH2M HILL prepared a numerical groundwater flow model of the western and central portions of the Santa Clarita Valley. The model simulated the groundwater flow in the Saugus Formation and the Alluvial Aquifer, accounting for the inflows and outflows to and from the Alluvial Aquifer, the Saugus Formation, and the Santa Clara River under historical conditions. The model was also used to simulate the changes in the groundwater flow system that would arise from operation of the ASR system. Of particular interest was the model's simulation of changes in subsurface groundwater flow out of the valley and changes in groundwater discharge into the Santa Clara River that would arise from ASR operations under a historical climatic cycle (wet and dry hydrologic conditions) observed during the 1980s and 1990s. These two groundwater discharge mechanisms were evaluated in detail with the model to estimate the potential changes in flow to Ventura County from the ASR system. The western limit of the model was placed at the county line, and the eastern limit of the Saugus Formation was established as the eastern limit of the model domain.

The primary findings from the analysis were:

a. On the basis of the historical timing of drought years, the proposed ASR system would provide long-term benefits to the river and the groundwater system. ASR pumping cycles would cause small (less than 1 foot) declines during drought years, and long-term operation of the ASR system would not cause long-term groundwater elevation declines in the Alluvial Aquifer, where riparian habitat is present along the river.

b. The combined influence of the proposed ASR program and the other water resource attributes[4] of Newhall Ranch would result in an overall increase in river flows over the long term.

c. The continued increase in water supplies to meet the water demands arising from a combination of growth outside Newhall Ranch and development of the Newhall Ranch

[4] Direct discharges of treated effluent into the river from the Newhall Ranch WRP, and the redistribution of irrigation demands (rates and locations) associated with conversion of water use from agricultural to municipal demands.

project would further enhance the long-term flows to the river, compared with present conditions. The occurrence of increased annual river flows during drought and nondrought years alike, compared with present conditions, is consistent with historical records, showing that continued urbanization and associated importation of water from areas outside the valley would increase river flows gradually over time.

Tables

TABLE 2-1

Annual Groundwater Pumping from the Alluvial Aquifer

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NCWD	Castaic1	244	257	253	189	251	274	295	450	520	478	444	561	515	458	496	401	385	535	166	426	118
	Castaic2	124	48	0	0	0	0	380	535	324	678	0	0	0	477	518	380	327	268	257	331	289
	Castaic3	0	108	136	172	240	301	0	0	324	0	660	532	488	0	0	0	0	0	0	0	0
	Castaic4	0	0	0	0	0	0	0	0	0	39	0	0	0	0	0	0	0	95	57	6	7
	Pinetree1	346	326	355	242	148	273	8	0	2	152	0	47	16	247	154	79	64	89	227	403	245
	Pinetree2	58	84	209	112	154	113	206	309	351	348	31	0	283	326	218	165	70	0	0	0	0
	Pinetree3	398	527	225	432	753	655	719	756	758	672	801	724	682	450	607	595	624	812	716	505	494
	Pinetree4	0	0	0	0	3	28	234	77	4	0	0	0	10	19	232	55	333	510	338	5	355
NLF	161	317	370	271	223	314	220	170	0	0	0	120	82	401	753	791	0	0	0	0	123	106
	B10	0	0	0	0	0	0	0	0	0	0	0	291	1,225	452	1,406	894	1,045	930	1,244	1,155	990
	B11	186	217	159	133	184	138	60	0	0	127	445	311	0	136	51	127	151	30	250	212	182
	B5	1,218	1,423	1,041	858	1,208	772	1,178	1,002	1,481	1,928	1,893	1,880	860	989	1,950	1,921	1,649	1,756	1,273	1,748	1,500
	B6	858	1,002	733	604	850	543	946	788	165	96	137	263	615	283	808	1,359	1,421	1,602	1,572	2,133	1,830
	B7	0	0	0	0	0	0	60	0	0	127	0	0	400	180	581	373	56	286	176	444	381
	C	723	845	618	510	717	575	660	387	418	557	338	226	756	1,024	417	1,324	715	1,126	598	716	614
	C3	196	229	168	138	195	140	254	63	130	71	134	48	197	259	582	333	397	355	378	619	531
	C4	260	304	222	183	258	196	137	25	30	7	213	225	166	12	108	150	293	483	609	819	703
	C5	459	536	392	323	455	359	328	191	198	154	147	250	428	414	394	472	676	894	628	685	588
	C6	203	237	174	143	201	166	161	103	117	77	59	123	0	0	0	360	229	226	128	154	132
	C7	575	671	491	405	570	354	195	192	318	337	339	220	427	279	625	778	582	779	779	1,167	1,001
	C8	0	0	0	0	0	0	0	0	0	0	0	0	126	254	166	199	458	432	179	236	202
	E	2,067	2,416	1,767	1,457	2,051	3,342	1,842	1,180	812	624	965	498	1,325	1,513	1,022	1,366	2,542	1,949	1,522	2,506	2,150
	E2	174	203	149	123	173	138	103	0	0	251	1,284	830	560	584	555	115	669	525	426	138	118
	E3	0	0	0	0	0	0	0	0	0	0	0	0	0	15	138	0	0	0	0	0	0
	E4	1,011	1,181	864	712	1,003	639	716	83	566	392	553	284	376	16	0	381	140	339	80	281	241
	E5	0	0	0	0	0	0	0	0	0	0	0	0	65	274	0	142	514	598	42	0	0
	E7	0	0	0	0	0	0	0	0	0	0	0	0	116	80	105	88	79	2	0	0	0
	E9	96	113	82	68	96	78	117	288	476	411	339	596	252	187	435	319	12	142	170	42	36
	G45	324	378	277	228	321	179	153	98	123	99	143	146	165	82	144	137	159	180	144	231	198
	Q	441	515	377	311	438	159	360	382	312	185	15	0	0	0	0	0	0	0	0	0	0
	R	0	0	0	0	0	0	0	205	0	0	0	0	0	0	0	0	0	0	0	0	0
	R2	159	186	136	112	158	71	104	47	0	0	0	87	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S2	293	342	250	206	290	95	0	958	0	0	503	0	0	0	0	0	0	0	0	276	237
	S3	655	765	560	461	649	327	124	0	0	0	29	37	52	99	87	109	97	55	10	3	0
	Topco 1	0	0	0	0	0	0	0	0	0	0	0	0	75	0	0	0	0	0	0	0	0
	Topco 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W4	303	354	259	213	300	138	60	1	0	300	157	252	1	0	36	5	128	29	20	3	3
	W5	553	646	472	389	548	191	315	205	308	192	0	175	0	0	0	0	0	0	0	21	18
	X3	260	304	222	183	258	508	244	314	497	308	412	215	350	135	205	222	8	108	22	112	96
SCWC	Clark	303	228	131	137	194	200	208	342	248	301	407	542	662	635	572	662	1,027	873	697	878	747
	Guida	1,058	795	457	477	677	698	221	569	158	530	676	801	978	895	942	744	1,252	1,479	1,274	1,556	853
	Honby	594	447	257	268	381	392	193	391	462	216	930	893	731	1,393	476	553	352	814	532	1,162	815
	Lost Canyon 2	1,083	814	468	489	693	714	765	923	787	588	601	404	465	692	669	773	678	792	757	946	708
	Lost Canyon 2A	0	0	0	0	0	0	0	0	0	0	293	832	1,284	1,080	1,383	1,230	1,370	1,055	973	890	998
	Methodist	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mitchell	1,189	893	515	537	761	785	444	582	485	435	264	3	474	663	564	610	598	633	482	913	439
	N.Oaks Central	488	367	211	220	313	322	304	361	153	329	525	704	701	1,403	1,313	965	851	870	1,490	1,682	1,145
	N.Oaks East	601	451	260	271	385	396	863	972	776	914	454	194	588	1,233	1,473	1,295	900	1,033	1,407	695	1,483
	N.Oaks West	643	483	278	290	412	424	874	465	842	413	275	78	634	866	972	795	663	952	934	1,894	1,663
	Sand Canyon	721	542	312	325	461	477	514	466	498	1,115	458	49	661	918	781	842	1,211	1,533	1,622	1,629	1,317
	Sierra	2,780	2,089	1,202	1,255	1,780	1,834	856	220	459	730	772	719	1,050	1,413	1,433	1,092	1,034	597	814	1,158	640
	Stadium	0	0	0	0	0	0	167	291	211	214	328	374	60	825	418	656	509	637	444	338	721

TABLE 2-1

Annual Groundwater Pumping from the Alluvial Aquifer

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
VWC	D	289	269	164	163	240	41	0	305	588	614	510	680	239	173	494	403	454	1,134	1,209	921	880
	I	214	200	122	121	177	181	95	0	91	132	73	108	1	0	1	0	0	0	0	0	0
	K2	0	0	0	0	0	0	0	0	0	0	0	982	1,134	1,708	2,089	1,155	1,305	1,076	1,489	1,420	861
	L2	9	8	5	5	7	91	0	0	0	0	0	838	526	996	1,236	818	961	308	190	532	494
	N	1,475	1,376	840	833	1,223	1,093	1,472	1,420	1,473	1,177	792	976	697	66	0	24	263	808	768	1,036	935
	N3	0	0	0	0	0	0	0	0	0	0	0	10	999	1,536	29	943	1,325	1,034	1,093	1,057	778
	N4	5	5	3	3	4	65	0	0	0	0	0	847	248	133	911	1,329	1,328	1,185	772	894	710
	Q2	440	411	251	248	367	461	838	893	512	1,483	1,398	1,783	335	548	1,348	1,126	1,385	1,462	1,655	1,288	1,387
	S6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	515
	S7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	111
	S8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	79
	T2	621	580	354	351	515	704	894	913	1,007	1,030	643	662	379	0	3	280	733	837	941	726	984
	T4	160	150	91	91	133	54	167	0	0	0	0	163	687	3	1	975	1,258	804	523	892	625
	U3	1,476	1,378	841	834	1,225	1,278	1,033	638	323	823	1,254	1,199	369	1	2	765	987	851	560	702	1,126
	U4	1,306	1,220	744	738	1,084	665	668	606	696	567	551	584	42	3	2	7	742	789	529	828	1,073
	W6	0	0	0	0	0	0	0	146	145	0	0	217	260	204	224	365	615	493	355	416	445
	W9	0	0	0	0	0	0	0	0	0	0	11	902	699	444	507	508	1,077	915	627	1,111	1,176
WHR	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,842	1,229	1,376	772	1,104	1,204	1,352	760	614	1,229	1,131	1,010
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	137	137	137	137	137	137	137	137	137	137	91	102	57	82	89	100	56	46	91	84	75
	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	17	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,021	1,021	680	762	427	612	666	748	421	340	680	627	559
	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Pumping (NCWD)		1,170	1,350	1,178	1,147	1,549	1,644	1,842	2,127	2,283	2,367	1,936	1,864	1,994	1,977	2,225	1,675	1,803	2,309	1,761	1,676	1,508
Total Pumping (NLF)		11,331	13,237	9,684	7,983	11,237	9,328	8,287	6,512	5,951	6,243	8,225	7,039	8,938	8,020	10,606	11,174	12,020	12,826	10,250	13,824	11,857
Total Pumping (SCWC)		9,460	7,109	4,091	4,269	6,057	6,242	5,409	5,582	5,079	5,785	5,983	5,593	8,288	12,016	10,996	10,217	10,445	11,268	11,426	13,741	11,529
Total Pumping (VWC)		5,995	5,597	3,415	3,387	4,975	4,633	5,167	4,921	4,835	5,826	5,232	9,951	6,615	5,815	6,847	8,698	12,433	11,696	10,711	11,823	12,179
Total Pumping (WHR)		3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	2,000	2,240	1,256	1,798	1,959	2,200	1,237	1,000	2,000	1,842	1,644
Total Pumping (All Purveyors)		30,956	30,293	21,368	19,786	26,818	24,847	23,705	22,142	21,148	23,221	23,376	26,687	27,091	29,626	32,633	33,964	37,938	39,099	36,148	42,906	38,717
Total Pumping (Others)		500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	932	953	890
Total Alluvial Aquifer Pumping		31,456	30,793	21,868	20,286	27,318	25,347	24,205	22,642	21,648	23,721	23,876	27,187	27,591	30,126	33,133	34,464	38,438	39,599	37,080	43,859	39,607

Notes:

N. = north

WHR = Wayside Honor Rancho, owned by LACWWD

All pumping volumes are listed in acre-feet.

Data source: Luhdorff and Scalmanini, Consulting Engineers. April 2003. *Santa Clarita Valley Water Report 2002.* Prepared for the Castaic Lake Water Agency, Los Angeles County Waterworks District #36, Newhall County Water District, and Valencia Water Company.

TABLE 2-2

Annual Groundwater Pumping from the Saugus Formation

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
NCWD	7	404	396	350	348	355	384	271	260	332	242	242	274	180	268	321	364	332	288	280	172	0
	4	440	449	319	385	315	369	222	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	119	227	115	138	1	0	5	1	1	0	4	1	1	0	1	0	0
	10	790	906	1,287	1,300	1,007	997	731	888	613	453	644	343	351	61	0	1	0	0	2	0	0
	11	729	870	716	754	1,159	1,278	2,209	2,371	1,265	1,280	1,252	1,034	428	730	614	522	353	81	14	0	0
	12	0	0	0	0	0	0	0	0	1,830	2,713	2,603	3,342	2,807	1,956	1,918	2,264	2,140	1,798	1,909	1,155	1,767
	13	0	0	0	0	0	0	0	0	0	0	0	0	1,393	2,053	2,246	1,623	2,045	3,001	2,351	1,295	419
NLF	156	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	266	445	426	479	374
SCWC	Saugus1	0	0	0	0	0	0	0	0	31	0	0	1,690	437	1,226	1,333	0	410	451	0	0	0
	Saugus2	0	0	0	0	0	0	0	0	32	0	40	3,091	2,476	1,675	2,530	1,726	1,766	617	0	0	0
VWC	157	635	604	529	239	387	314	581	483	1,223	1,146	635	1,005	570	436	616	403	46	80	0	0	0
	159	0	0	0	0	0	0	0	0	0	0	3	63	65	74	147	68	3	0	0	0	0
	160	1,571	1,725	368	372	467	571	846	822	1,077	1,326	839	1,325	580	920	957	585	206	401	133	95	776
	201	0	0	0	0	0	0	0	0	0	57	2,039	2,249	1,170	752	845	530	71	35	16	11	172
	205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59
Total Pumping (NCWD)		2363	2621	2672	2787	2955	3255	3548	3657	4041	4688	4746	4994	5160	5068	5103	4775	4871	5168	4557	2622	2186
Total Pumping (NLF)		20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	266	445	426	479	374
Total Pumping (SCWC)		0	0	0	0	0	0	0	0	63	0	40	4781	2913	2901	3863	1726	2176	1068	0	0	0
Total Pumping (VWC)		2206	2329	897	611	854	885	1427	1305	2300	2529	3516	4642	2385	2182	2565	1586	326	516	149	106	1007
Total Pumping (All Purveyors)		4,589	4,970	3,589	3,418	3,829	4,160	4,995	4,982	6,424	7,237	8,322	14,437	10,478	10,171	11,551	8,107	7,639	7,197	5,132	3,207	3,567
Total Pumping (Others)		0	0	501	434	620	555	490	579	504	522	539	480	446	439	474	453	547	548	423	509	513
Total Saugus Formation Pumping		4,589	4,970	4,090	3,852	4,449	4,715	5,485	5,561	6,928	7,759	8,861	14,917	10,924	10,610	12,025	8,560	8,186	7,745	5,555	3,716	4,080

Note:

All pumping volumes are listed in acre-feet.

Data source: Luhdorff and Scalmanini, 2003.

TABLE 2-3

Summary of Selected Tests and Estimated Parameter Values for the Alluvial Aquifer

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Area	Well Owner-Name	Estimated T (ft^2/day)	Model T (ft^2/day)	Estimated K (ft/day)	Model K (ft/day)	Model Zone
West of I-5	NLF-B5	80,000 to 150,000	60,500	750 to 1,400	550	C1c
	NLF-B6	40,000 to 70,000	60,500	100 to 600	550	C1c
	NLF-C4	20,000 to 35,000	60,500	100 to 300	550	C1b
	NLF-E5	40,000 to 55,000	71,500	100 to 400	550	C1a
Between I-5 and Soledad Canyon	VWC-I	30,000 to 45,000	22,500	250 to 350	375	B1b2
	VWC-K2	60,000 to 90,000	54,375	400 to 600	375	B1a
	VWC-N3	55,000 to 80,000	79,750	375 to 550	550	B1a
	VWC-N4	75,000 to 100,000	54,375	500 to 750	375	B1a
	VWC-Q2	35,000 to 50,000	79,750	250 to 350	550	B1a
	NLF-R2	50,000 to 105,000	22,050	600 to 1,200	245	B1a
	NLF-S	35,000 to 85,000	54,375	250 to 600	375	B1a
	NLF-S3	35,000 to 55,000	79,750	250 to 350	550	B1a
Lower Soledad Canyon	SCWC-Stadium	85,000 to 150,000	63,250	950 to 1,650	550	A1e1
	VWC-U3	90,000 to 170,000	63,250	800 to 1,500	550	A1e2
	VWC-U4	65,000 to 135,000	63,250	550 to 1,200	550	A1e2
	SCWC-Honby	30,000 to 50,000	49,500	300 to 550	550	A1d1
Upper Soledad Canyon	SCWC-N.Oaks West	35,000 to 55,000	49,500	400 to 600	550	A1d4
	SCWC-N.Oaks Central	85,000 to 120,000	49,500	900 to 1,350	550	A1d4
	SCWC-N.Oaks East	50,000 to 70,000	49,500	500 to 800	550	A1d4
	SCWC-Sierra	80,000 to 145,000	49,500	900 to 1,600	550	A1c1
	SCWC-Mitchell	40,000 to 60,000	49,500	450 to 650	550	A1c2
	SCWC-Sand Canyon	35,000 to 125,000	36,000	400 to 1,400	400	A1c3
	NCWD-Pinetree 3 and 4	30,000 to 50,000	31,500	300 to 550	350	A1b1
Castaic Valley	VWC-D	30,000 to 50,000	35,000	300 to 500	350	C2b
	NLF-E	60,000 to 90,000	35,000	600 to 900	350	C2b
	NLF-E2	45,000 to 100,000	35,000	450 to 1,000	350	C2b
	WHR Wellfield	40,000 to 75,000	35,000	400 to 750	350	C2a and C2b
Northern Canyons	NLF-W4	25,000 to 35,000	10,500	250 to 350	105	B4c
	VWC-W6	25,000 to 40,000	10,500	250 to 400	105	B4c
	SCWC-Guida	45,000 to 65,000	12,600	500 to 700	140	B2b
	SCWC-Clark	55,000 to 80,000	22,050	650 to 900	245	B2c

Note:

See Section 4.3.1 for a discussion of the model zones.

TABLE 2-4

Summary of Selected Tests and Estimated Parameter Values for the Saugus Formation

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Well Owner-Name	Date	Type of Test	Pumping or Injection Rates (gpm)	Length of Test (minutes)	Well Monitored	Specific Capacity (gpm/ft)[a]	T (gpd/ft)	T (ft^2/day)	Storativity	Model Zone
NCWD-7	03/04/1987	Drawdown	341	1,440	NCWD-7	3.1	26,400	3,530		F
NCWD-7	03/05/1987	Recovery		1,500	NCWD-7		23,300	3,110		F
NCWD-10	03/11/1987	Drawdown	364	1,440	NCWD-10	8.3	28,500	3,810		F
NCWD-10	03/11/1987	Drawdown	364	1,440	NCWD-12 (160 feet away)		57,700	7,710	9.10E-04	F
NCWD-10	03/11/1987	Recovery		1,480	NCWD-10		38,400	5,130		F
NCWD-10	03/11/1987	Recovery		1,490	NCWD-12 (160 feet away)		61,500	8,220	7.60E-04	F
NCWD-9	03/17/1987	Drawdown	256	1,460	NCWD-9	1.9	3,700	490		A
NCWD-9	03/17/1987	Recovery		1,500	NCWD-9		3,000	400		A
VWC-160	03/24/1987	Drawdown	2,562	720	VWC-160	49.8	163,000	21,790		E
VWC-160	03/24/1987	Recovery		850	VWC-160		182,000	24,330		E
VWC-205	07/01/2000	Injection + Recovery	500-800-1,100	30,240 / 12,960	VWC-205M (40 feet)	12.2	41,370	5,530	8.88E-04	E
VWC-205	07/02/2000	Injection + Recovery	500-800-1,100	30,240 / 12,960	VWC-201 (2,400 feet)		50,450	6,740	7.56E-04	E
VWC-205	07/03/2000	Injection + Recovery	500-800-1,100	30,240 / 12,960	VWC-157 (4,100 feet)		54,880	7,340	6.45E-04	E
VWC-205	08/01/2000	Pumping	2,273	12,960 / 14,440	VWC-205	18.7				E
VWC-205	08/01/2000	Pumping + Recovery	2,273	12,960 / 14,440	VWC-205M (40 feet)	18.7	78,910	10,550	9.48E-04	E
VWC-205	08/02/2000	Pumping + Recovery	2,273	12,960 / 14,440	VWC-201 (2,400 feet)		76,410	10,220	1.37E-03	E
VWC-205	08/03/2000	Pumping + Recovery	2,273	12,960 / 14,440	VWC-157 (4,100 feet)		65,880	8,810	1.36E-03	E
VWC-201	10/01/2000	Pumping	2,439	14,440 / 2,880	VWC-201	30	65,100	8,700	5.75E-04	E
VWC -201	10/01/2000	Pumping + Recovery	2,439	14,440 / 2,880	VWC-157 (1,900 feet)		44,230	5,910	1.17E-03	E
VWC-201	10/01/2000	Pumping + Recovery	2,439	14,440 / 2,880	VWC-205M (2,360 feet)		57,210	7,650	8.49E-04	E
VWC-201	10/01/2000	Pumping + Recovery	2,439	14,440 / 2,880	VWC-205 (2,400 feet)		47,890	6,400	6.75E-04	E
SCWC-Saugus1	07/01/1988	Pumping	2,941	1,440	SCWC-Saugus1	30.2	69,300	9,260		E
SCWC-Saugus1	07/01/1988	Recovery	2,941	480	SCWC-Saugus1		59,700	7,980		E
SCWC-Saugus2	09/01/1988	Pumping	2,531	2,880	SCWC-Saugus2	24.1	53,500	7,150		E
SCWC-Saugus2	09/01/1988	Recovery	2,531	1,320	SCWC-Saugus2		55,700	7,450		E
SCWC-Saugus2	09/01/1988	Pumping	2,531	2,880	SCWC-Saugus1		71,500	9,560	3.60E-04	E
SCWC-Saugus3	09/01/1988	Recovery	2,531	1,320	SCWC-Saugus1		60,200	8,050		E

[a]gpm/ft of drawdown

Note:

See Section 4.3.1 for a discussion of the model zones.

Data source: RCS, 2002 (except model zones)

TABLE 2-5
Recharge and Discharge Components of the Hydrologic Cycle in the Upper Santa Clara River Basin
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Recharge	Discharge
Surface Water	
Direct runoff of precipitation	Evapotranspiration of precipitation
Precipitation runoff from upstream watershed areas	Santa Clara River flow to Ventura County
Castaic Lake/Lagoon releases into Castaic Creek	Streamflow seepage to the Alluvial Aquifer
WRP discharges into the Santa Clara River	Evapotranspiration of applied irrigation water
Groundwater seepage into the Santa Clara River	
Irrigation return flows (agricultural and urban)	
Groundwater	
Infiltration of precipitation	Pumping
Infiltration of outdoor applied water (agricultural and urban)	Evapotranspiration of Alluvial Aquifer groundwater by riparian vegetation
Alluvial Aquifer subsurface inflow (Castaic Dam)	Alluvial Aquifer subsurface outflow (western study area boundary)
Streamflow seepage to Alluvial aquifer	Groundwater seepage into the Santa Clara River

Notes:

The two sources of water for agricultural and municipal water uses in the basin are groundwater pumping and imported water from the SWP.

Because SWP water is stored in Castaic Lake, which is outside the limits of the Alluvial and Saugus aquifers, it is not considered to be a part of the valley's hydrologic cycle while it is still in storage. However, SWP water that is land-applied or that is discharged from a WRP qualifies as a component of the hydrologic cycle. In addition, subsurface groundwater flow occurs into the Santa Clarita Valley beneath Castaic Creek due to water seepage beneath Castaic Dam.

TABLE 2-6
Estimated Annual Groundwater Discharge to the Santa Clara River
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Total Gaged Flow at Mouth of Castaic Creek (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-Storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)[a]	Local Rainfall Condition[b]
1953	0	4,986	4,943	0	4,943	4.88	Dry
1954	977	7,316	5,554	0	5,554	15.82	Normal
1955	134	4,795	4,122	0	4,122	13.91	Normal
1956	311	5,429	3,803	0	3,803	14.21	Normal
1957	559	4,782	2,410	0	2,410	22.85	Wet
1958	21,204	38,756	5,344	0	5,344	23.14	Wet
1959	473	3,277	2,206	0	2,206	9.81	Dry
1960	1	777	586	0	586	11.64	Dry
1961	79	804	410	0	410	8.82	Dry
1962	5,101	28,460	2,433	0	2,433	21.22	Wet
1963	32	1,884	1,058	0	1,058	12.79	Normal
1964	1	1,030	646	0	646	10.09	Dry
1965	3,702	35,614	996	0	996	32.28	Wet
1966	5,780	10,101	2,332	No data	---	14.57	Normal
1967	27,819	40,480	8,640	No data	---	23.23	Wet
1968	4,381	7,216	3,895	No data	---	6.90	Dry
1969	46,461	258,660	29,395	No data	---	32.42	Wet
1970	6,597	31,066	14,924	No data	---	23.19	Wet
1971	2,310	15,883	10,843	No data	---	13.75	Normal
1972	2,205	16,027	12,975	No data	---	4.15	Dry
1973	12,671	52,631	26,115	No data	---	19.79	Wet
1974	7,288	25,265	11,918	No data	---	18.04	Wet
1975	2,027	14,770	10,806	5,534	5,272	10.92	Dry
1976	156	10,162	9,754	6,095	3,659	14.02	Normal
1977	1,380	13,454	9,359	6,004	3,355	20.87	Wet
1978	35,378	129,187	60,955	6,982	53,973	42.17	Wet
1979	13,626	57,594	42,448	7,397	35,051	21.47	Wet
1980	16,785	95,211	57,593	7,372	50,221	27.00	Wet
1981	6,519	24,232	21,172	7,949	13,223	13.42	Normal
1982	9,102	36,488	32,531	8,436	24,095	20.20	Wet
1983	67,058	131,236	55,878	9,420	46,458	39.07	Wet
1984	13,787	39,279	35,215	9,512	25,703	12.86	Normal
1985	2,619	24,466	24,089	9,614	14,475	8.37	Dry
1986	4,945	48,024	31,327	10,822	20,505	18.02	Wet

TABLE 2-6
Estimated Annual Groundwater Discharge to the Santa Clara River
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Total Gaged Flow at Mouth of Castaic Creek (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-Storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)[a]	Local Rainfall Condition[b]
1987	911	26,198	23,663	11,844	11,819	14.45	Normal
1988	2,415	36,611	24,934	12,363	12,571	16.92	Wet
1989	Unavailable	24,799	23,453	13,560	9,893	7.56	Dry
1990	0	23,472	21,772	14,006	7,766	6.98	Dry
1991	65	34,901	18,702	14,108	4,594	17.21	Wet
1992	4,450	68,577	23,601	15,703	7,898	32.03	Wet
1993	7,725	152,783	65,054	17,179	47,875	32.72	Wet
1994	Unavailable	32,039	31,239	16,946	14,293	10.27	Dry
1995	5,611	82,409	51,001	17,824	33,177	29.15	Wet
1996	5,632	47,930	36,366	16,831	19,535	15.88	Normal
1997	9,885	36,780	27,521	15,778	11,743	13.35	Normal
1998	47,803	205,139	81,744	17,695	64,049	30.73	Wet
1999	5,830	32,382	27,176	17,847	9,329	8.96	Dry

[a]Annual rainfall values are based on monthly records for this gage, as reported by NCDC and LADPW.

[b]Defined from median rainfall (14.57 in/yr) from 1950 through 2000. Dry year < 12.38 in/yr (85 percent of median rainfall). Wet year > 16.75 in/yr (115 percent of median rainfall).

TABLE 2-7
Statistics on Annual Groundwater Discharge to the Santa Clara River, All Years
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

	Castaic Creek Flows (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-Storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)
Statistics for 1953 through 1965						
Minimum	0	777	410	0	410	4.88
Median	311	4,795	2,410	0	2,410	13.91
Average	2,506	10,608	2,655	0	2,655	15.50
Maximum	21,204	38,756	5,554	0	5,554	32.28
Statistics for 1975 through 1999						
Minimum	0	10,162	9,359	5,534	3,355	6.98
Median	5,632	36,611	27,521	11,844	14,293	16.92
Average	11,466	57,125	33,894	11,873	22,021	19.38
Maximum	67,058	205,139	81,744	17,847	64,049	42.17
Statistics for 1953 through 1965 and 1975 through 1999						
Minimum	0	777	410	5,534	410	4.88
Median	3,161	30,250	22,613	11,844	8,613	15.14
Average	8,230	41,211	23,207	11,873	15,396	18.05
Maximum	67,058	205,139	81,744	17,847	64,049	42.17
Statistics for 1953 through 1999						
Minimum	0	777	410	5,534	410	4.15
Median	4,450	28,460	18,702	11,844	8,613	15.82
Average	9,151	43,050	21,338	11,873	15,396	17.92
Maximum	67,058	258,660	81,744	17,847	64,049	42.17

TABLE 2-8
Statistics on Annual Groundwater Discharge to the Santa Clara River, 1953 through 1965 vs. 1975 through 1999
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

	Castaic Creek Flows (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-Storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)
Statistics for 5 Dry Years during 1953 through 1965						
Minimum	0	777	410	0	410	4.88
Median	1	1,030	646	0	646	9.81
Average	111	2,175	1,758	0	1,758	9.05
Maximum	473	4,986	4,943	0	4,943	11.64
Statistics for 4 Normal Years during 1953 through 1965						
Minimum	32	1,884	1,058	0	1,058	12.79
Median	222	5,112	3,963	0	3,963	14.06
Average	363	4,856	3,634	0	3,634	14.18
Maximum	977	7,316	5,554	0	5,554	15.82
Statistics for 4 Wet Years during 1953 through 1965						
Minimum	559	4,782	996	0	996	21.22
Median	4,402	32,037	2,421	0	2,421	23.00
Average	7,641	26,903	2,796	0	2,796	24.87
Maximum	21,204	38,756	5,344	0	5,344	32.28
Statistics for 6 Dry Years during 1975 through 1999						
Minimum	0	14,770	10,806	5,534	5,272	6.98
Median	2,323	24,633	23,771	13,783	9,611	8.67
Average	2,619	25,322	23,089	12,918	10,171	8.84
Maximum	5,830	32,382	31,239	17,847	14,475	10.92
Statistics for 6 Normal Years during 1975 through 1999						
Minimum	156	10,162	9,754	6,095	3,659	12.86
Median	6,076	31,489	25,592	10,678	12,521	13.72
Average	6,148	30,763	25,615	11,335	14,280	14.00
Maximum	13,787	47,930	36,366	16,831	25,703	15.88
Statistics for 13 Wet Years during 1975 through 1999						
Minimum	65	13,454	9,359	6,004	3,355	16.92
Median	7,725	68,577	42,448	10,822	33,177	27.00
Average	16,642	83,970	42,702	11,639	31,063	26.74
Maximum	67,058	205,139	81,744	17,824	64,049	42.17

TABLE 2-9
Statistics on Annual Groundwater Discharge to the Santa Clara River, Including and Excluding 1966 through 1974
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

	Castaic Creek Flows (acre-feet)	Total Gaged Flow at County Line (acre-feet)	Estimated Non-Storm Flow at County Line (acre-feet)	WRP Flows (acre-feet)	Estimated Groundwater Discharge to River (acre-feet)	Rainfall at Newhall-Soledad Gage (inches)
Statistics for 13 Dry Years during 1953 through 1999						
Minimum	0	777	410	5,534	410	4.15
Median	473	14,770	10,806	13,783	5,272	8.82
Average	1,601	14,311	12,630	12,918	6,347	8.41
Maximum	5,830	32,382	31,239	17,847	14,475	11.64
Statistics for 12 Normal Years during 1953 through 1999						
Minimum	0	7,316	2,433	6,004	2,433	13.35
Median	5,101	26,198	21,172	11,844	11,743	16.92
Average	5,238	27,883	16,963	10,788	8,671	17.10
Maximum	12,671	52,631	27,521	15,778	13,223	21.22
Statistics for 22 Wet Years during 1953 through 1999						
Minimum	65	4,782	996	6,004	996	16.92
Median	7,507	44,252	25,525	10,822	20,505	23.17
Average	15,807	73,060	29,877	11,639	24,412	25.62
Maximum	67,058	258,660	81,744	17,824	64,049	42.17
Statistics for 11 Dry Years during 1953 through 1965 and 1975 through 1999						
Minimum	0	777	410	5,534	410	4.88
Median	79	14,770	10,806	13,783	5,272	8.96
Average	1,226	14,800	13,393	12,918	6,347	8.94
Maximum	5,830	32,382	31,239	17,847	14,475	11.64
Statistics for 10 Normal Years during 1953 through 1965 and 1975 through 1999						
Minimum	32	1,884	1,058	6,095	1,058	12.79
Median	944	17,197	15,463	10,678	8,649	13.97
Average	3,834	20,400	16,823	11,335	10,022	14.07
Maximum	13,787	47,930	36,366	16,831	25,703	15.88
Statistics for 17 Wet Years during 1953 through 1965 and 1975 through 1999						
Minimum	65	4,782	996	6,004	996	16.92
Median	5,611	48,024	31,327	10,822	20,505	23.14
Average	14,524	70,543	33,312	11,639	24,412	26.30
Maximum	67,058	205,139	81,744	17,824	64,049	42.17

TABLE 2-10
Historical Hydrology in Northern California and the Santa Clarita Valley
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Northern California Hydrology[a]	Local Hydrology[b]
1944	Dry	Wet
1945	Below Normal	Normal
1946	Below Normal	Wet
1947	Dry	Dry
1948	Below Normal	Dry
1949	Dry	Dry
1950	Below Normal	Dry
1951	Above Normal	Normal
1952	Wet	Wet
1953	Wet	Dry
1954	Above Normal	Normal
1955	Dry	Normal
1956	Wet	Normal
1957	Above Normal	Wet
1958	Wet	Wet
1959	Below Normal	Dry
1960	Dry	Dry
1961	Dry	Dry
1962	Below Normal	Wet
1963	Wet	Normal
1964	Dry	Dry
1965	Wet	Wet
1966	Below Normal	Normal
1967	Wet	Wet
1968	Below Normal	Dry
1969	Wet	Wet
1970	Wet	Wet
1971	Wet	Normal
1972	Below Normal	Dry
1973	Above Normal	Wet
1974	Wet	Wet
1975	Wet	Dry
1976	Critical	Normal
1977	Critical	Wet
1978	Above Normal	Wet
1979	Below Normal	Wet

TABLE 2-10
Historical Hydrology in Northern California and the Santa Clarita Valley
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Northern California Hydrology[a]	Local Hydrology[b]
1980	Above Normal	Wet
1981	Dry	Normal
1982	Wet	Wet
1983	Wet	Wet
1984	Wet	Normal
1985	Dry	Dry
1986	Wet	Wet
1987	Dry	Normal
1988	Critical	Wet
1989	Dry	Dry
1990	Critical	Dry
1991	Critical	Wet
1992	Critical	Wet
1993	Above Normal	Wet
1994	Critical	Dry
1995	Wet	Wet
1996	Wet	Normal
1997	Wet	Normal
1998	Wet	Wet
1999	Wet	Dry

[a]Defined by water year, using the Sacramento Four Rivers Index (Figure 3-4 in Bulletin 160-98; DWR, 1998): wet = wettest; critical = driest.

[b]Defined from median rainfall (14.57 in/yr) from 1950 through 2000. Dry year < 12.38 in/yr (85 percent of median rainfall). Wet year > 16.75 in/yr (115 percent of median rainfall).

TABLE 2-11
Historical State Water Project Allocations and Local Hydrology, 1980 through 1999
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	SWP Hydrology[a]	SWP Allocations[b]	Local Hydrology[c]
1980	Above Normal	100%	Wet
1981	Dry	100%	Normal
1982	Wet	100%	Wet
1983	Wet	100%	Wet
1984	Wet	100%	Normal
1985	Dry	100%	Dry
1986	Wet	100%	Wet
1987	Dry	85%	Normal
1988	Critical	100%	Wet
1989	Dry	100%	Dry
1990	Critical	100%	Dry
1991	Critical	30%	Wet
1992	Critical	45%	Wet
1993	Above Normal	85%	Wet
1994	Critical	50%	Dry
1995	Wet	80%	Wet
1996	Wet	100%	Normal
1997	Wet	100%	Normal
1998	Wet	100%	Wet
1999	Wet	100%	Dry

[a]Defined by water year, using the Sacramento Four Rivers Index (Figure 3-4 in Bulletin 160-98; DWR, 1998): wet = wettest; critical = driest. SWP = State Water Project.

[b]Contractor demands, and therefore requests for water, have been increasing through the time period shown. Water allocations in the earlier part of the time period reflect that 100% of contractor requests were met. Those requests were for amounts of water less than the full SWP contract (i.e., Table A) amounts totaling 4.1 million acre-feet. In recent years, SWP contractors have been requesting nearly all of the 4.1 million acre-foot Table A amount contained in the 29 SWP contracts.

[c]Defined from median rainfall (14.57 in/yr) from 1950 through 2000. Dry year < 12.38 in/yr (85 percent of median rainfall). Wet year > 16.75 in/yr (115 percent of median rainfall).

TABLE 2-12

Castaic Creek Flood Flows

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Water Year[a]	Natural Inflows	Flood Flows 10/1 - 4/30	Late Flood Flows[b] 5/1 - 9/30	Total Flood Flows	Net Flood Flows[c]	Flood Flow Shares				Total NLF/LACWWD/ NCWD Flood Flows
						UWCD 48%	NLF 44.867%	LACWWD 4.471%	NCWD 2.662%	
1977	752	0	0	0	0	0	0	0	0	0
1978	92,780	89,592	325	89,917	67,438	32,370	30,257	3,015	1,795	35,068
1979	31,440	19,641	0	19,641	14,731	7,071	6,609	659	392	7,660
1980	54,158	47,625	101	47,726	35,794	17,181	16,060	1,600	953	18,613
1981	6,186	628	0	628	471	226	211	21	13	245
1982	8,930	3,544	0	3,544	2,658	1,276	1,193	119	71	1,382
1983	78,010	74,287	3,020	77,307	57,981	27,831	26,014	2,592	1,543	30,150
1984	10,582	2,106	0	2,106	1,580	758	709	71	42	822
1985	3,361	0	0	0	0	0	0	0	0	0
1986	20,005	13,867	0	13,867	10,400	4,992	4,666	465	277	5,408
1987	1,212	0	0	0	0	0	0	0	0	0
1988	4,401	807	0	807	605	290	272	27	16	315
1989	919	0	0	0	0	0	0	0	0	0
1990	540	0	0	0	0	0	0	0	0	0
1991	6,719	4,375	0	4,375	3,281	1,575	1,472	147	87	1,706
1992	29,409	22,631	0	22,631	16,973	8,147	7,615	759	452	8,826
1993	81,264	77,722	0	77,722	58,291	27,980	26,154	2,606	1,552	30,312
1994	6,424	502	0	502	377	181	169	17	10	196
1995	57,914	53,363	0	53,363	40,022	19,211	17,957	1,789	1,065	20,812
1996	7,105	1,654	0	1,654	1,241	596	557	55	33	645
1997	9,028	3,918	0	3,918	2,938	1,410	1,318	131	78	1,528
1998	68,846	66,597	11,639	78,236	58,677	28,165	26,327	2,623	1,562	30,512
1999	7,793	238	0	238	179	86	80	8	5	93
2000	7,212	4,118	0	4,118	3,088	1,482	1,386	138	82	1,606
Totals	**594,990**	**487,215**	**15,085**	**502,300**	**376,725**	**180,828**	**169,025**	**16,843**	**10,028**	**195,897**
Average	**24,791**	**20,301**	**629**	**20,929**	**15,697**	**7,535**	**7,043**	**702**	**418**	**8,162**
Median	**8,362**	**3,731**	**0**	**3,731**	**2,798**	**1,343**	**1,255**	**125**	**74**	**1,455**

[a]A water year is from October 1 to September 30, but the flood flow water is generally available only from October 1 through April 30.

[b]Late flood flows are from May 1 through September 30.

[c]Net flood flows are 75% of total flood flows.

Note:

All flows are listed in acre-feet.

Figures

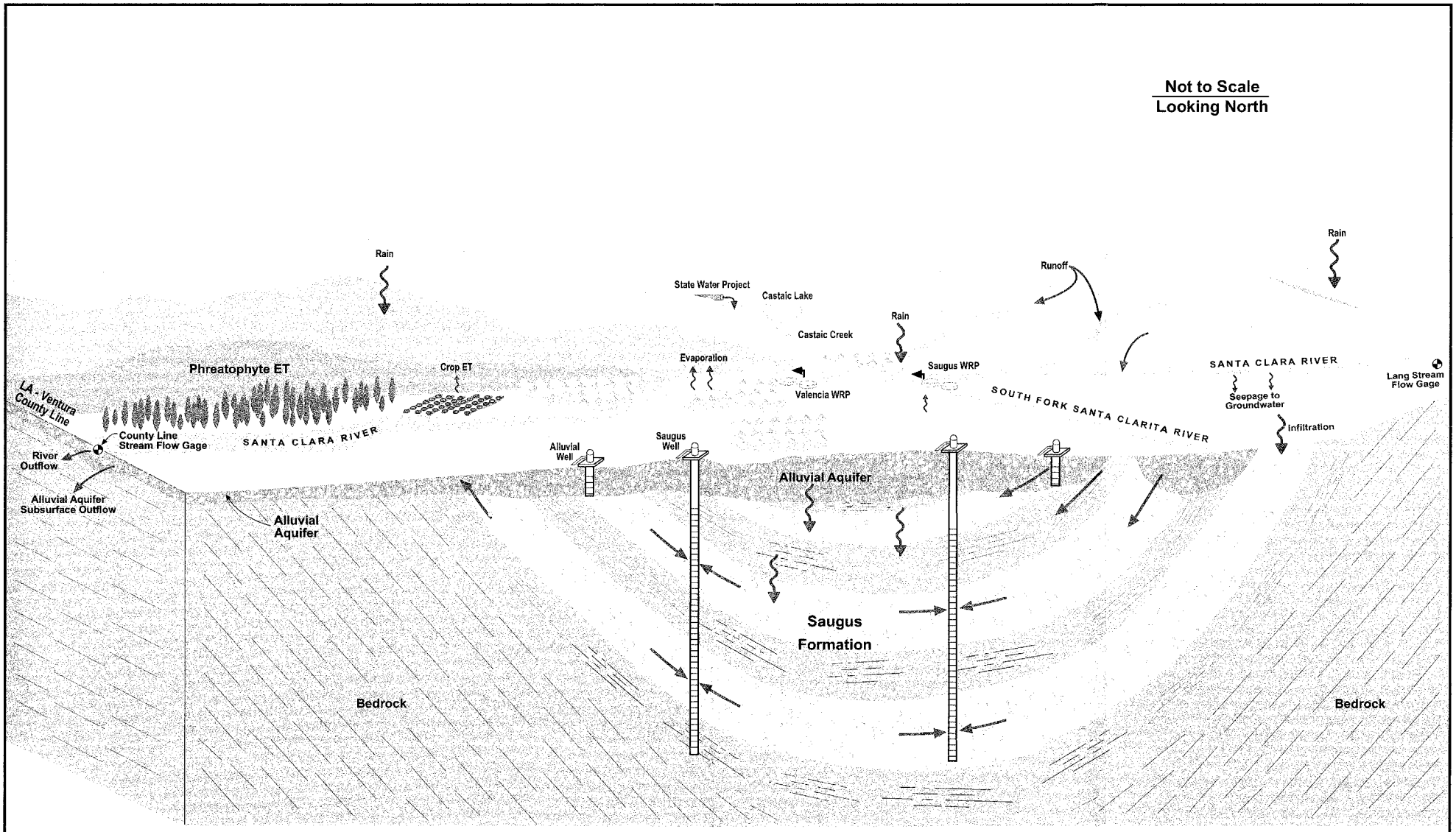

FIGURE 2-1
SANTA CLARITA VALLEY HYDROLOGY
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

E012004006RDD .01 (1/20/04)

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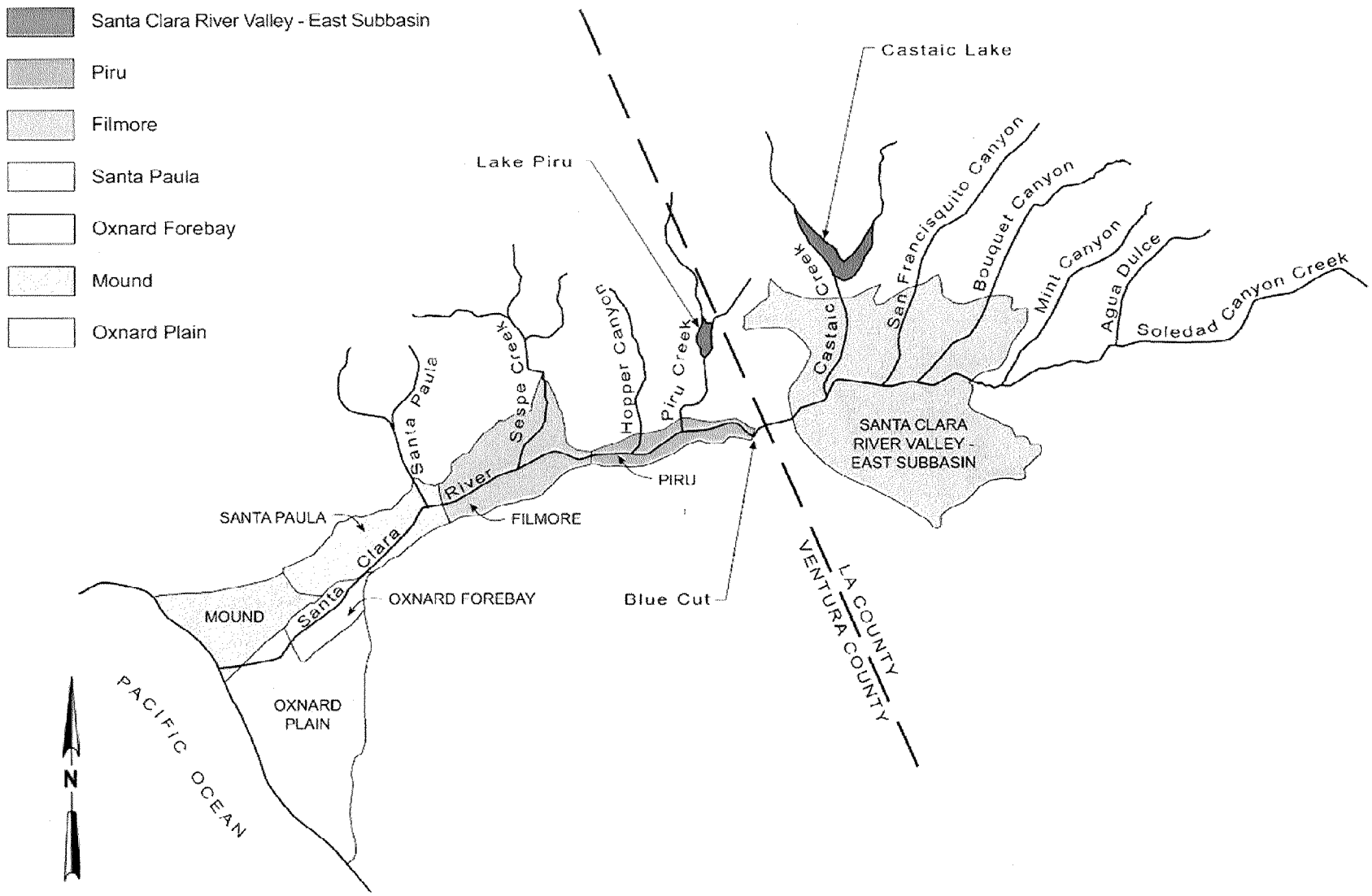

FIGURE 2-2
GROUNDWATER BASINS IN THE SANTA CLARA RIVER DRAINAGE
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

178973-001.FH9

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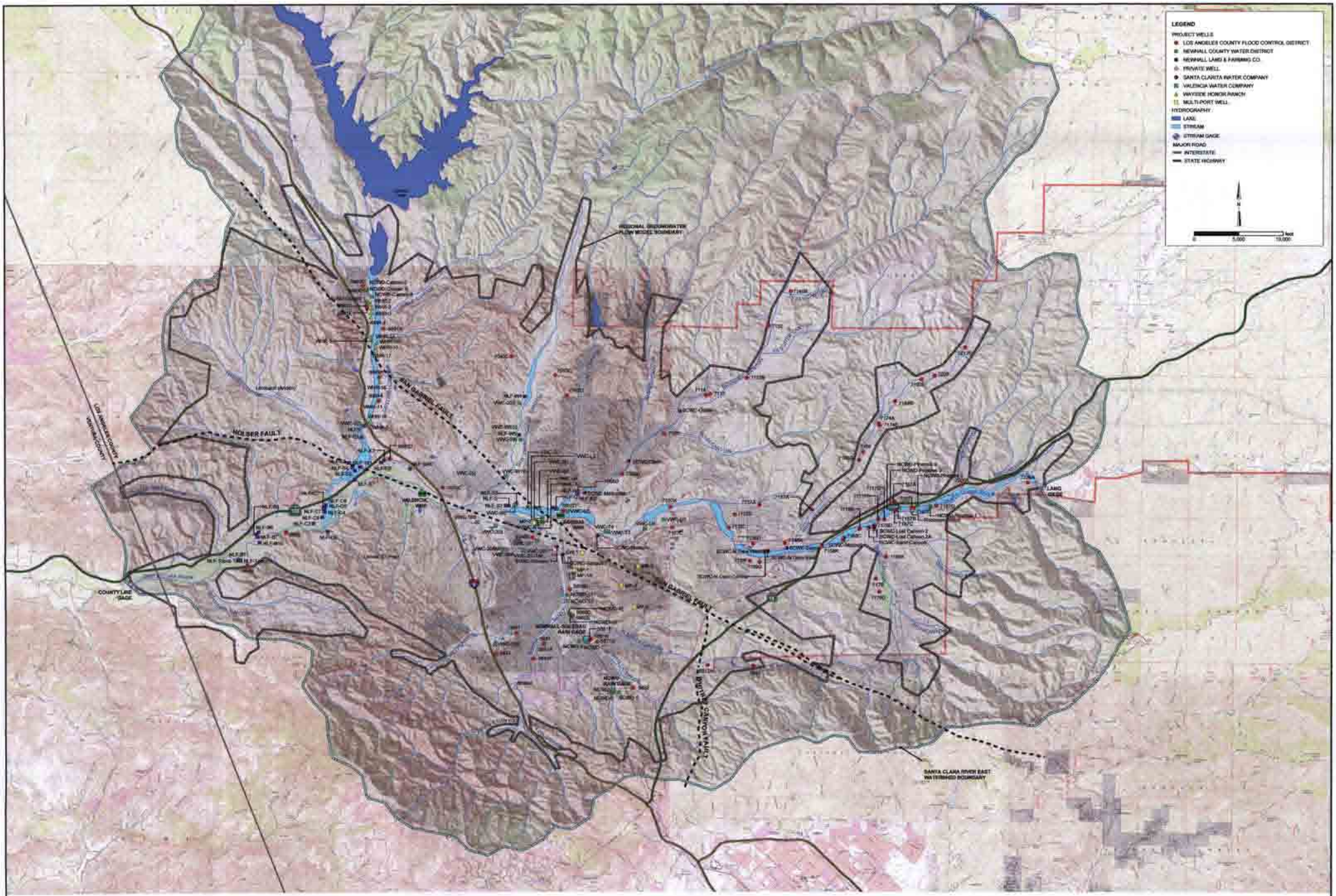

FIGURE 2-3
WELL LOCATIONS AND FEATURES MAP
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

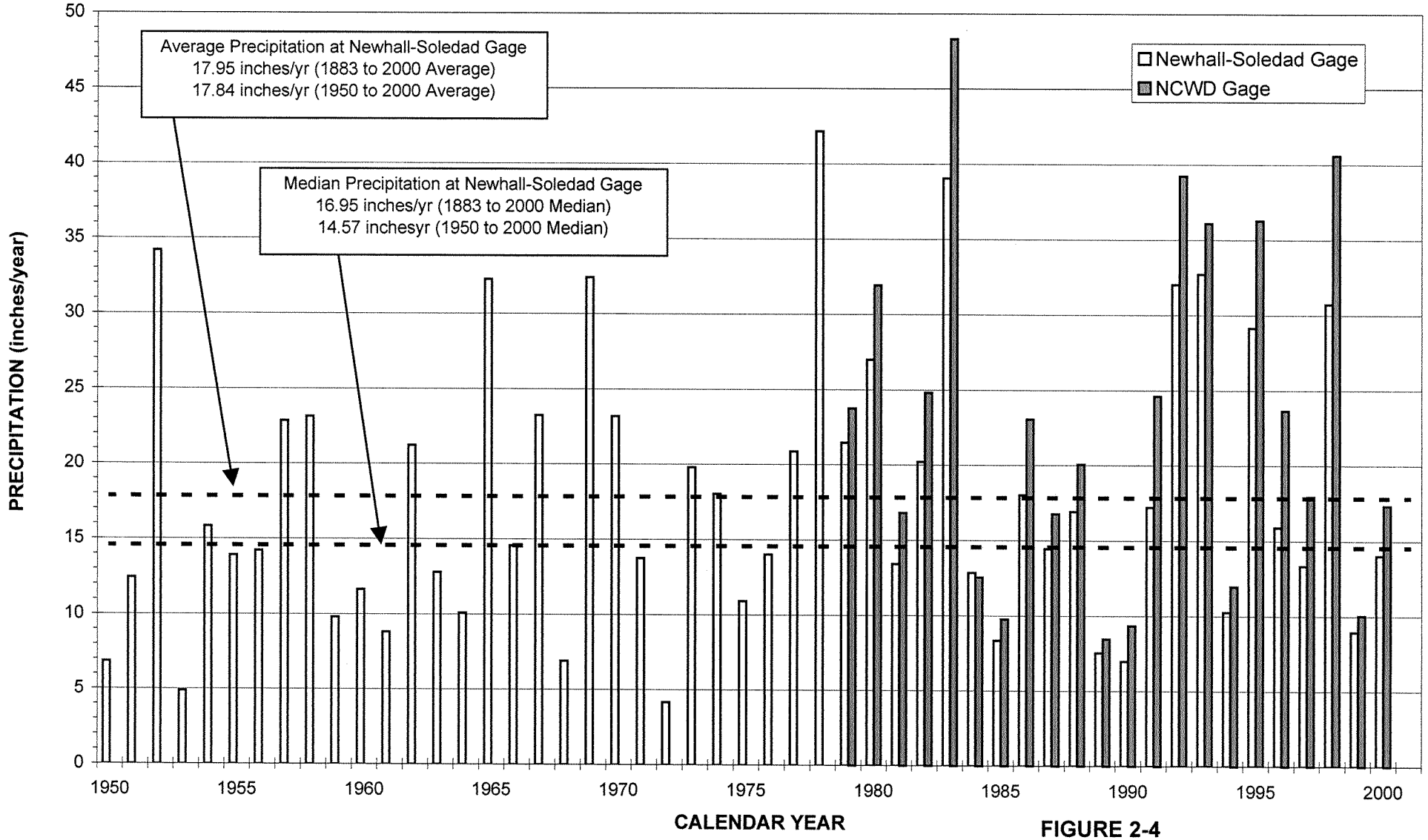

FIGURE 2-4
ANNUAL PRECIPITATION AT THE NEWHALL-SOLEDAD AND NCWD RAIN GAGES SINCE 1950
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

178973-401.xls\Fig 2-4

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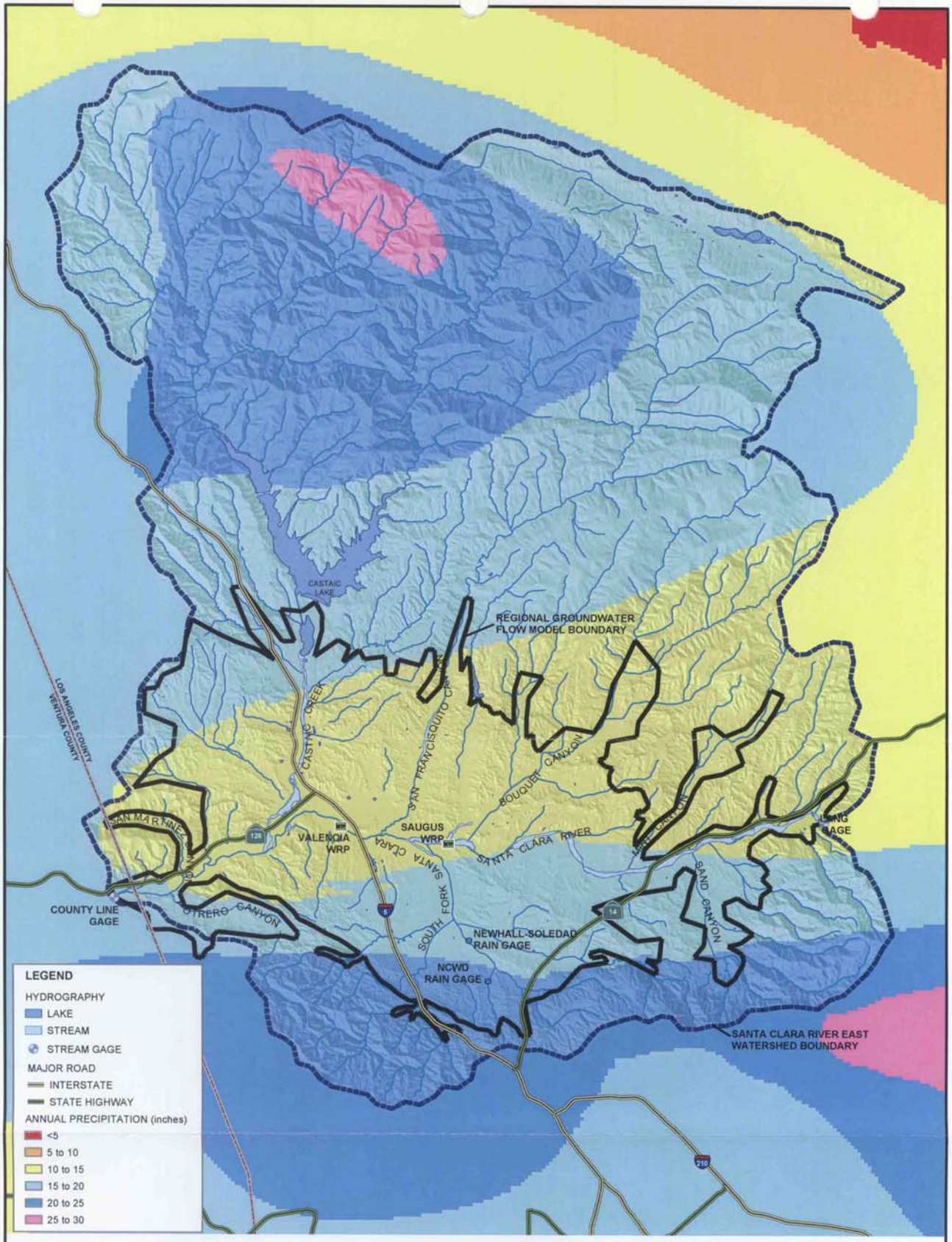

SOURCE: SEE THE INTERNET SITE HTTP://GIS.CA.GOV/META.EPL?OID=286 FOR MORE INFORMATION.

FIGURE 2-5
ISOHYETAL MAP SHOWING AVERAGE ANNUAL PRECIPITATION PATTERN FROM 1900 TO 1960
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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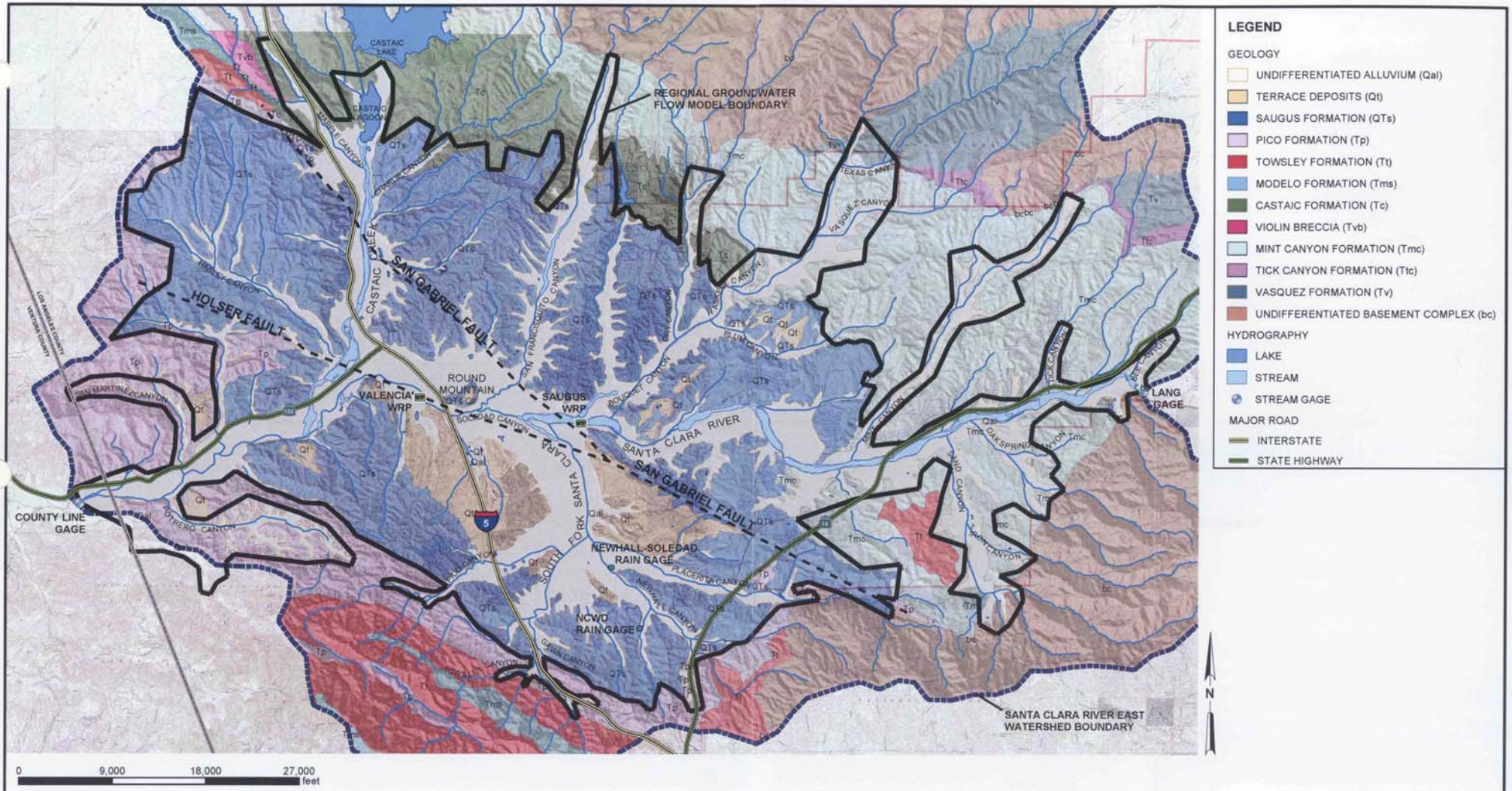
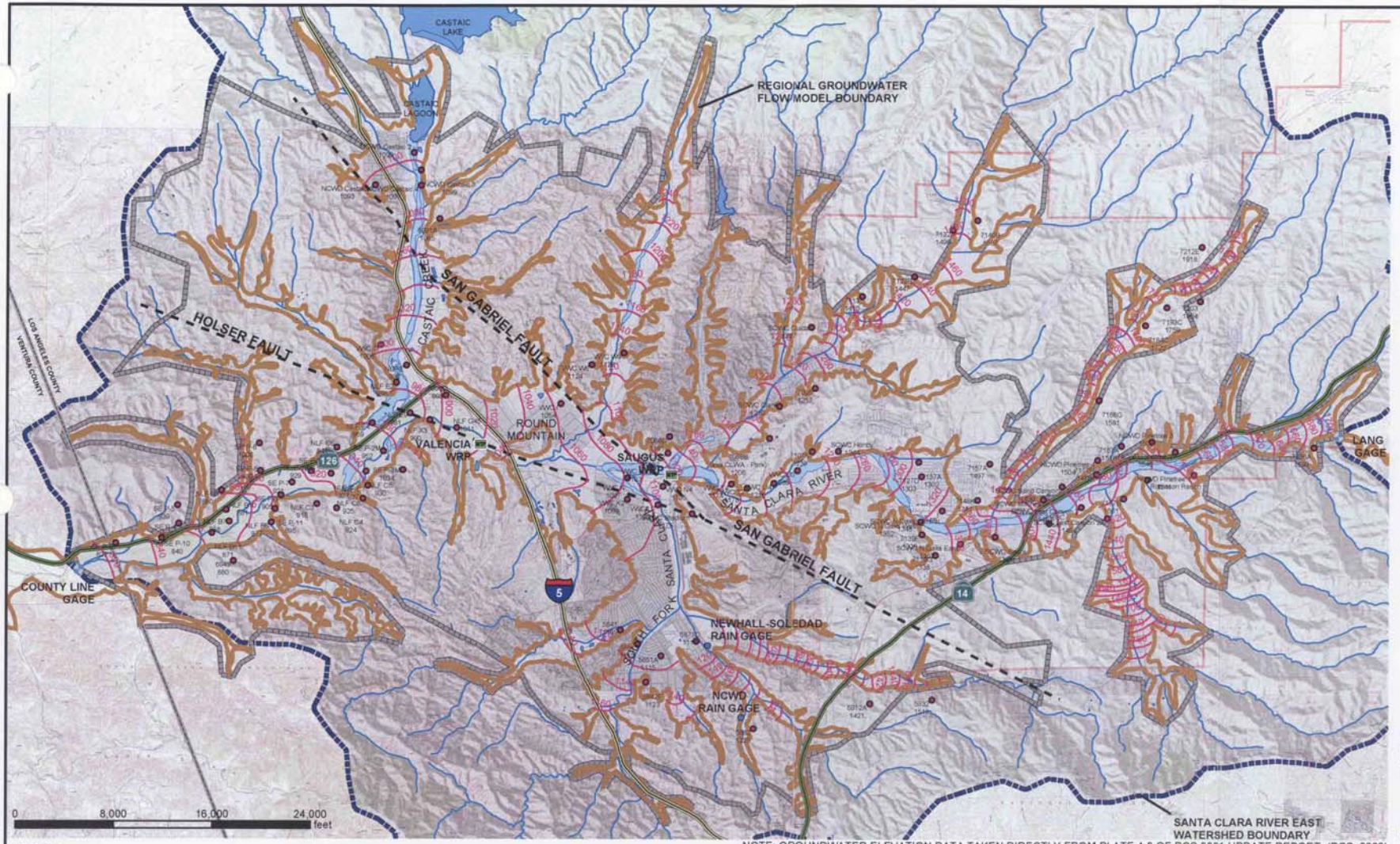


FIGURE 2-6
BASIN GEOLOGIC MAP
REGIONAL GROUNDWATER FLOW MODEL REPORT FOR THE SANTA CLARITA VALLEY SANTA CLARITA, CALIFORNIA

RDD \\RDD31002540\SANTACLARITA\MXD\FIG0206.MXD FIG02-06.PDF 04/04/2004 17:54:36



NOTE: GROUNDWATER ELEVATION DATA TAKEN DIRECTLY FROM PLATE 4-3 OF RCS 2001 UPDATE REPORT. (RCS, 2002)

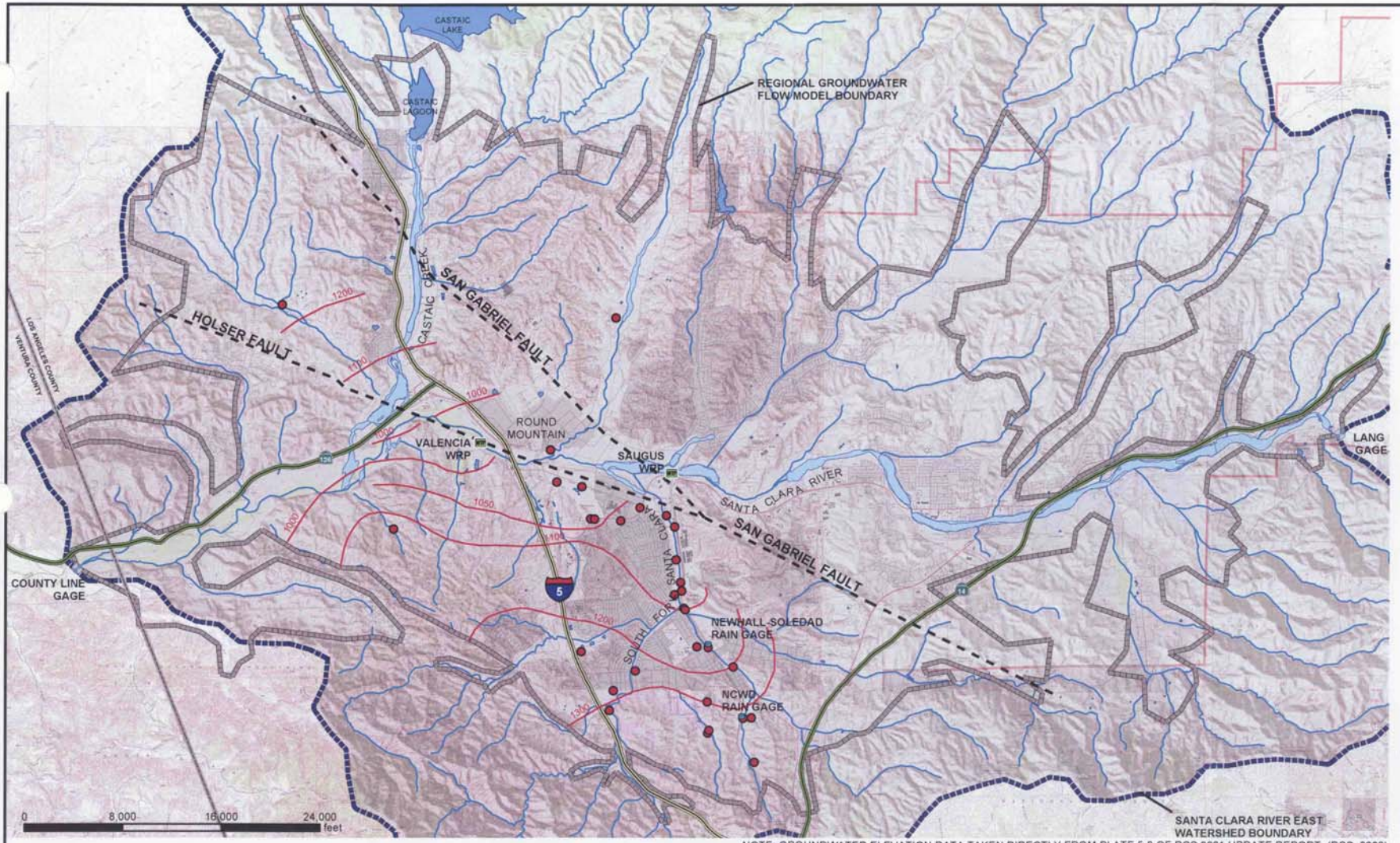
LEGEND

- CONTOUR OF SPRING 2000 GROUNDWATER ELEVATION (feet MSL)
- SPRING 2000 GROUNDWATER ELEVATION (feet MSL)
- EXTENT OF ALLUVIUM
- LAKE
- STREAM

FIGURE 2-7
GROUNDWATER ELEVATION CONTOUR MAP FOR THE ALLUVIUM – SPRING 2000
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG0207.MXD FIG02-07.PDF 02/02/2004 12:27:27



NOTE: GROUNDWATER ELEVATION DATA TAKEN DIRECTLY FROM PLATE 5-3 OF RCS 2001 UPDATE REPORT. (RCS, 2002)

LEGEND

- SAUGUS WELLS
- CONTOUR OF FALL 2000 GR0UNDWATER ELEVATION (feet MSL)
- LAKE
- STREAM

FIGURE 2-8
GROUNDWATER ELEVATION CONTOUR MAP FOR THE SAUGUS – FALL 2000
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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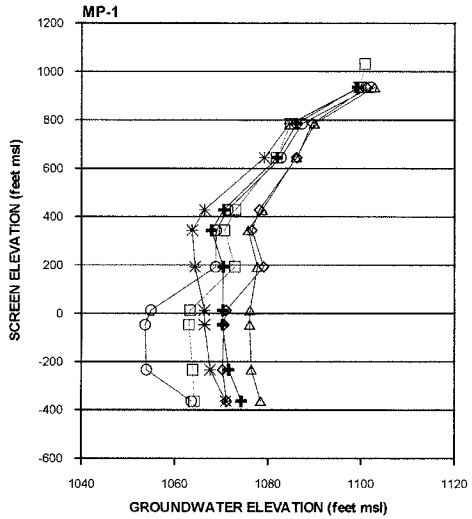
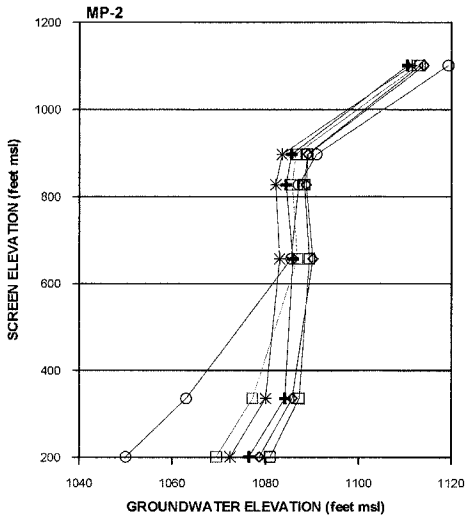
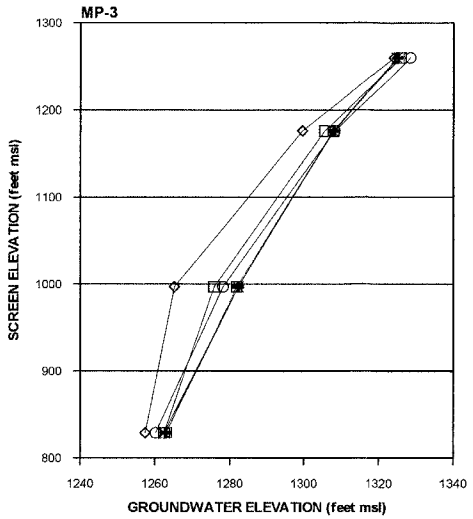
RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG0208.MXD FIG02-08.PDF 02/04/2004 10:57:48





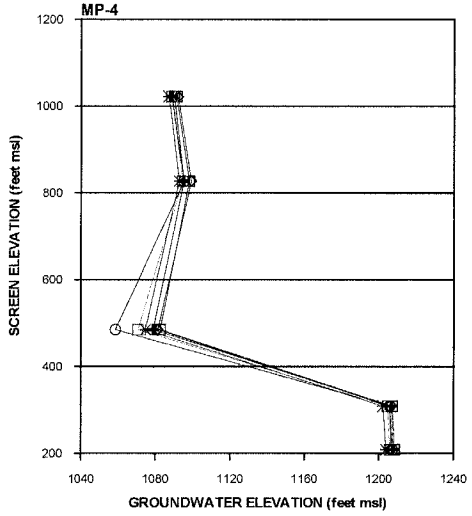


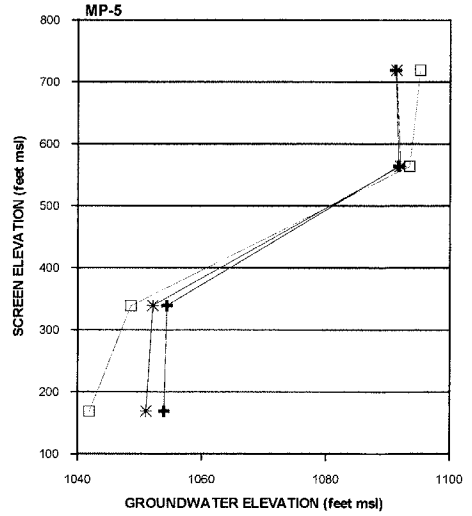
LEGEND

- JANUARY to FEBRUARY 2003
- APRIL 2003
- JULY 2003
- OCTOBER 2003
- NOVEMBER 2003
- DECEMBER 2003

NOTE:

1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.





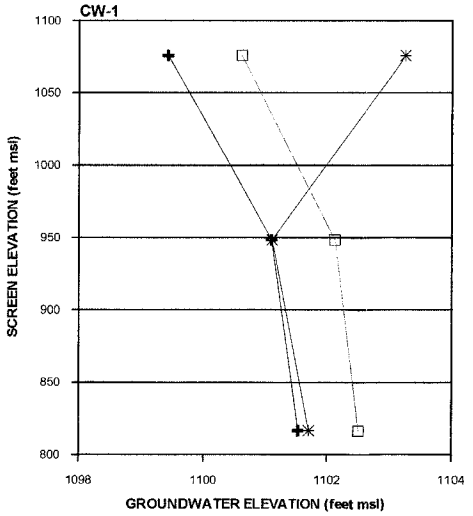


FIGURE 2-9
GROUNDWATER ELEVATIONS IN MULTI-PORT SAUGUS FORMATION MONITORING WELLS JANUARY 2003 THROUGH DECEMBER 2003
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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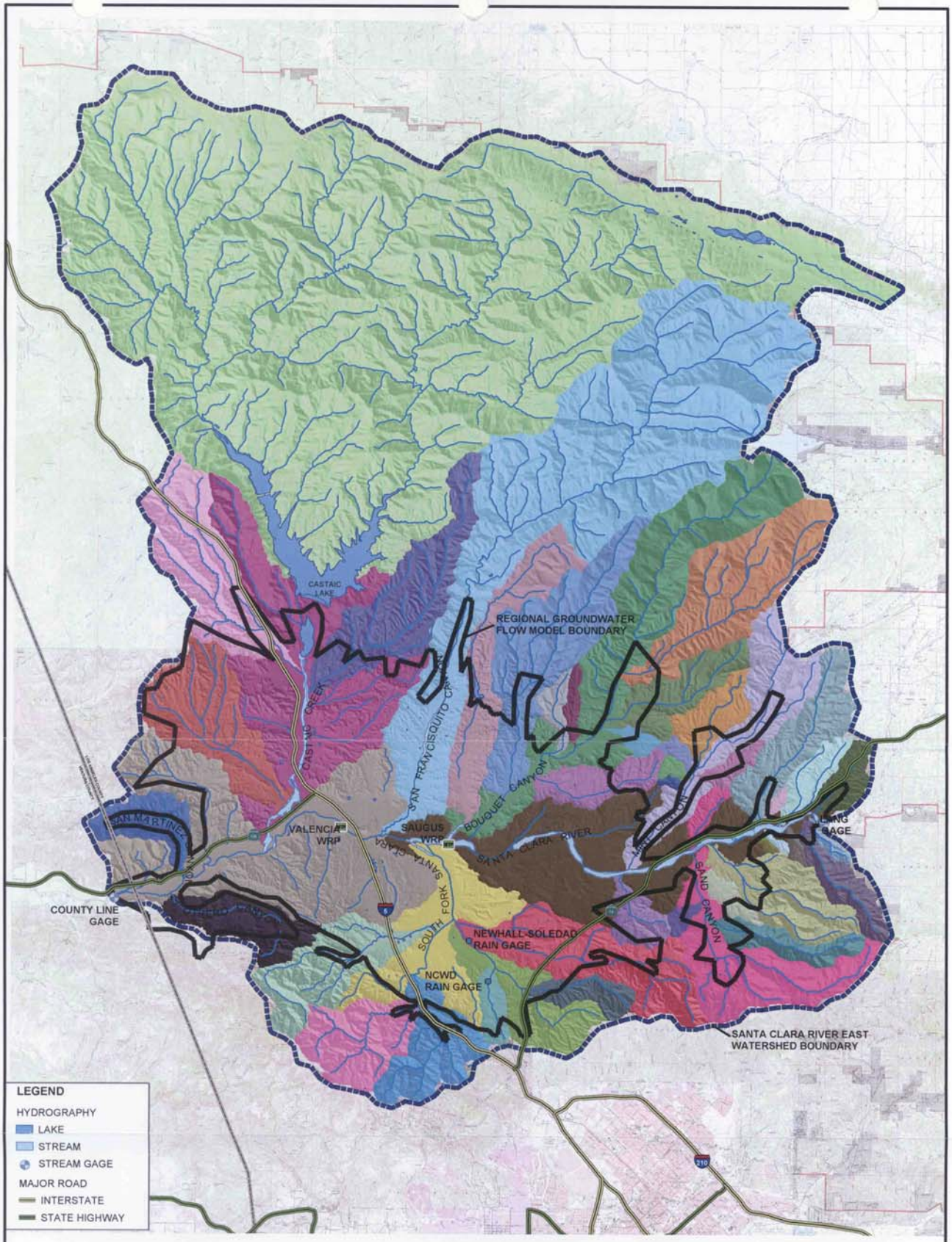

FIGURE 2-10
SUBWATERSHEDS WITHIN THE SANTA CLARA VALLEY EAST WATERSHED
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

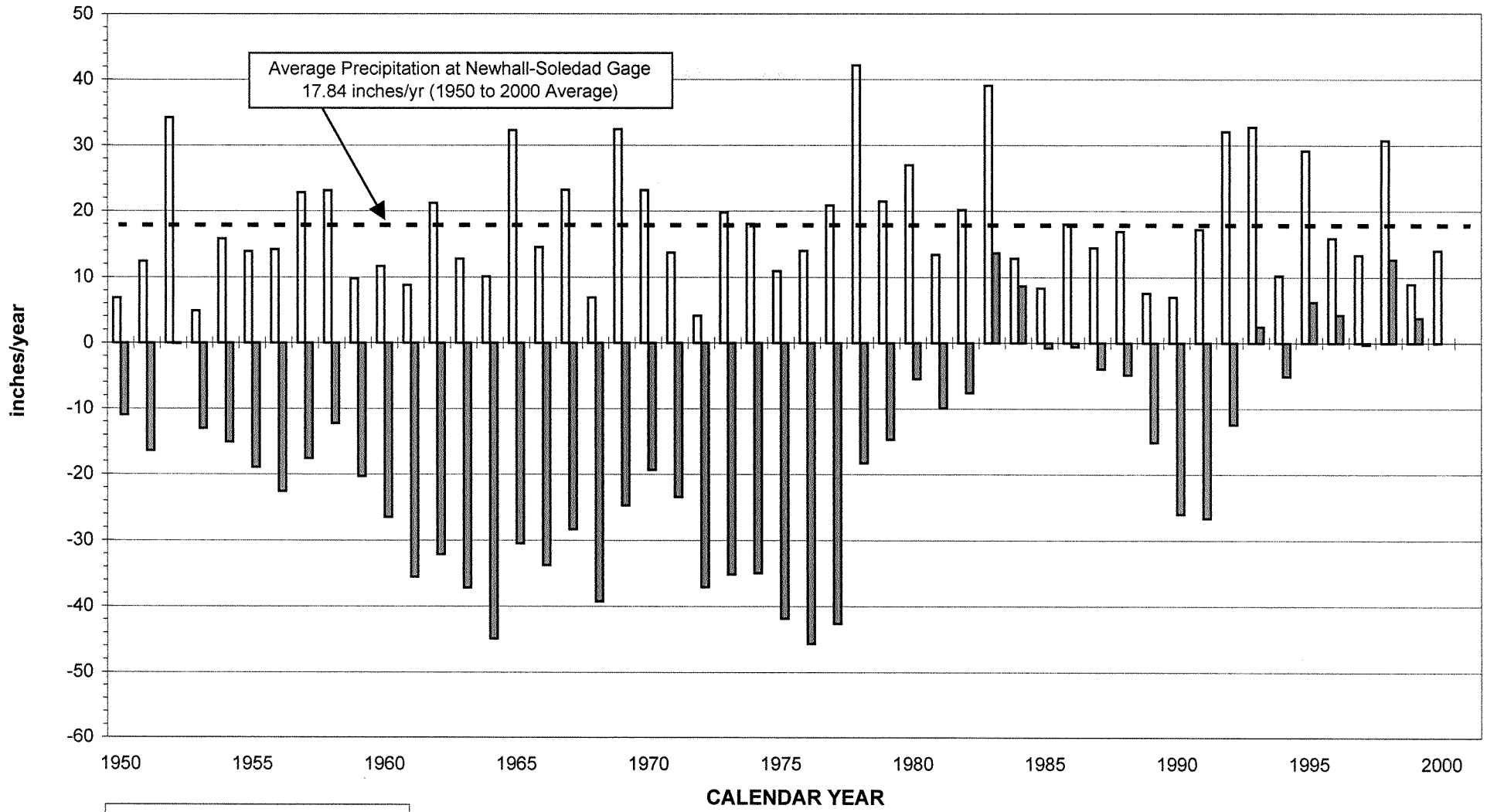

FIGURE 2-11
ANNUAL PRECIPITATION AND CUMULATIVE DEPARTURE FROM THE 1950 TO 2000 AVERAGE AT THE NEWHALL-SOLEDAD RAIN GAGE SINCE 1950
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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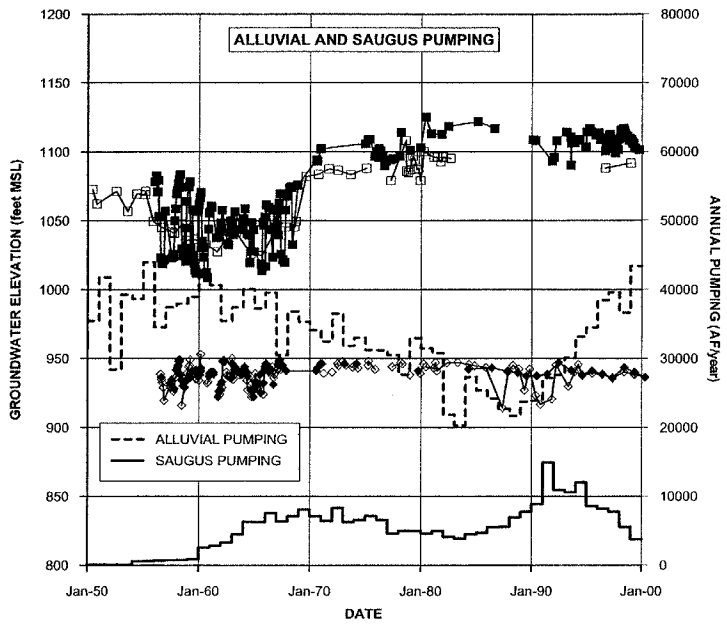
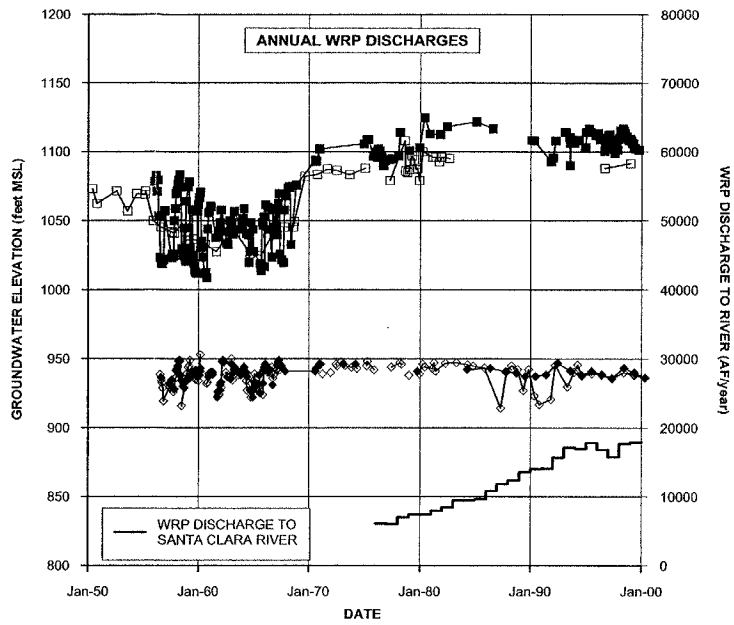
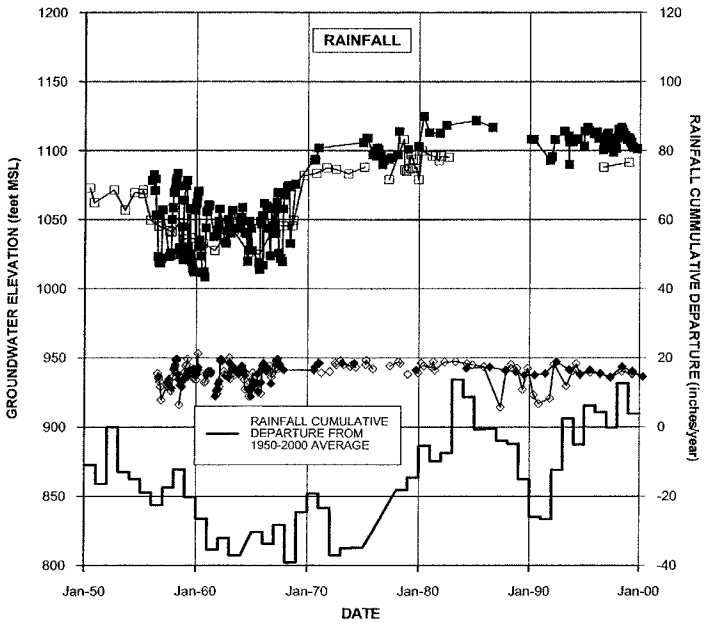
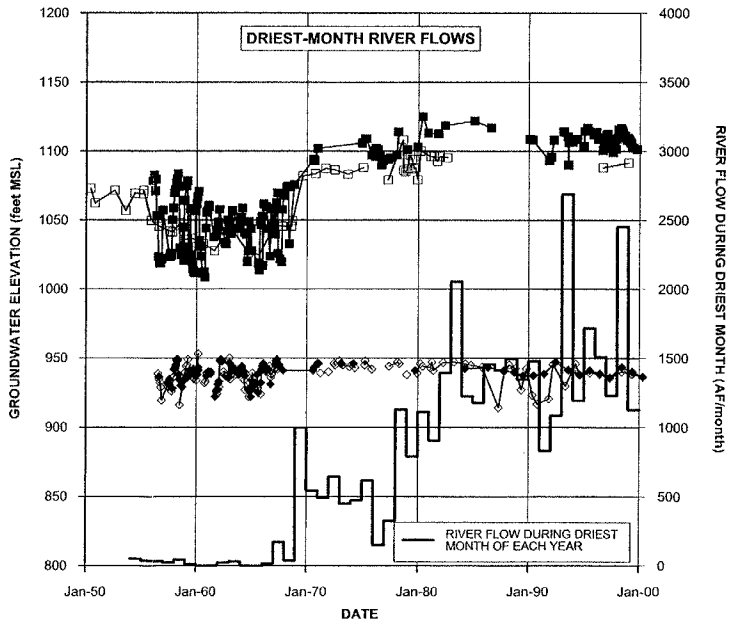








LEGEND

- ELEVATION OF GROUNDWATER IN VWC-N
- ELEVATION OF GROUNDWATER IN NLF-S
- ELEVATION OF GROUNDWATER IN NLF-C5
- ELEVATION OF GROUNDWATER IN NLF-C7

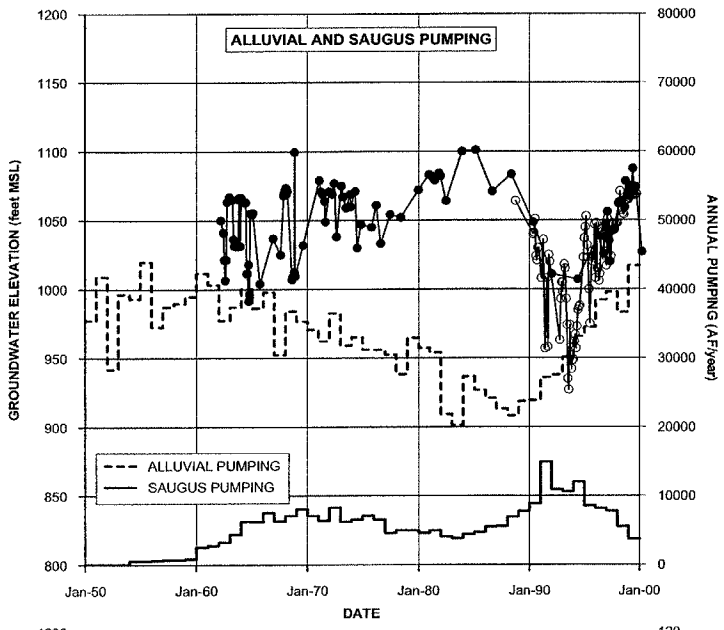
NOTES:

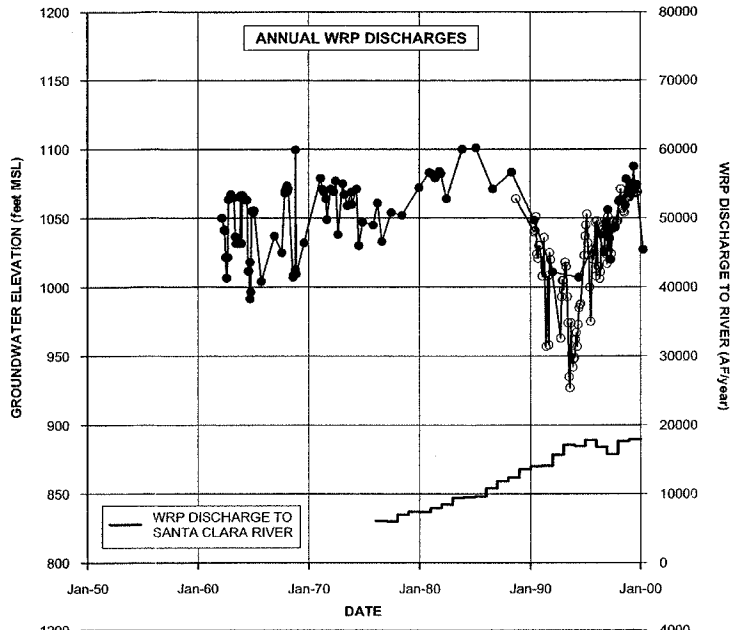
1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

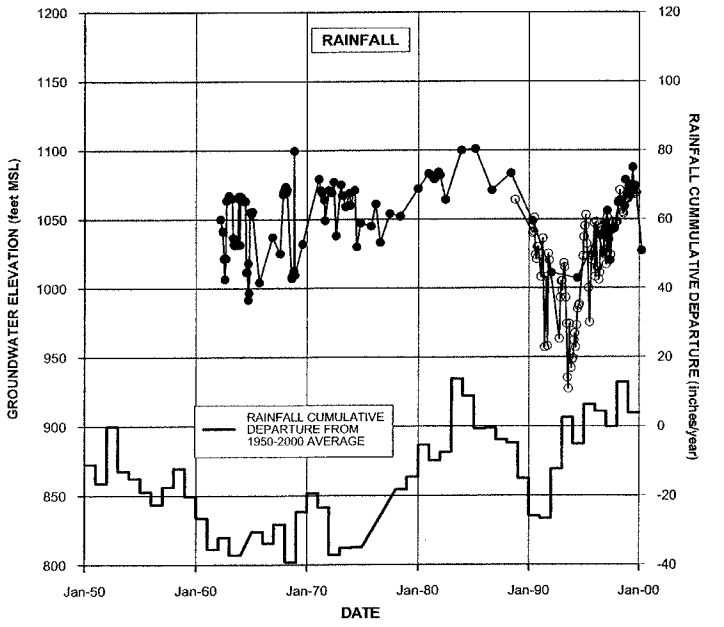
FIGURE 2-12
ALLUVIAL GROUNDWATER ELEVATIONS VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

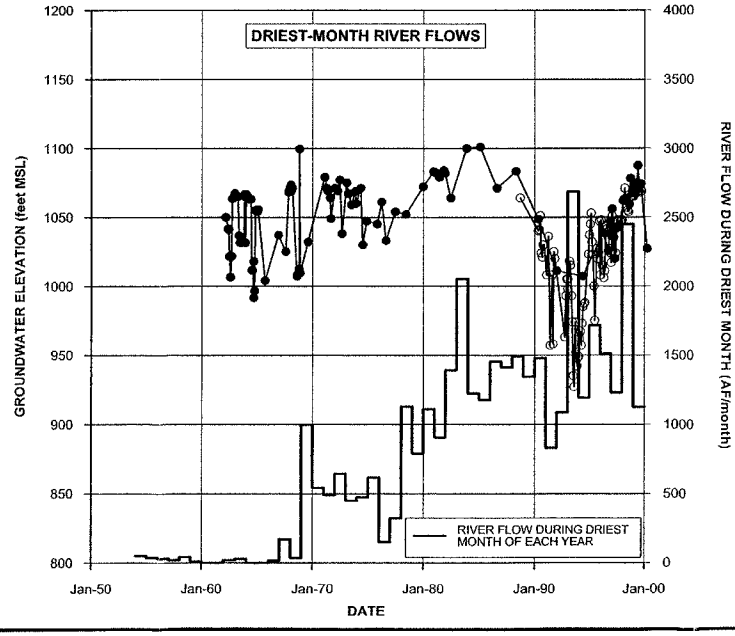
CH2MHILL

178973-301.GRF









LEGEND

- ELEVATION OF GROUNDWATER IN VWC-157
- ELEVATION OF GROUNDWATER IN SCWC SAUGUS 2

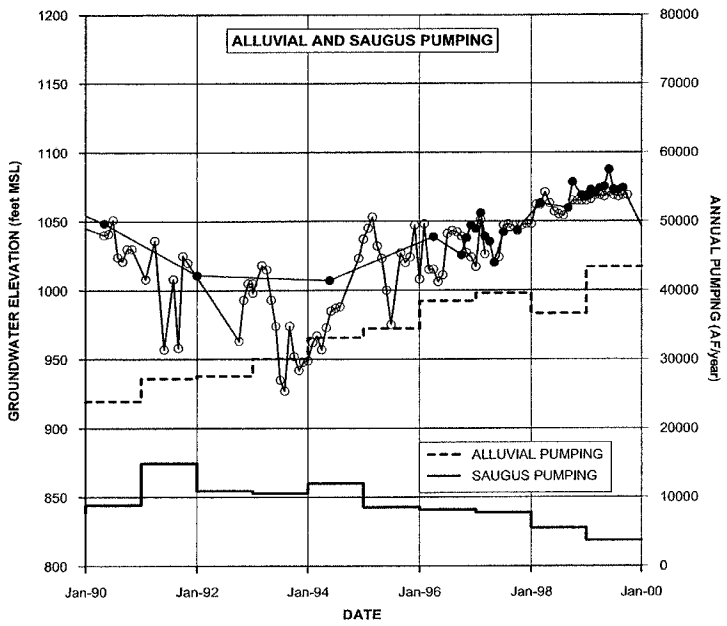
NOTES:

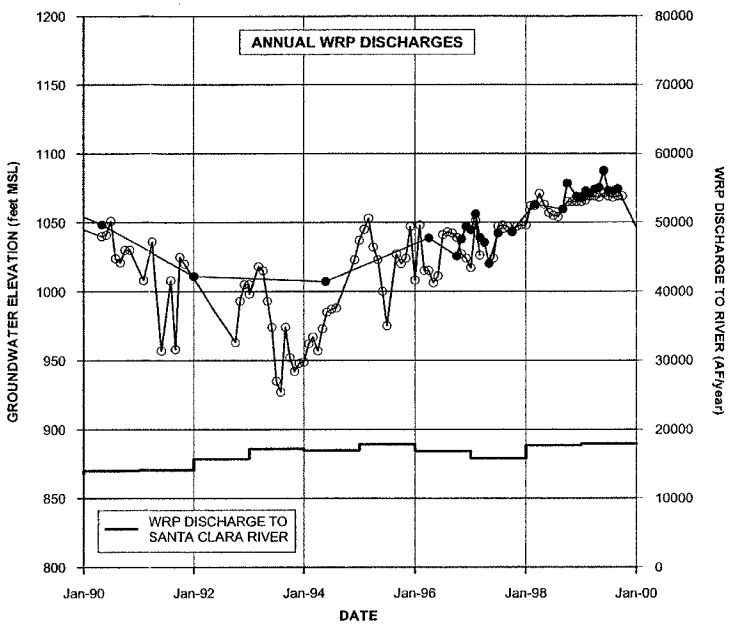
1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

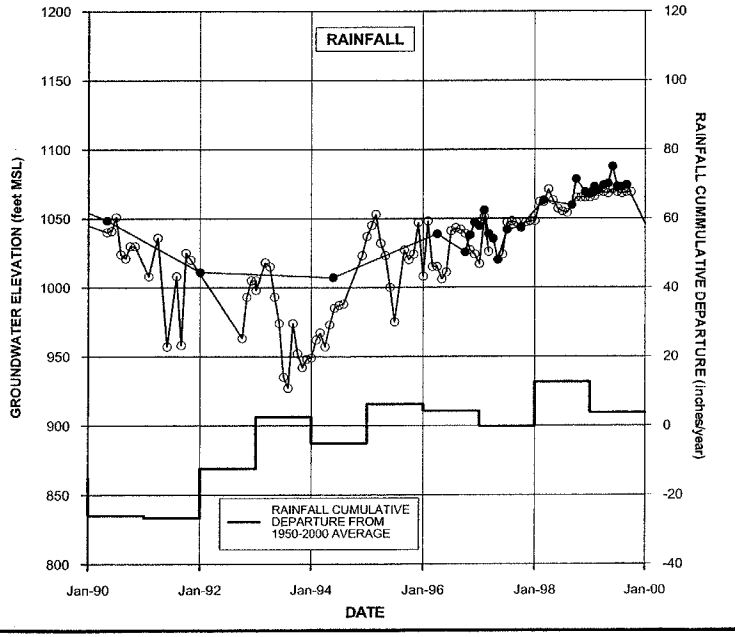
FIGURE 2-13
SAUGUS GROUNDWATER ELEVATIONS CLOSEST TO SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

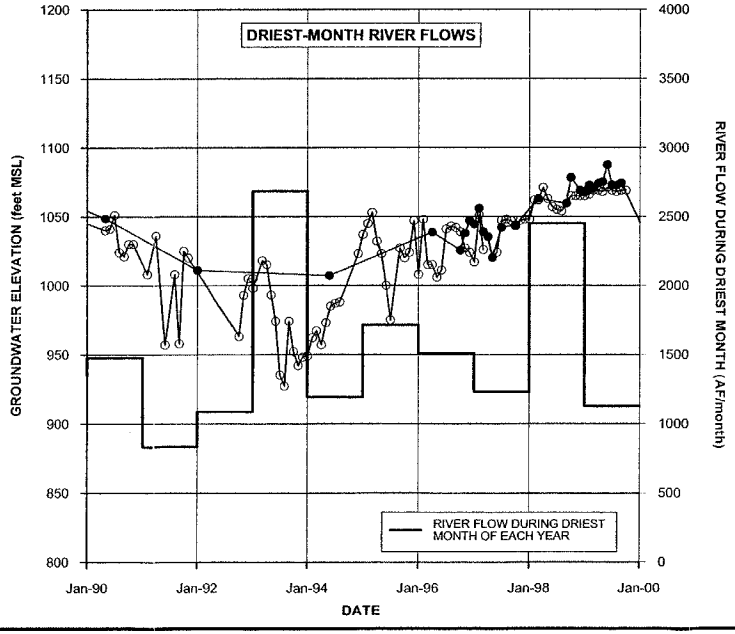
CH2MHILL

178973-302.GRF









LEGEND

- ELEVATION OF GROUNDWATER IN VWC-157
- ELEVATION OF GROUNDWATER IN SCWC SAUGUS 2

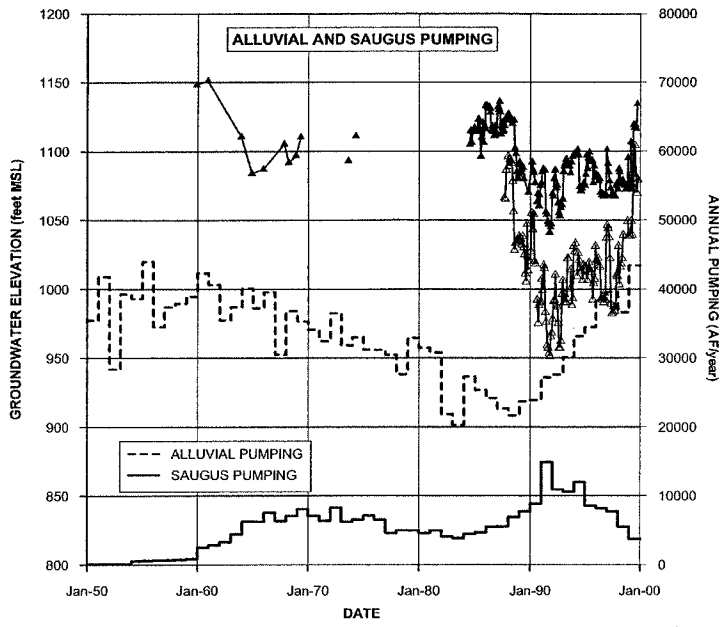
NOTES:

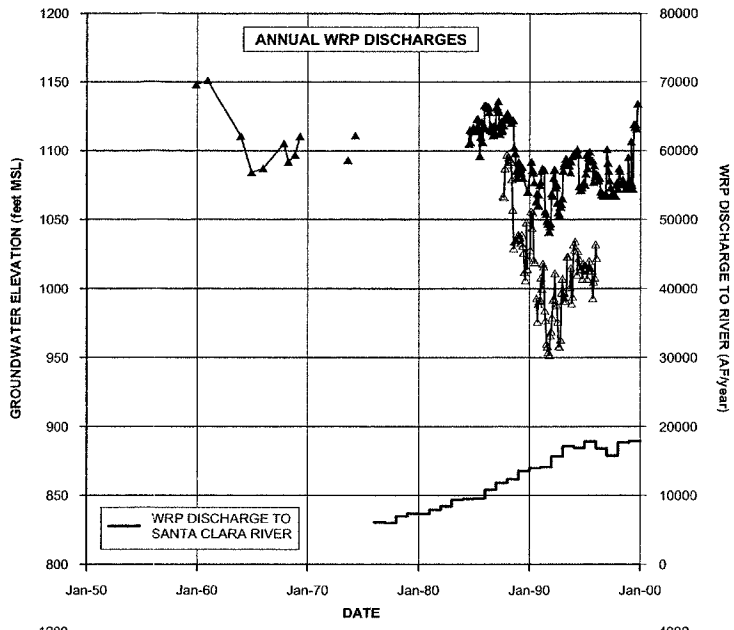
1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

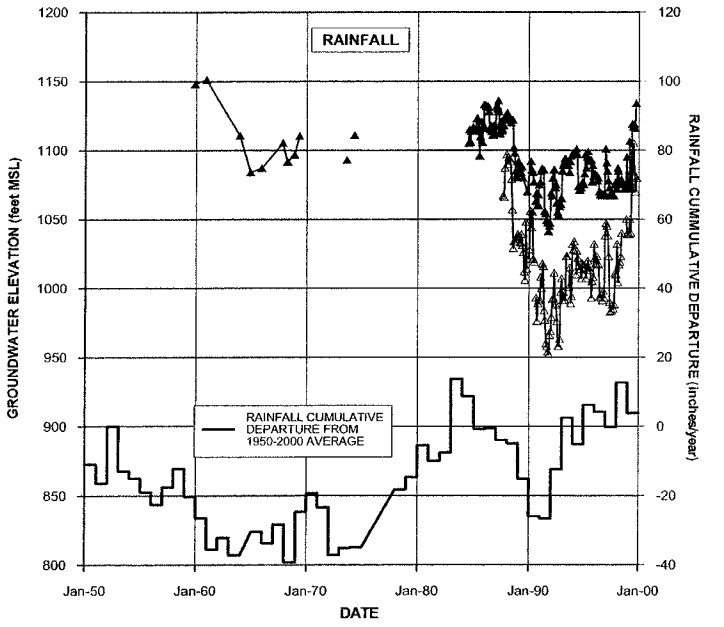
FIGURE 2-14
SAUGUS GROUNDWATER ELEVATIONS CLOSEST TO SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1990 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

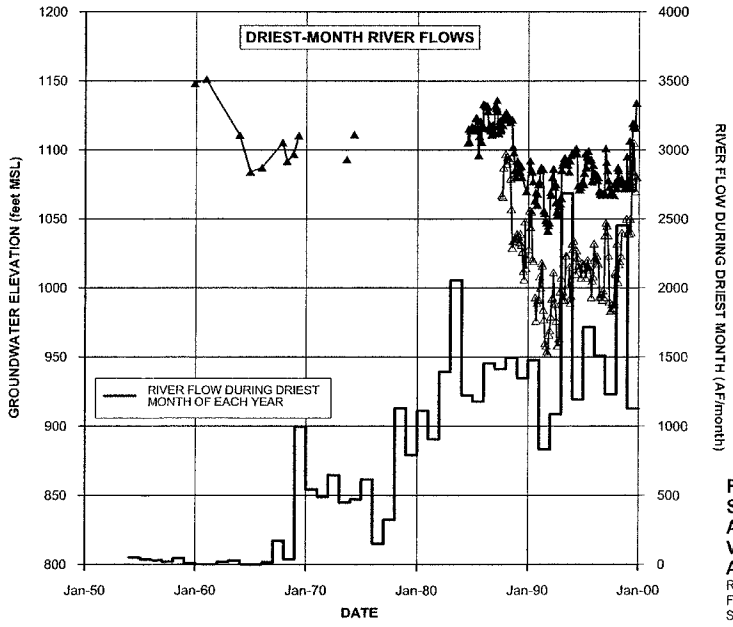
CH2MHILL

178973-303.GRF









LEGEND

- ELEVATION OF GROUNDWATER IN NCWD-7
- ELEVATION OF GROUNDWATER IN NCWD-12

NOTES:

1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-15
SAUGUS GROUNDWATER ELEVATIONS ALONG THE SOUTH FORK SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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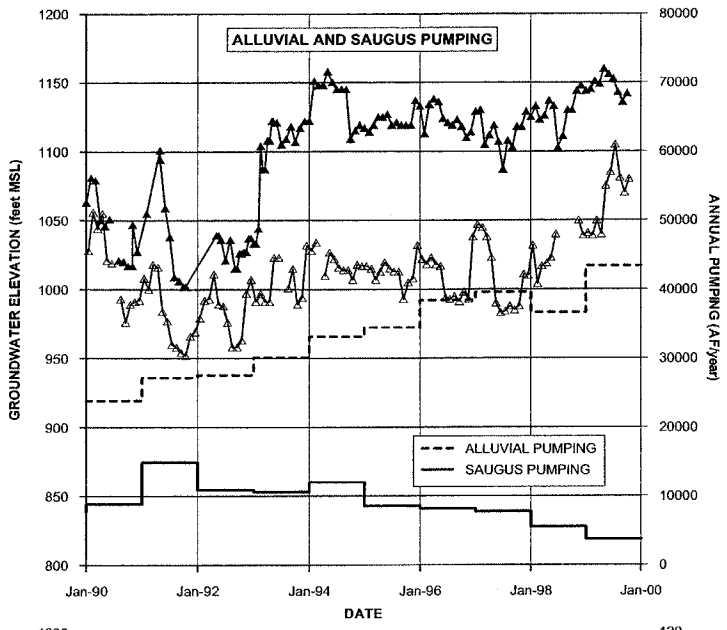

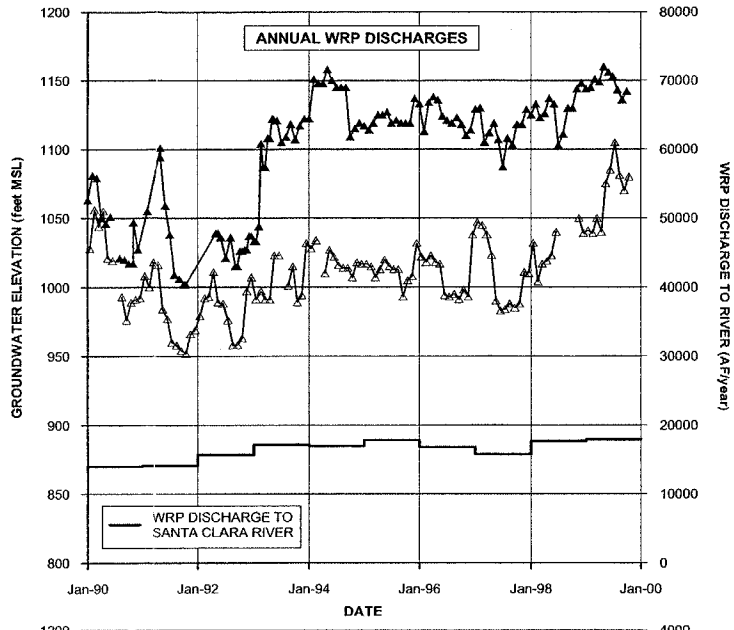

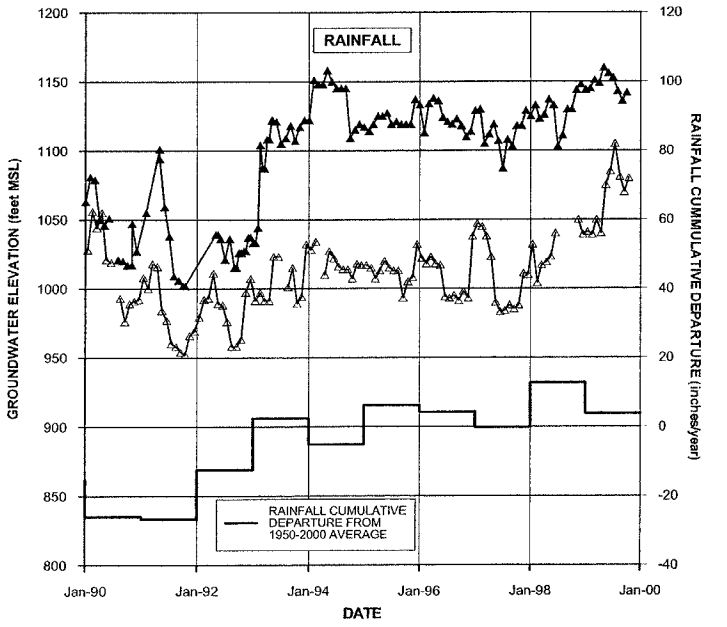

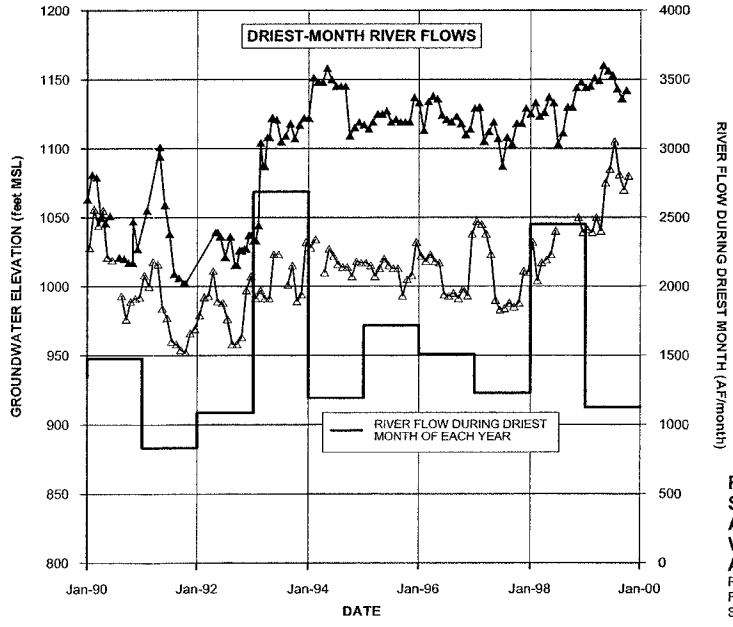

LEGEND

- ELEVATION OF GROUNDWATER IN NCW-10
- ELEVATION OF GROUNDWATER IN NCW-12

NOTES:

1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-16
SAUGUS GROUNDWATER ELEVATIONS ALONG THE SOUTH FORK SANTA CLARA RIVER VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1990 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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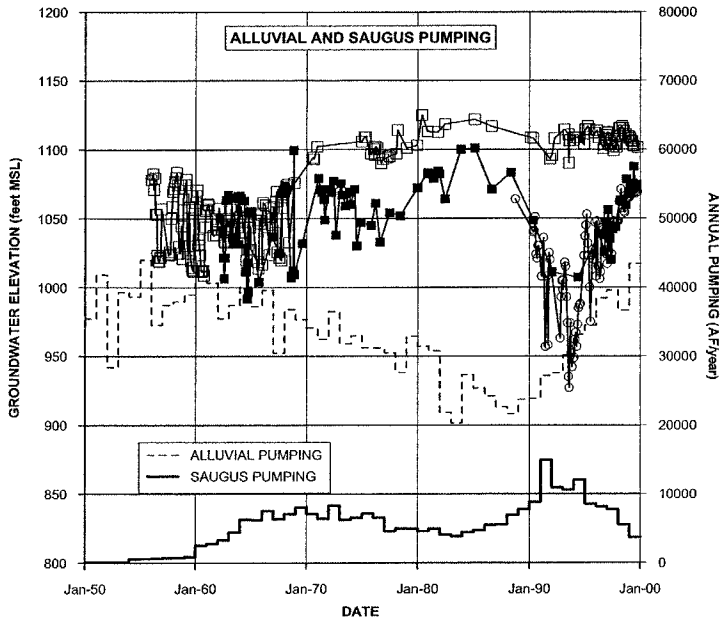

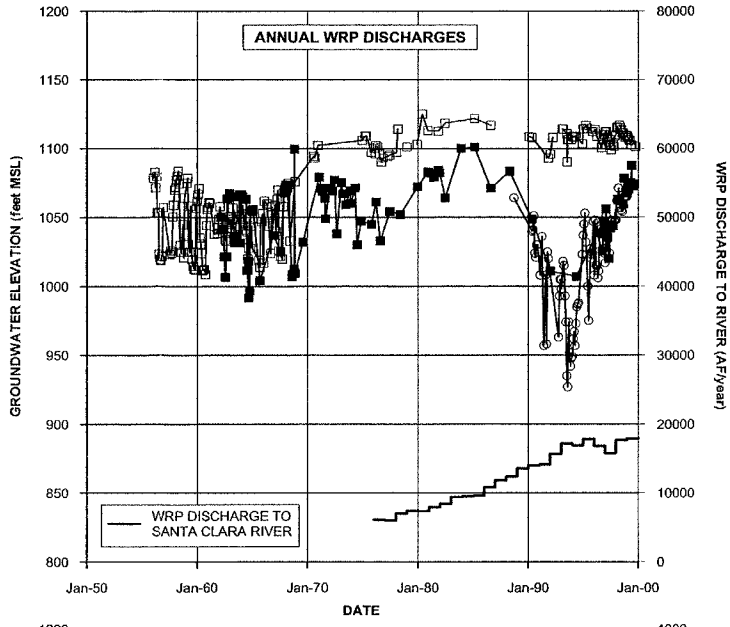

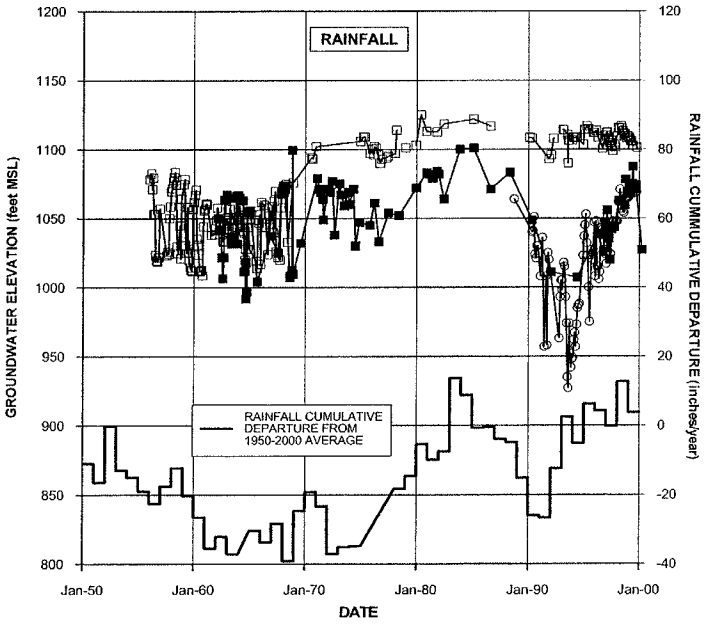

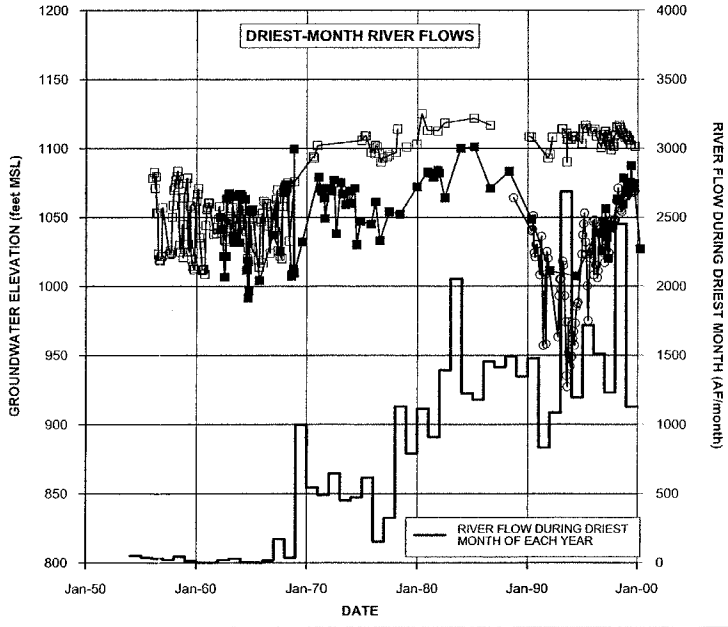

LEGEND

- ELEVATION OF GROUNDWATER IN VWC-N (ALLUVIUM)
- ELEVATION OF GROUNDWATER IN NVWC-157 (SAUGUS)
- ELEVATION OF GROUNDWATER IN SWC SAUGUS 2 (SAUGUS)

NOTES:

1. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.
2. WRP = WATER RECLAMATION PLANT.

FIGURE 2-17
GROUNDWATER ELEVATIONS IN ADJACENT ALLUVIAL AND SAUGUS WELLS VERSUS GROUNDWATER RECHARGE AND DISCHARGE MECHANISMS (1950 to 2000)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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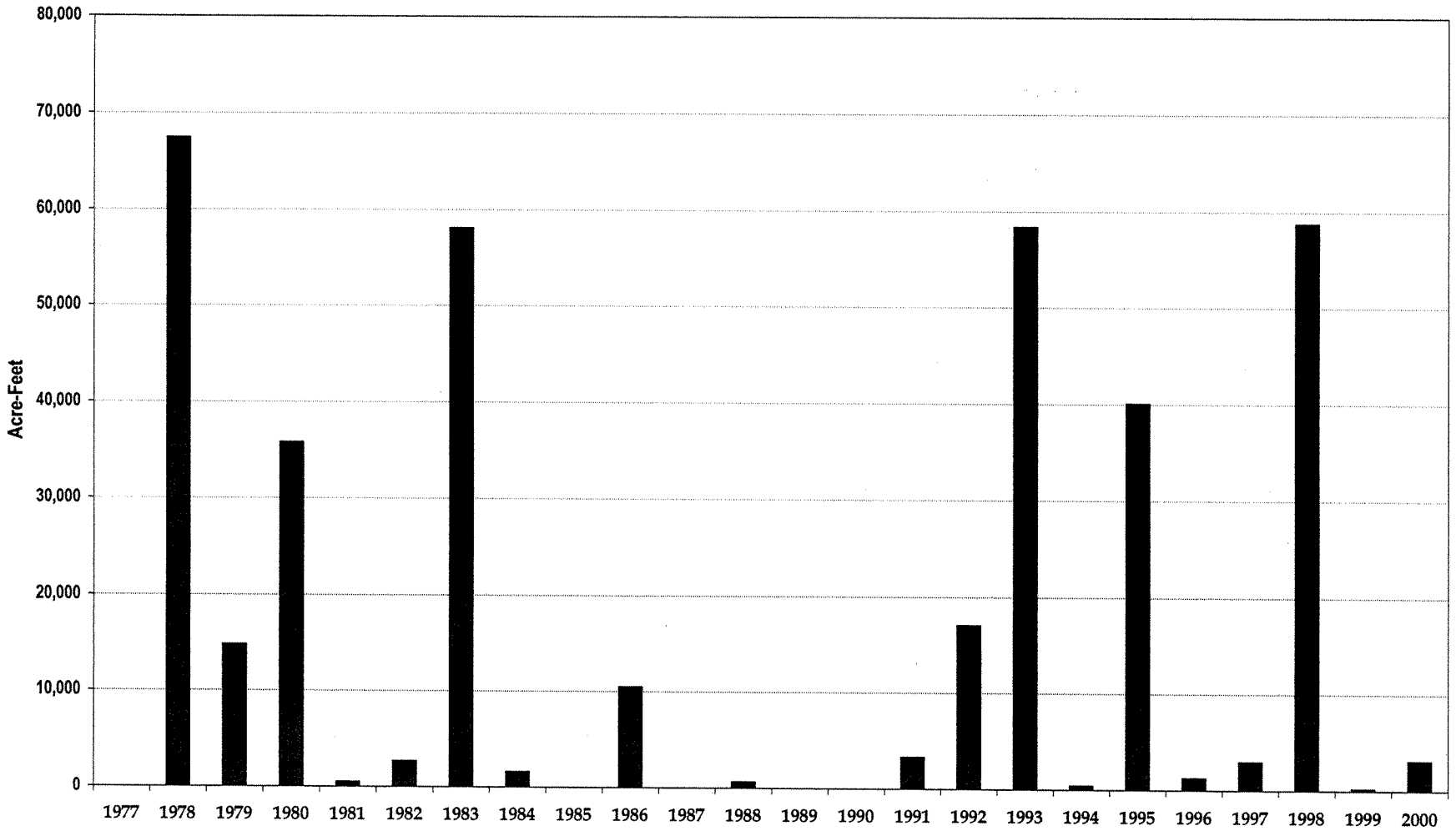

This chart shows the potential Flood Flows available during water years 1977 through 2000. Water Year 1977 is defined as October 1, 1976 through September 30, but the water is generally available only from October 1 through April 30.

FIGURE 2-18
NET CASTAIC CREEK FLOOD FLOWS AVAILABLE TO DOWNSTREAM USERS
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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SECTION 3

Model Construction

The Regional Model is a three-dimensional numerical model of groundwater flow in the Alluvial Aquifer and the Saugus Formation. The model simulates changes in groundwater flow and storage during the recent 20-year period from 1980 through 1999. This section of the report presents the overall approach to the construction of the Regional Model including the model software; model domain; grid design; layering scheme; boundary conditions; designation of subareas within the model domain; and the process for estimating the magnitudes of groundwater recharge and pumping terms required by the model.

3.1 Modeling Software

The Regional Model was constructed using the three-dimensional finite-element groundwater modeling software called MicroFEM® (Hemker and de Boer, 2003). MicroFEM® operates in a Windows™ environment and can be used to solve groundwater flow problems for unconfined, semi-confined, or confined aquifer systems. This software simulates steady-state or transient flow conditions in up to a 20-layer aquifer system; the finite-element mesh may contain as many as 50,000 nodes in each model layer. The software contains several different methods for simulating groundwater/surface water interactions. MicroFEM® is based on software developed in the Netherlands during the 1980s for use in evaluating the effects of groundwater pumping in areas with complicated meandering rivers. Further details regarding this software's design, capabilities, and functionality can be found on the Internet at www.microfem.com and in two reviews of the software by Diodato (1997, 2000).

3.2 Extent of the Model Domain

A finite-element mesh was designed that covers the entire area underlain by the Saugus Formation, plus the portions of the Alluvial Aquifer that lie beyond the limits of the Saugus Formation. The model area largely coincides with the Santa Clara River Valley East Groundwater Subbasin, extending from the Lang stream gage at the eastern end of the valley to the County Line gage area in the west. The northern and southern edges of the model domain are defined by the geologic contacts mapped by RCS (2002) for the Alluvial Aquifer and the Saugus Formation. Figure 2-10 shows the model domain, along with its location relative to the upstream watersheds that contribute runoff into the model study area.

3.3 Model Grid

Figure 3-1 shows the spacing of the individual nodes that comprise the grid. The mesh contains 17,103 nodes in each model layer. The nodes are connected by segments, forming 32,496 triangular elements. Calculations of all flow components (recharge and discharge),

groundwater storage, and groundwater elevations are performed by the model for each node and segment.

The nodes are 500 feet apart in the majority of the modeled area. However, a finer node spacing (150 feet) was used along the Santa Clara River and its tributaries to allow a more exact simulation of surface water/groundwater exchanges. Additionally, specific nodes were placed within this regional grid at the locations of production and monitoring wells.

3.4 Layering

The groundwater system was represented in the Regional Model with seven layers. The layer representation is summarized schematically on Figure 3-2. The Alluvial Aquifer, where present, was modeled with a single layer, and the Saugus Formation was modeled with multiple layers to its total depth, which was defined as the base of the Sunshine Ranch Member of the Saugus Formation. Figures 3-3 through 3-9 show the assigned thicknesses in model layers 1 through 7. Figure 3-10 shows the total modeled saturated thickness of the Saugus Formation. Figures 3-11 through 3-17 show the elevations of the base of each model layer. Figure 3-18 shows the model layering in three cross-sectional views. Further details regarding model layering are presented below.

3.4.1 Alluvial Aquifer Layer

In 2002, RCS compiled and geographically grouped hydrogeologic data from Alluvial Aquifer wells to estimate the aquifer's saturated thickness during various historical periods. The saturated thickness was defined from the average base elevation of the aquifer and the water level elevations measured during the fall of 1985 and the spring of 2000, then typical saturated thicknesses for geographic subareas were defined. The spatial distribution of the Alluvial Aquifer's typical saturated thickness is shown on Figure 3-3. Along the Santa Clara River, the typical saturated thickness ranges between 110 and 130 feet west of I-5; is less than 100 feet near Round Mountain; ranges between 100 and 150 feet between Round Mountain and Soledad Canyon; and ranges between 80 and 90 feet in Soledad Canyon. The typical saturated thickness ranges between 80 and 100 feet in the Castaic Creek Valley and in the lower reach of Bouquet Canyon. Other tributary canyons to the Santa Clara River have typical saturated thicknesses of 60 feet or less, and the saturated thickness decreases significantly in the upstream direction within each canyon, particularly along the South Fork Santa Clara River, where all production wells are constructed in the Saugus Formation, rather than the alluvium (RCS, 2002).

3.4.2 Saugus Formation Layers

The Saugus Formation was simulated using 500-foot-thick model layers through the freshwater-bearing deposits, which are present in the basin at depths up to 2,500 feet (RCS, 1988, 2002). The model layers were specified at each node by importing digitized contours of the total thickness of the Saugus Formation's freshwater-bearing deposits (Plate 5 in RCS, 1988). Figure 3-4 is a contour fill map showing the total thickness of the Saugus Formation's freshwater-bearing deposits that was programmed into the model. As shown in the individual thickness maps for each model layer, the Saugus is present in the

model at progressively fewer nodes with depth, due to the bowl-shaped structure of the unit and the underlying bedrock.

3.5 Boundary Conditions

The boundary conditions used in the Regional Model were the following:

a. **Specified flux for precipitation within the model grid.** Deep percolation of precipitation was simulated using the precipitation top-system package contained in MicroFEM®.

b. **Specified flux for irrigation.** Deep percolation of agricultural irrigation and urban irrigation in developed areas was simulated using the precipitation top-system package contained in MicroFEM®.

c. **Specified flux and head-dependent flux along ephemeral streams.** With respect to groundwater discharges to streams, the Santa Clara River was modeled as an ephemeral, predominantly losing stream at and upstream of the mouth of San Francisquito Canyon, and as a perennial, predominantly gaining stream downstream of San Francisquito Canyon. Although flows in the river are currently perennial below the mouth of Bouquet Canyon, because of discharges from the Saugus WRP, the river was perennial only below the mouth of San Francisquito Canyon in the 1960s, prior to WRP operations. The tributaries to the Santa Clara River were modeled as ephemeral streams, using the precipitation top-system package to specify stream leakage to groundwater. Aerial photos and historical observations indicate that under high water table conditions, groundwater can locally discharge into Castaic Creek and the ephemeral reach of the Santa Clara River wherever Alluvial groundwater levels rise above the riverbed elevation. Consequently, the drain package in MicroFEM® was used in these streams to allow drainage of any groundwater that was calculated to be above the riverbed elevation at each river node.

d. **Specified flux and head-dependent flux along perennial Santa Clara River.** In the perennial reach of the Santa Clara River, the river was modeled using the wadi top-system package contained in MicroFEM®. The wadi package allows groundwater to discharge to the river whenever groundwater elevations are higher than the specified river stage. When groundwater levels are below the river stage, the river recharges the Alluvial Aquifer. The rate of recharge is proportional to the difference between the river stage elevation and the model-calculated groundwater elevation. However, once the groundwater elevation drops below the streambed sediments, the rate of leakage from the stream is constant (i.e., does not vary as the groundwater elevation fluctuates). For the Regional Model, each node along the perennial reach of the Santa Clara River was assigned a river stage 1 foot higher than the mapped bed elevation of the river. The riverbed permeability, or conductance, which helps control the model-calculated groundwater/surface water exchange rates, was adjusted during model calibration by calibrating to streamflow data collected at the county line. (See Section 4.3 for further details on the use of the streamflow data during model calibration.)

e. **Specified flux for pumping.** Pumping rates and locations for wells completed in the Alluvial Aquifer and the Saugus Formation were directly imported into the Regional

Model from the Upper Santa Clara River Groundwater Basin database. Further information on how pumping was specified in the model is contained in Section 3.7.

f. **Specified flux at upgradient Alluvial Aquifer boundaries.** Where there is Alluvial groundwater flow into the study area from beneath Castaic Dam, the magnitude of the specified flux was adjusted during the model calibration process, using groundwater elevations and gradients published by RCS (1986 and 2002).

g. **Specified groundwater elevation in the Alluvial Aquifer at the county line.** The groundwater elevation (805 feet) was obtained from water level contour maps for the Alluvial Aquifer prepared by RCS (1986, 2002). (See Figure 2-7 for groundwater elevation contours during Spring 2000, as mapped by RCS [2002].)

h. **Head-dependent flux for evapotranspiration.** ET from the water table by riparian vegetation was simulated using the evaporation top-system package contained in MicroFEM®. This package requires specification of the maximum rooting depth for the riparian vegetation, the maximum potential ET rate, and the ground surface elevation.

i. **No-flow.** In general, the outermost line of nodes that form the model boundary and the bottom of the model are no-flow boundaries. The exceptions are the western model boundary (specified head) and the specified-flux nodes representing underflow into the Alluvial Aquifer from beneath Castaic Dam. Also, all nodes on the model boundary are assigned specified fluxes due to precipitation and, in some cases, ephemeral streamflow.

3.6 Estimation of Groundwater Recharge Rates

The groundwater recharge rates required by the model were derived from the following information sources:

a. Precipitation records

b. Watershed maps and topographic maps

c. Aerial photography (to identify vegetation patterns and areas of agricultural and urban irrigation)

Groundwater recharge was defined on a month-to-month basis for the transient calibration process. Groundwater recharge rates were assigned at all model nodes using the GIS for the valley and a Surface Water Routing Model (SWRM), which was written specifically for the Regional Model using the Visual Basic Editor within Microsoft® Excel 97. For each month during the transient calibration period, the SWRM estimated the following:

a. The amount of water potentially available to recharge the aquifer, which consisted of:

   1. Infiltration of direct precipitation within the model grid area
   2. Infiltration of urban irrigation water
   3. Infiltration of agricultural irrigation water
   4. The amount of stormwater yielded by upstream watersheds in each tributary to the Santa Clara River
   5. The amount of water entering the valley in the Santa Clara River at the Lang gage

6. The amount of water released into Castaic Creek by DWR
7. The locations and volumes of flow discharged into the Santa Clara River from the two LACSD WRPs

b. The amount of water in each stream that actually infiltrates to the aquifer, based on an assigned streambed leakage rate at each model node

c. The amount of water in each stream that does not infiltrate and therefore remains as surface water in the Santa Clara River at the west end of the valley, at the County Line gage

During model calibration, the SWRM was used to adjust the streambed conductance terms for Castaic Creek and the ephemeral reach of the Santa Clara River. These adjustments were made by examining the differences between measured and modeled groundwater elevations at wells located in the valleys where these ephemeral streams are present. In addition, the streambed conductance terms were allowed to vary from month to month because the conductance implicitly incorporates the streambed area, which is large during high river flows and smaller during low-flow periods.

A detailed discussion of the SWRM's design, operations, and input data is contained in Appendix C.

3.7 Assignment of Pumping Rates

Pumping rates were assigned in the Regional Model using the following information:

a. Water use records maintained by the Purveyors and other agencies in the valley. These records were available in the form of AF/yr of water use at each well.

b. Estimates of monthly water demand for urban water use and agricultural water use.

c. Well construction records, which were needed to determine which model layers at each individual well should be assigned pumping.

Tables 2-1 and 2-2 summarize annual pumping rates at each well and for each year during the transient model calibration period. All production wells in the Alluvial Aquifer were assigned pumping rates in model layer 1. For each production well completed in the Saugus Formation, the pumping assignments in each model layer were based on the total pumping rate, the percentage of the model layer in which the well was open, and the thickness and hydraulic conductivity of each model layer. Table 3-1 summarizes this information and shows the percentage of the total well yield that was derived from each model layer.

Table 3-2 summarizes the monthly distribution of the annual pumping volumes. Separate distributions were used for agricultural demands, which are exclusively for outdoor uses, and for urban demands, which are for both indoor and outdoor uses. The monthly distribution of agricultural pumping was derived from crop consumptive use requirements published by the California Irrigation Management Information Service. The monthly distribution of urban demand was determined by examining monthly flow records for the two LACSD WRPs and monthly demand distributions recorded by VWC during the past several years.

Tables

TABLE 3-1

Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Well Owner - Well Name	Model Layer	Depth to Open Interval (feet) Top	Bottom	Length of Open Interval in Model Layer (feet)	Kh (ft/day)	T in Open Interval (ft^2/day)	Percentage of Yield from Model Layer
NCWD-7	3	520	974	454	2	908	100.0
NCWD-8	2	342	970	158	10	1,580	62.7
NCWD-8	3	342	970	470	2	940	37.3
NCWD-9	2	311	674	189	0.03371	6.37	59.4
NCWD-9	3	311	674	174	0.025	4.35	40.6
NCWD-10	3	780	1,544	220	2	440	28.8
NCWD-10	4	780	1,544	500	2	1,000	65.4
NCWD-10	5	780	1,544	44	2	88	5.8
NCWD-11	2	200	1,075	300	10	3,000	72.3
NCWD-11	3	200	1,075	500	2	1,000	24.1
NCWD-11	4	200	1,075	75	2	150	3.6
NCWD-12	2	485	1,280	15	10	150	8.8
NCWD-12	3	485	1,280	500	2	1,000	58.5
NCWD-12	4	485	1,280	280	2	560	32.7
NCWD-13	2	420	750	80	10	800	61.5
NCWD-13	3	420	750	250	2	500	38.5
NLF-156	2	320	1,800	180	10	1,800	21.8
NLF-156	3	320	1,800	500	6.5	3,250	39.4
NLF-156	4	320	1,800	500	4	2,000	24.2
NLF-156	5	320	1,800	300	4	1,200	14.5
SCWC-Saugus1	2	490	1,620	10	10	100	1.8
SCWC-Saugus1	3	490	1,620	500	6.5	3,250	59.9
SCWC-Saugus1	4	490	1,620	500	4	2,000	36.8
SCWC-Saugus1	5	490	1,620	20	4	80	1.5
SCWC-Saugus2	2	490	1,591	10	10	100	1.8
SCWC-Saugus2	3	490	1,591	500	6.5	3,250	56.9
SCWC-Saugus2	4	490	1,591	500	4	2,000	35.0
SCWC-Saugus2	5	490	1,591	91	4	364	6.4
VWC-157	3	586	2,008	414	6.5	2,691	40.2
VWC-157	4	586	2,008	500	4	2,000	29.9
VWC-157	5	586	2,008	500	4	2,000	29.9
VWC-159	3	662	1,900	338	0.025	8.45	27.3
VWC-159	4	662	1,900	500	0.025	12.5	40.4
VWC-159	5	662	1,900	400	0.025	10	32.3
VWC-160	3	950	2,000	50	6.5	325	7.5
VWC-160	4	950	2,000	500	4	2,000	46.2
VWC-160	5	950	2,000	500	4	2,000	46.2

TABLE 3-1

Allocation of Pumping by Layer for Wells Completed in the Saugus Formation

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Well Owner - Well Name	Model Layer	Depth to Open Interval (feet) Top	Depth to Open Interval (feet) Bottom	Length of Open Interval in Model Layer (feet)	Kh (ft/day)	T in Open Interval (ft^2/day)	Percentage of Yield from Model Layer
VWC-201	3	540	1,670	460	6.5	2,990	52.7
VWC-201	4	540	1,670	500	4	2,000	35.3
VWC-201	5	540	1,670	170	4	680	12.0
VWC-205	3	820	1,930	180	6.5	1,170	23.9
VWC-205	4	820	1,930	500	4	2,000	40.9
VWC-205	5	820	1,930	430	4	1,720	35.2

TABLE 3-2

Allocation of Pumping by Month for Agricultural and Urban Production Wells

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Month	% of Annual Water Use, Agricultural	% of Annual Water Use, Urban	% of May through October Water Use, Urban
January	3.8	5.2	
February	5.1	3.7	
March	6.6	5.2	
April	9.1	6.6	
May	10.6	8.7	13.2
June	11.4	10.4	15.8
July	14.1	13.0	19.7
August	12.9	13.6	20.6
September	10.2	10.9	16.5
October	7.5	9.3	14.1
November	5.0	7.1	
December	3.8	6.3	
Total	**100.0**	**100.0**	**100.0**

Figures

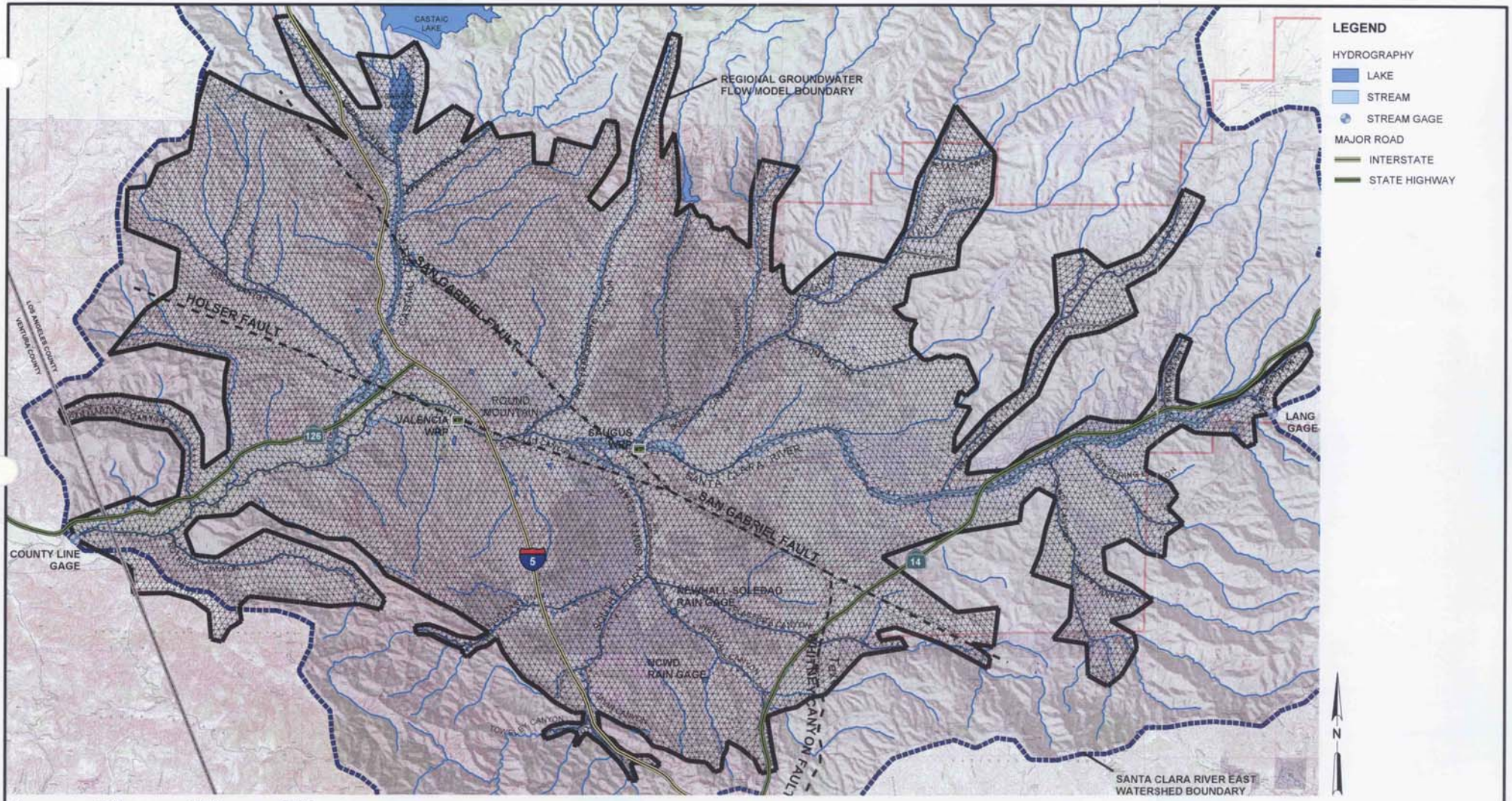

FIGURE 3-1
MODEL GRID
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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	Stratigraphy		Model Layer	Thickness (feet)
Saugus	Alluvium	Saugus	1	500
Saugus	Saugus	Saugus	2	
Saugus	Saugus	Saugus	3	500
Saugus	Saugus	Saugus	4	500
Saugus	Saugus	Saugus	5	500
Saugus	Saugus	Saugus	6	500
Sunshine	Sunshine	Sunshine	7	Variable

FIGURE 3-2
SHEMATIC DIAGRAM OF THE MODEL'S REPRESENTATION OF STRATIGRAPHY IN THE MIDDLE OF THE BASIN
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

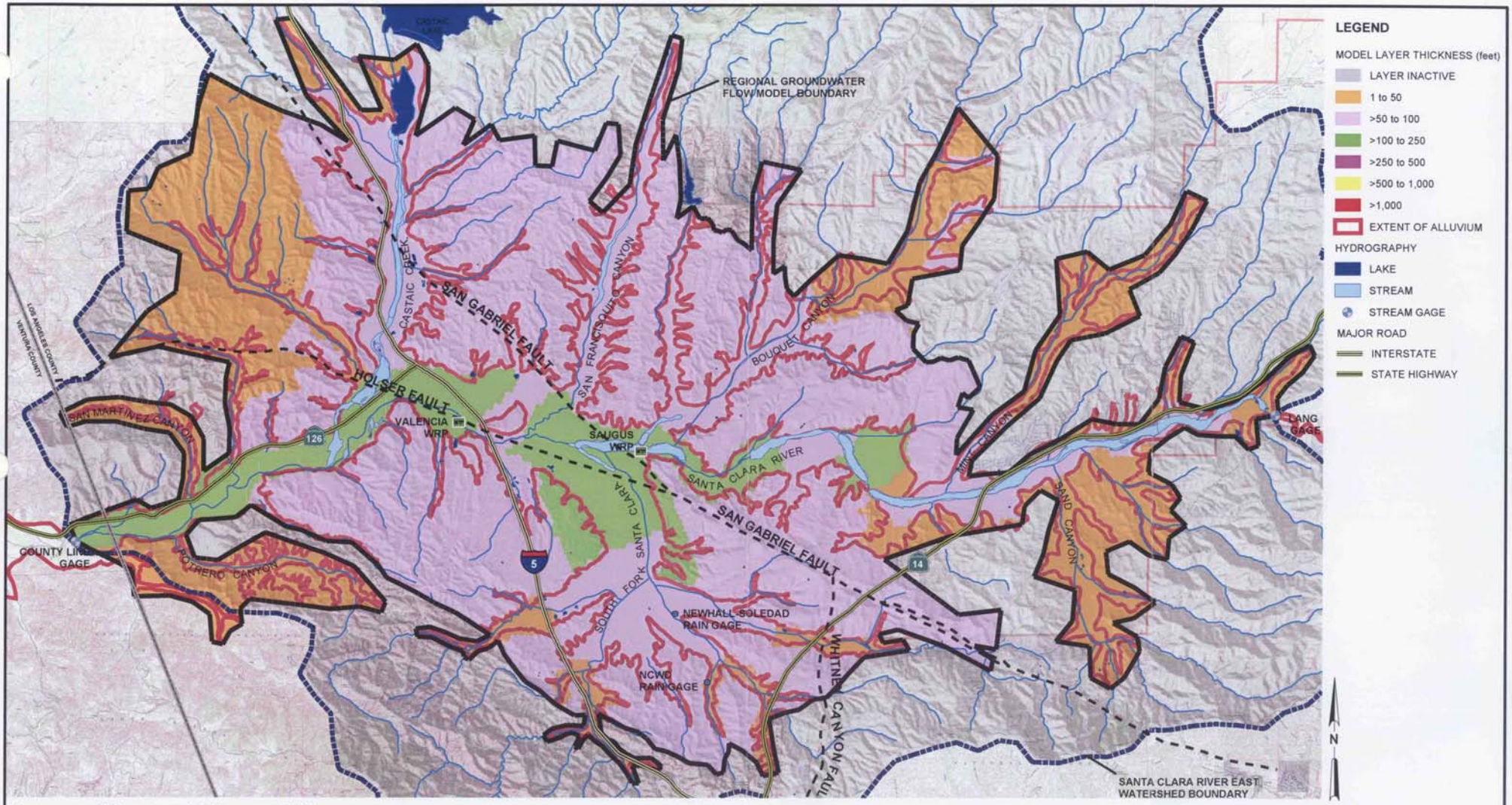

FIGURE 3-3
THICKNESS OF MODEL LAYER 1
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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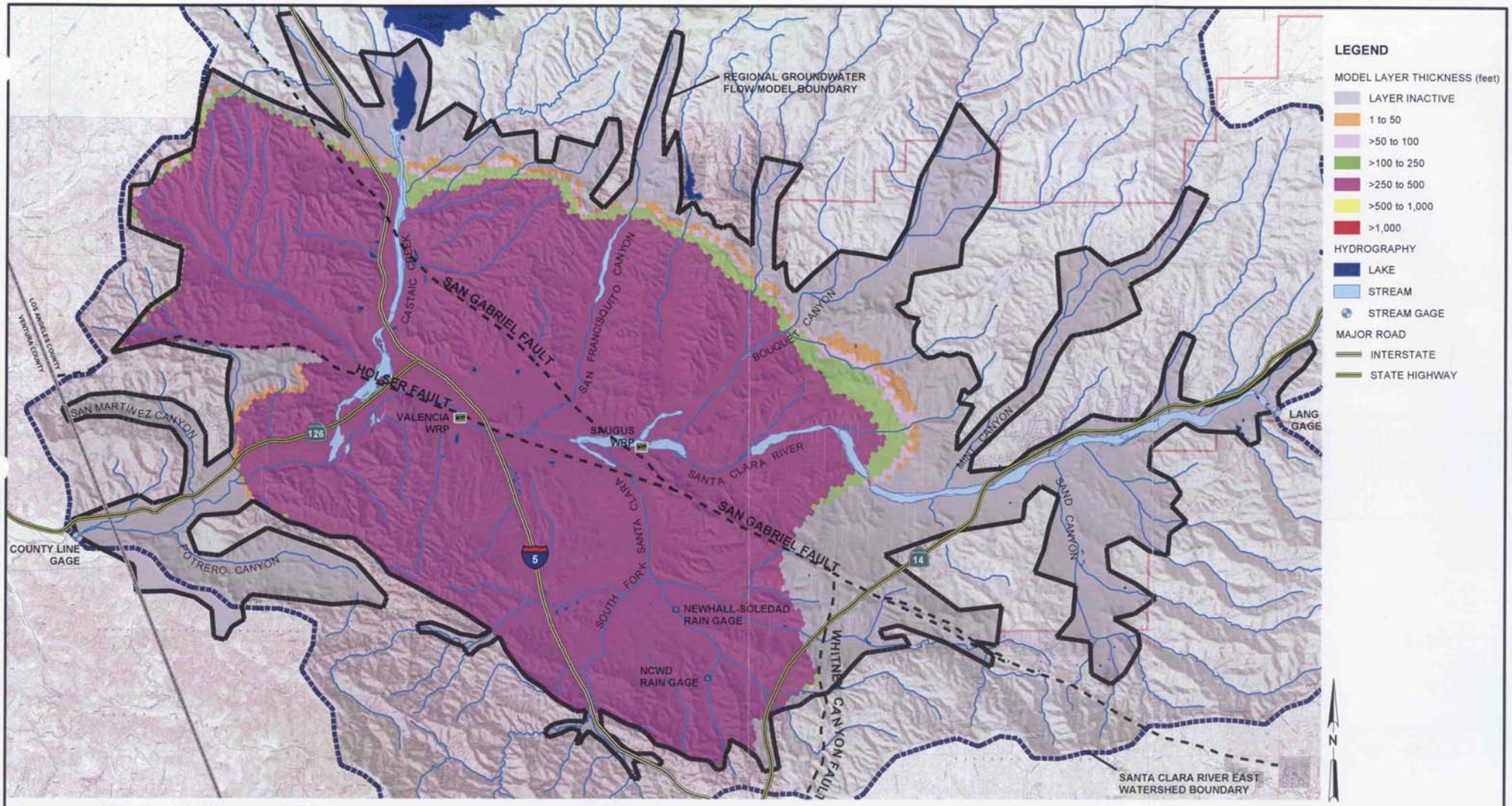

FIGURE 3-4
THICKNESS OF MODEL LAYER 2
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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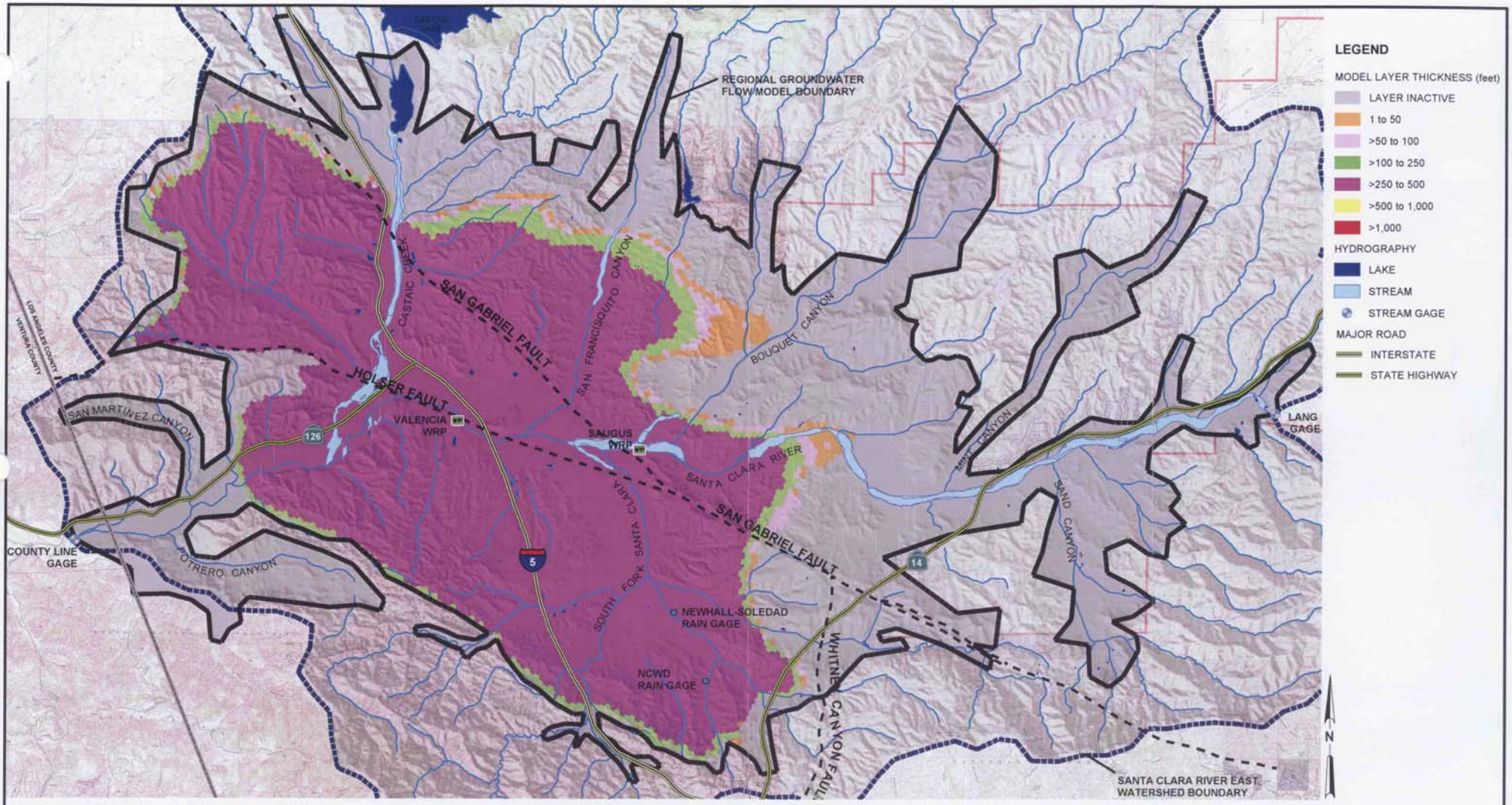

FIGURE 3-5
THICKNESS OF MODEL LAYER 3
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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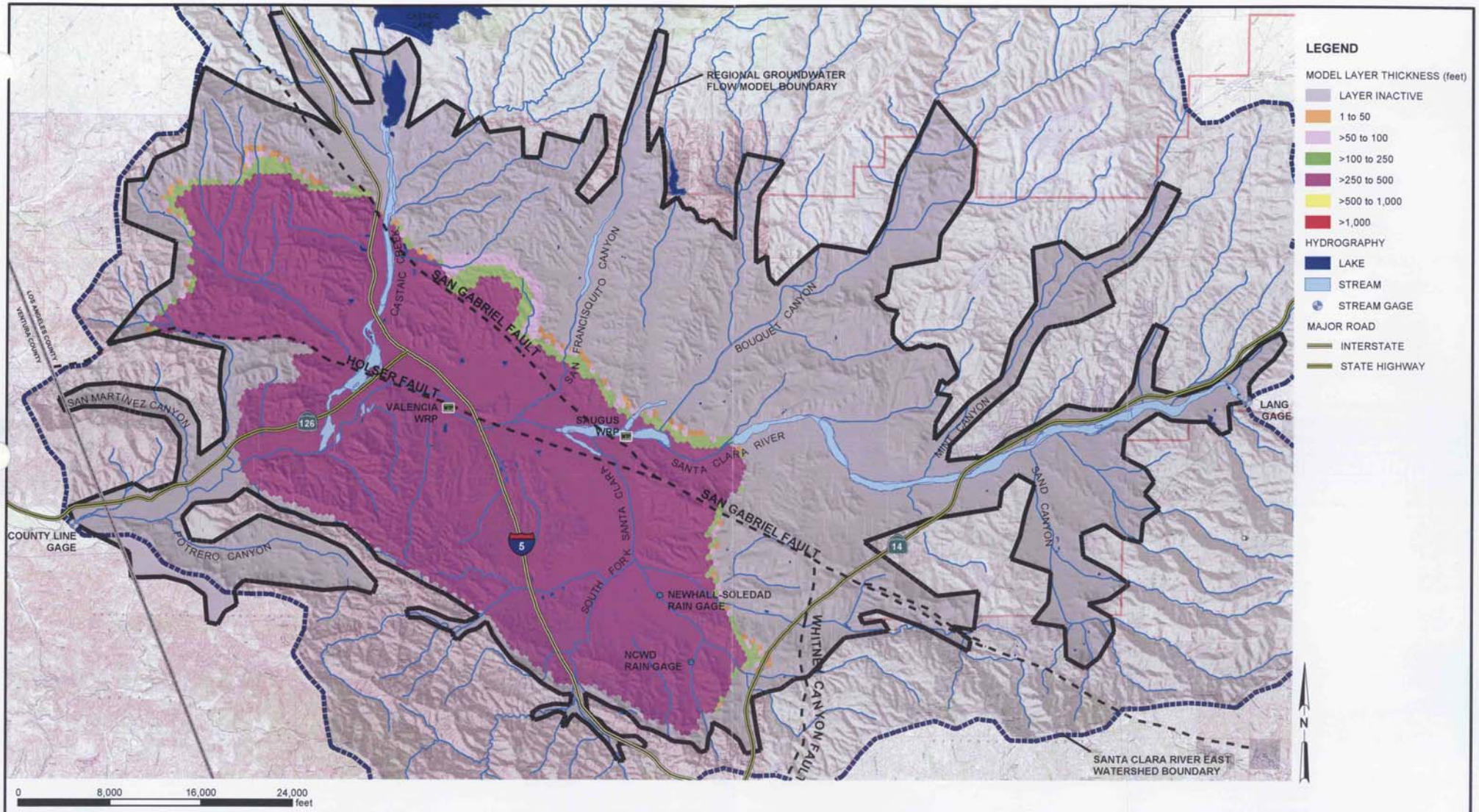

FIGURE 3-6
THICKNESS OF MODEL LAYER 4
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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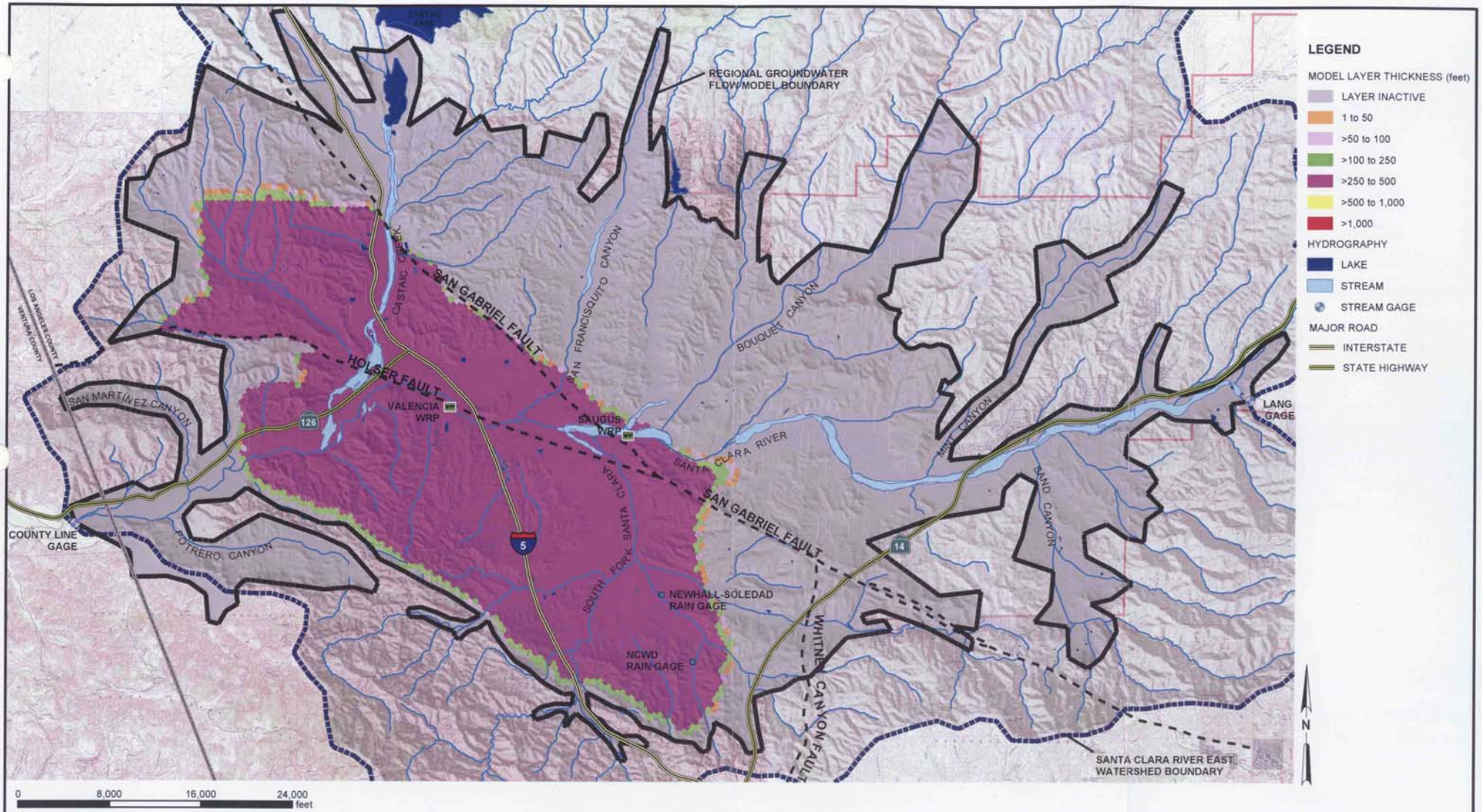

FIGURE 3-7
THICKNESS OF MODEL LAYER 5
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG024.MXD FIG03-07.PDF 02/04/2004 11:23:01

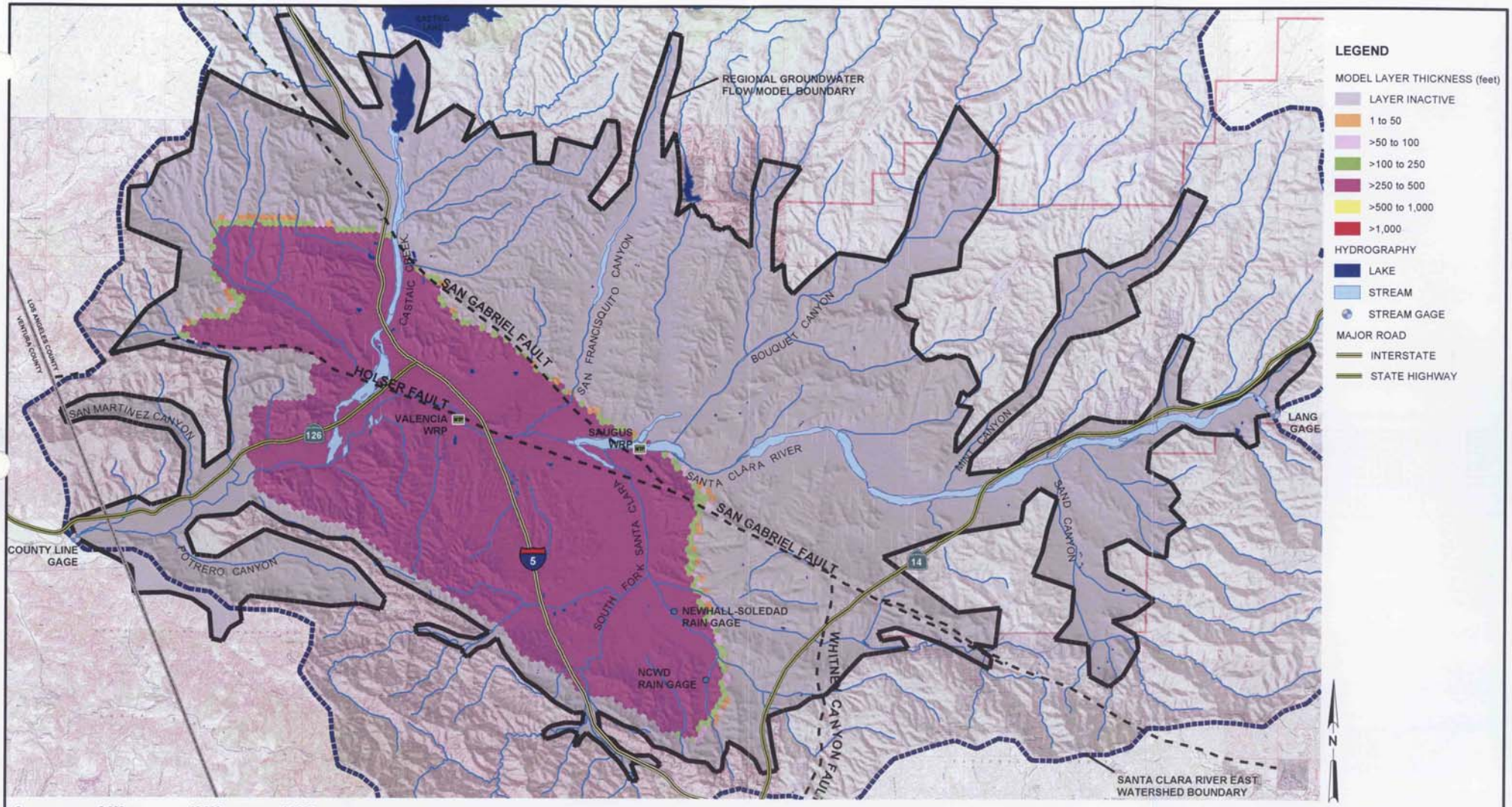

FIGURE 3-8
THICKNESS OF MODEL LAYER 6
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG025.MXD FIG03-08.PDF 02/04/2004 11:26:22

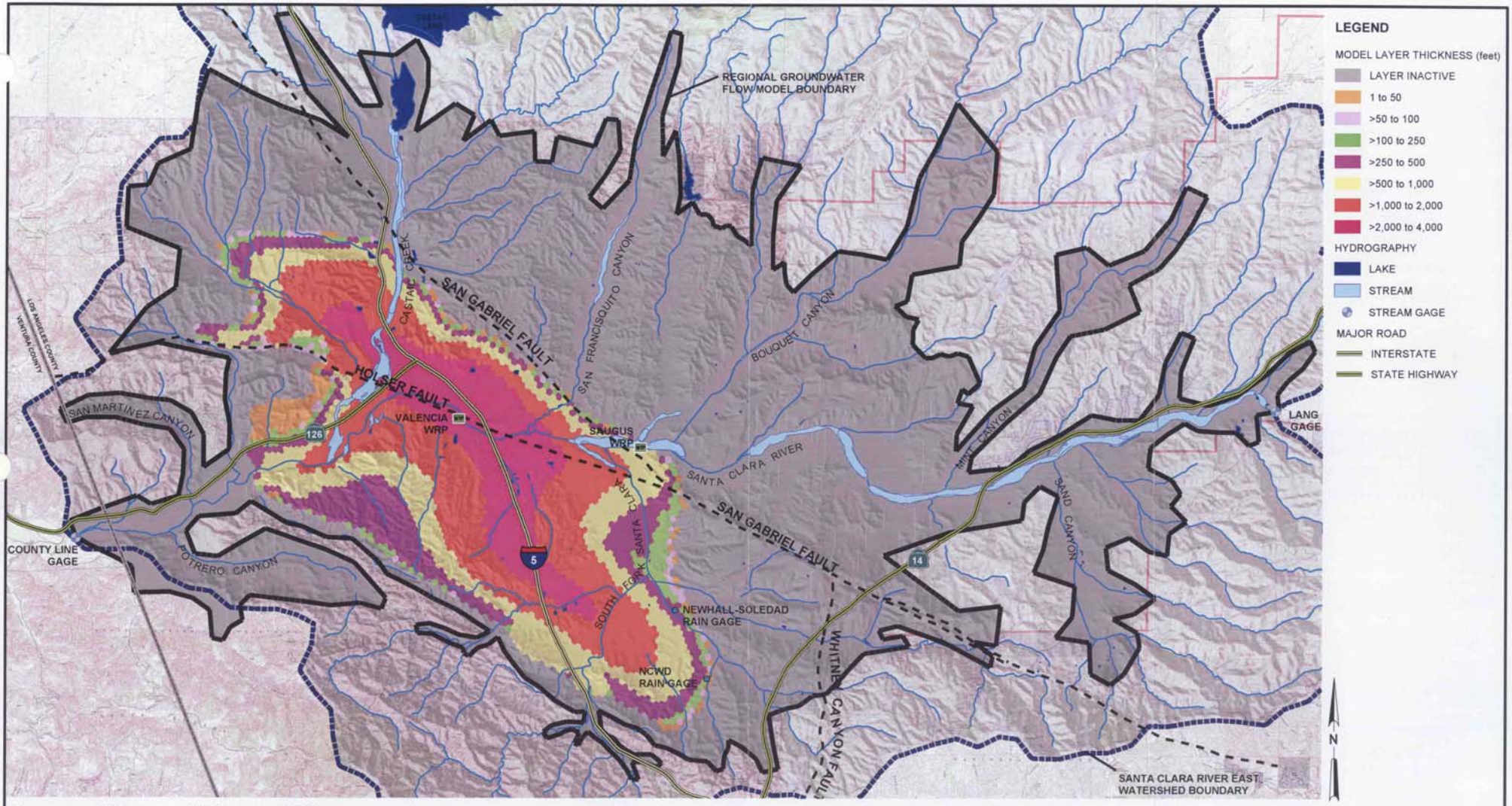

FIGURE 3-9
THICKNESS OF MODEL LAYER 7
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG026.MXD FIG03-09.PDF 02/02/2004 14:09:12

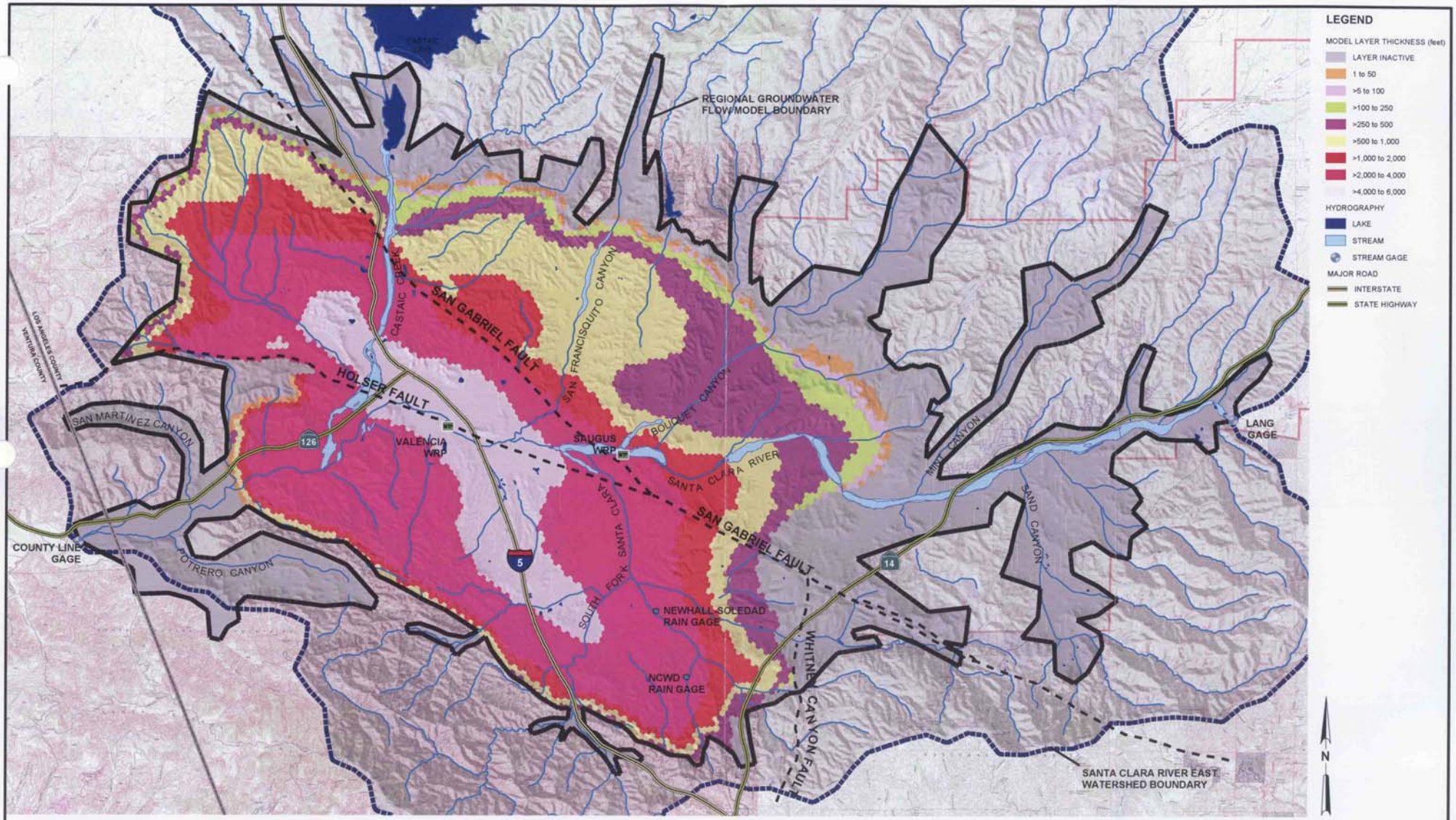

FIGURE 3-10
THICKNESS OF SAUGUS FORMATION (MODEL LAYERS 1 THROUGH 7)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG044.MXD FIG03-10.PDF 02/04/2004 14:19:00

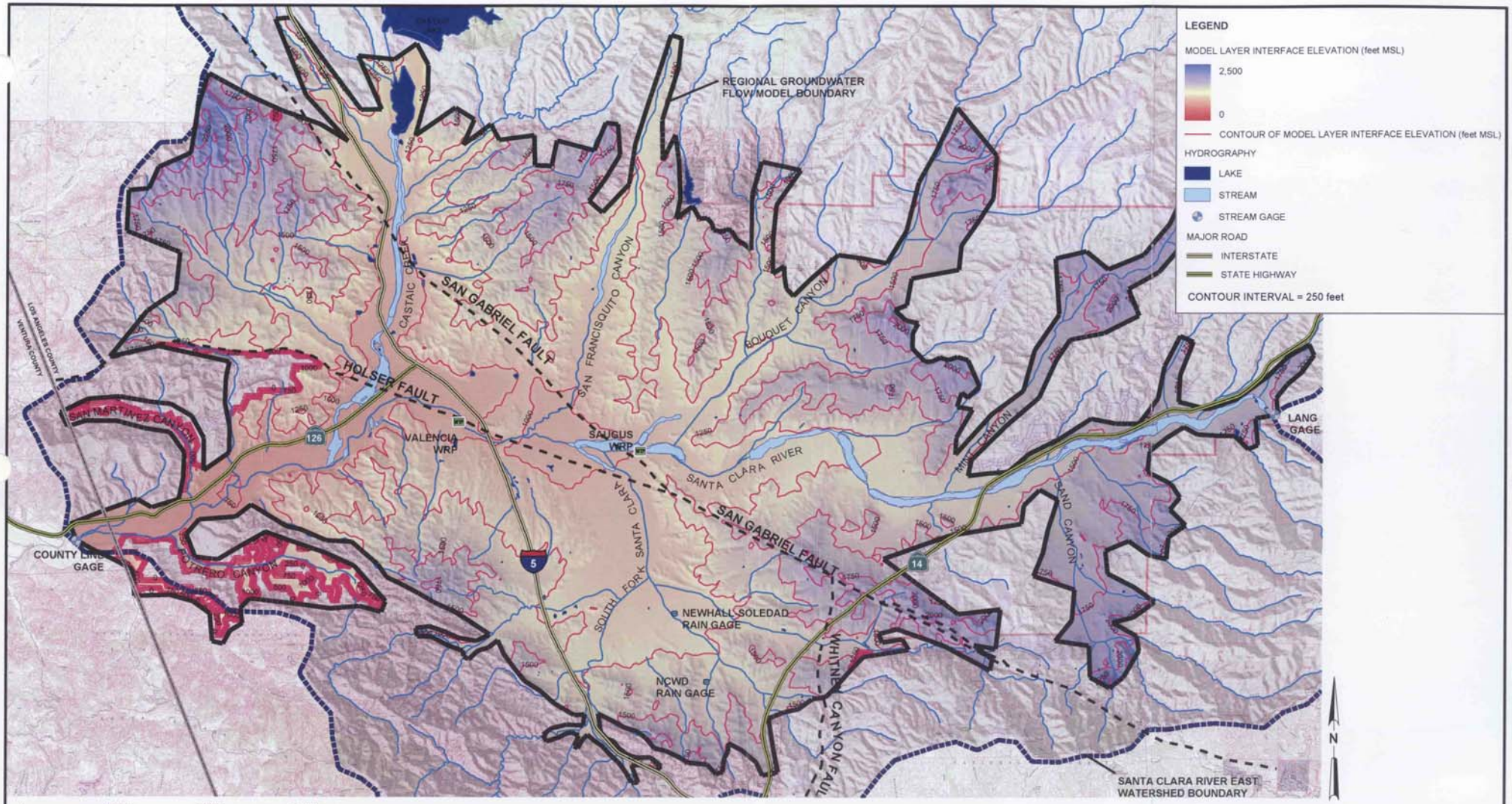

FIGURE 3-11
LAYER 1 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG027.MXD FIG03-11.PDF 02/04/2004 11:36:12

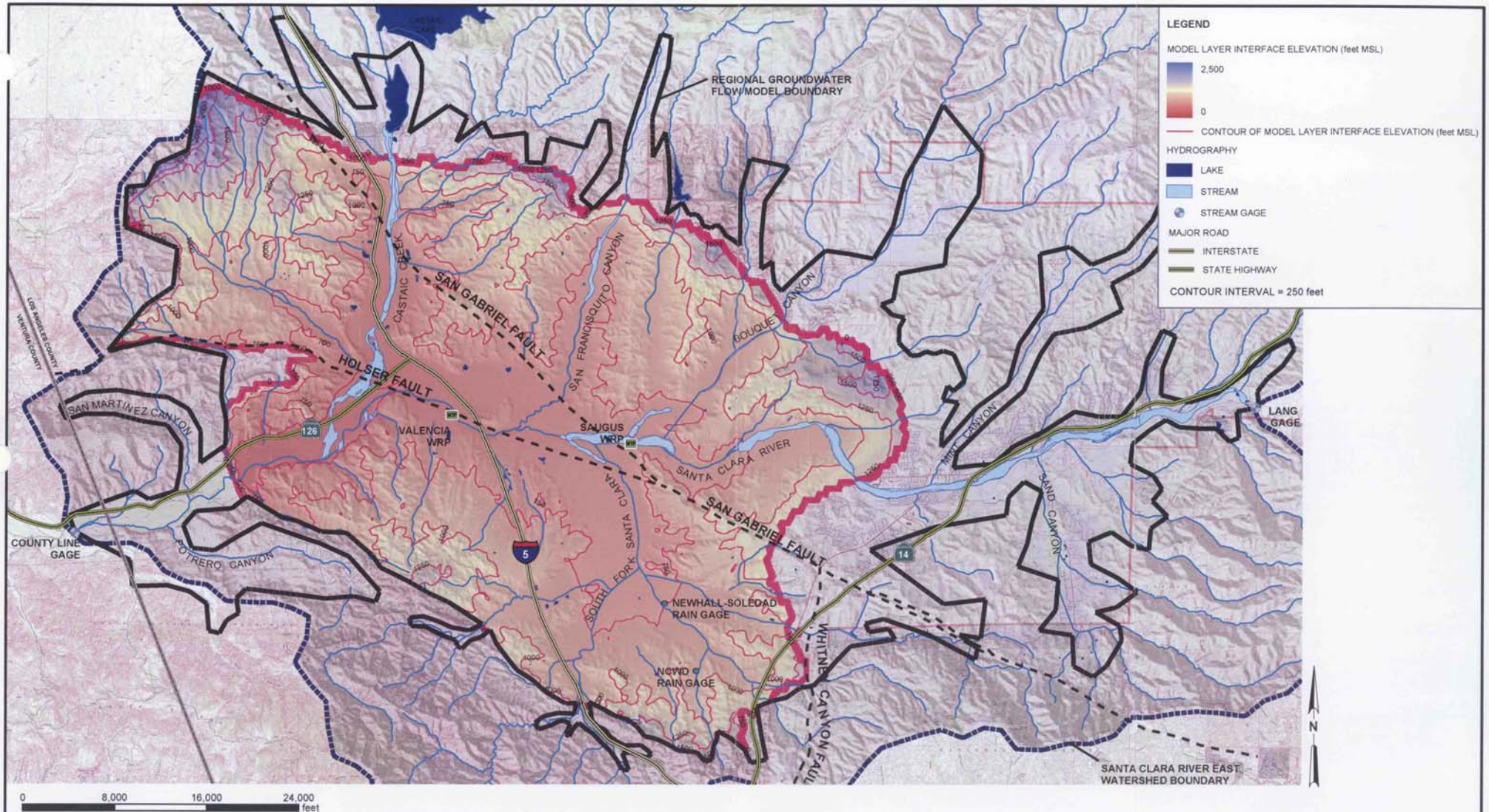

FIGURE 3-12
LAYER 2 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG028.MXD FIG03-12.PDF 02/04/2004 11:36:12

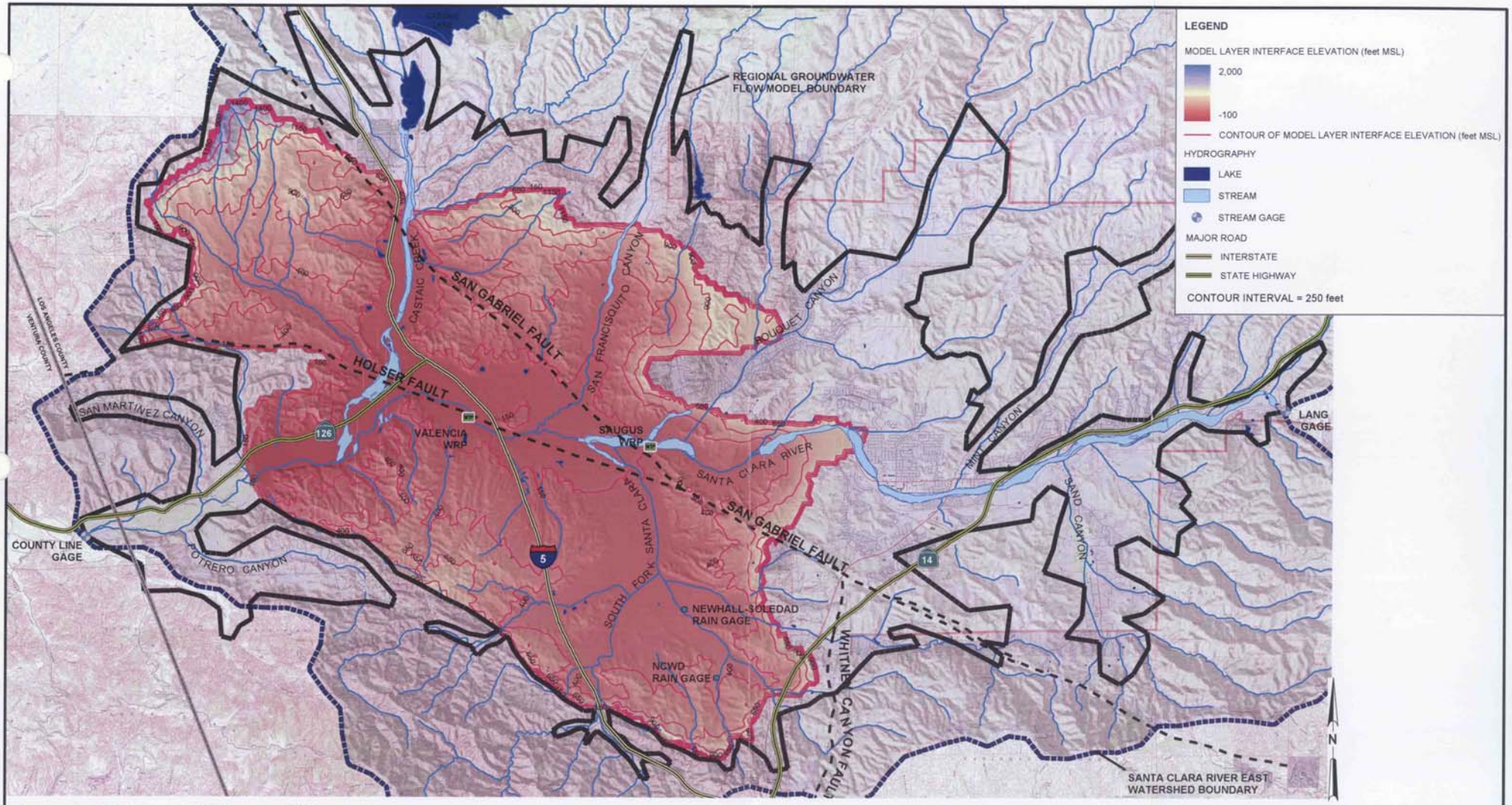

FIGURE 3-13
LAYER 3 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG029.MXD FIG03-13.PDF 02/04/2004 11:42:48

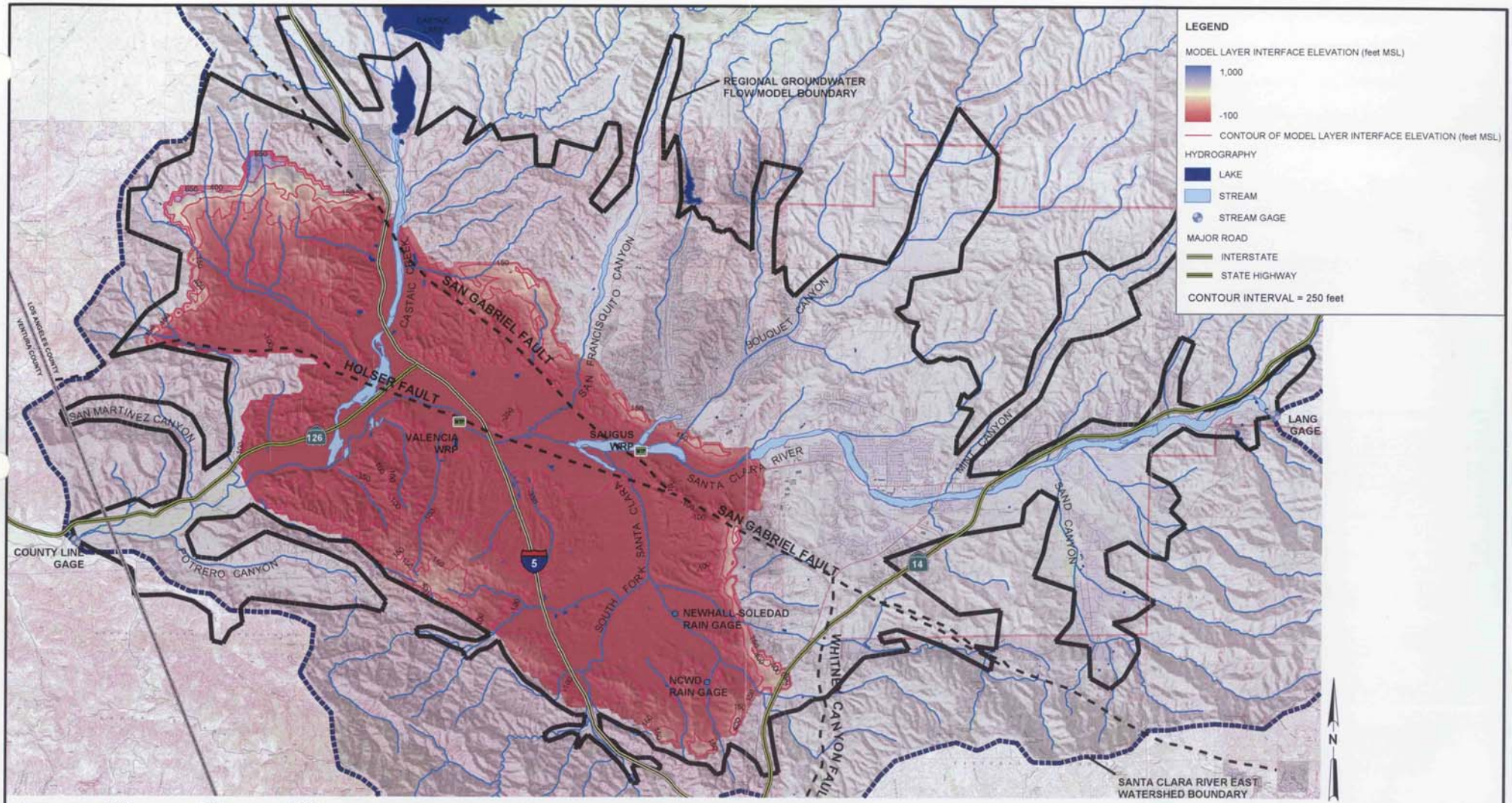

FIGURE 3-14
LAYER 4 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG030.MXD FIG03-14.PDF 02/04/2004 11:53:17

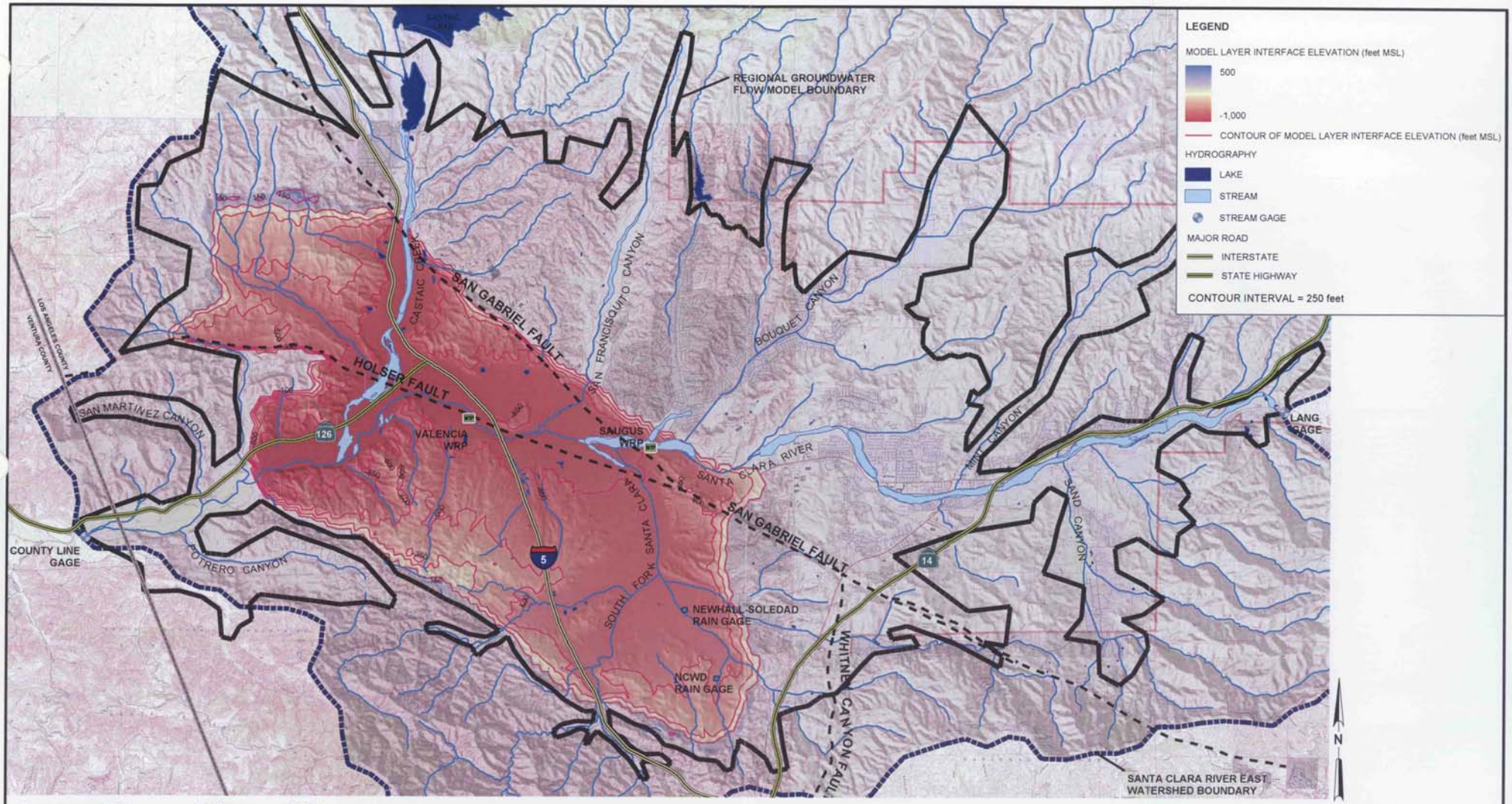

FIGURE 3-15
LAYER 5 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG031.MXD FIG03-15.PDF 02/04/2004 12:53:31

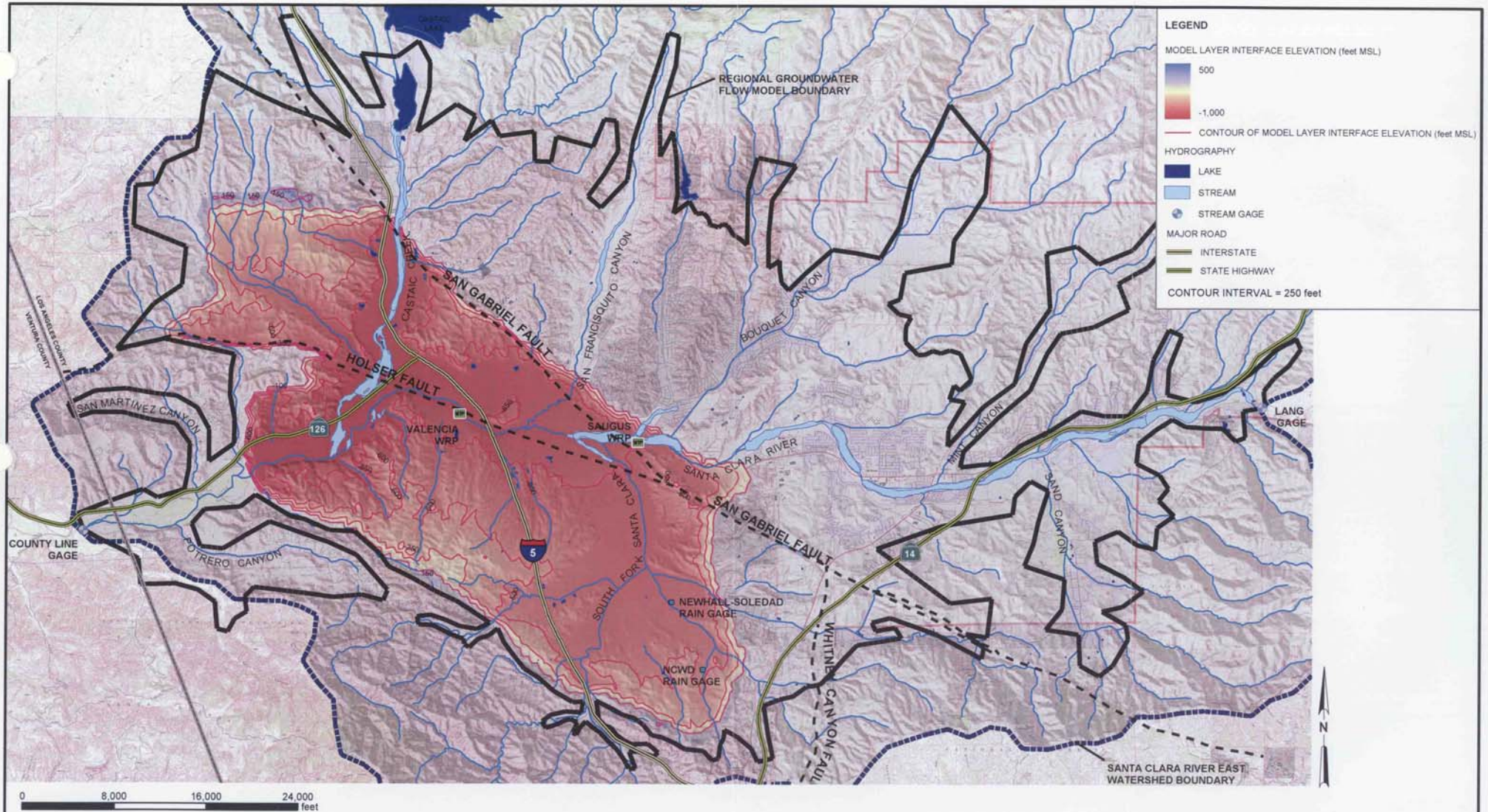

FIGURE 3-16
LAYER 6 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG032.MXD FIG03-16.PDF 02/04/2004 13:03:59

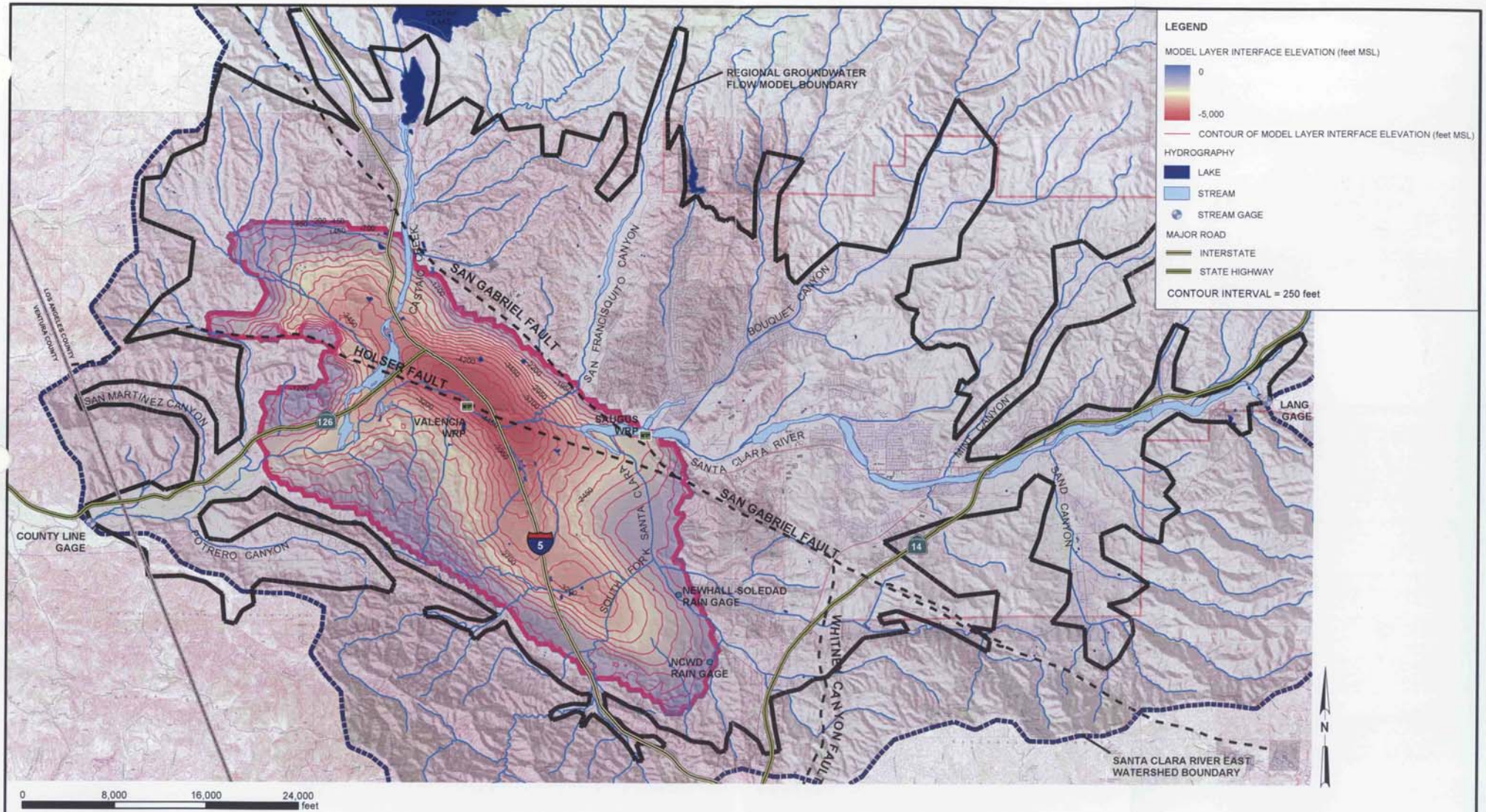

FIGURE 3-17
LAYER 7 BASE ELEVATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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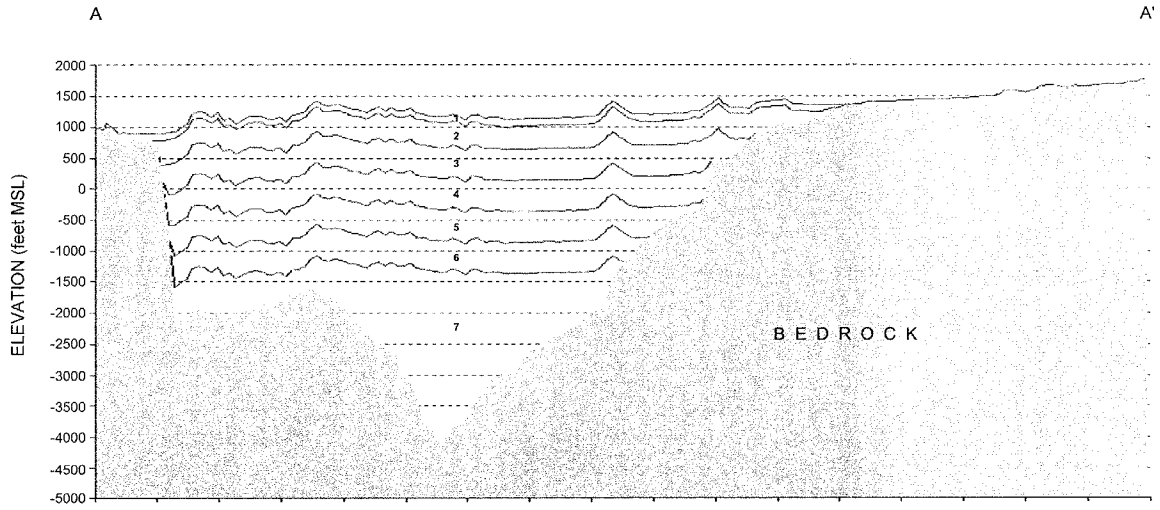
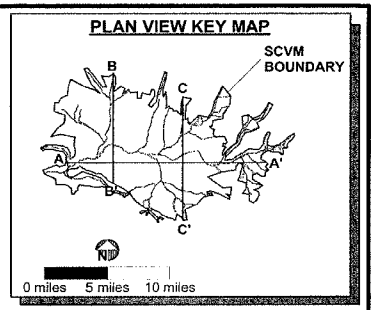
RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG033.MXD FIG03-17.PDF 02/03/2004 13:13:34





LEGEND

1 = MODEL LAYER 1

2 = MODEL LAYER 2

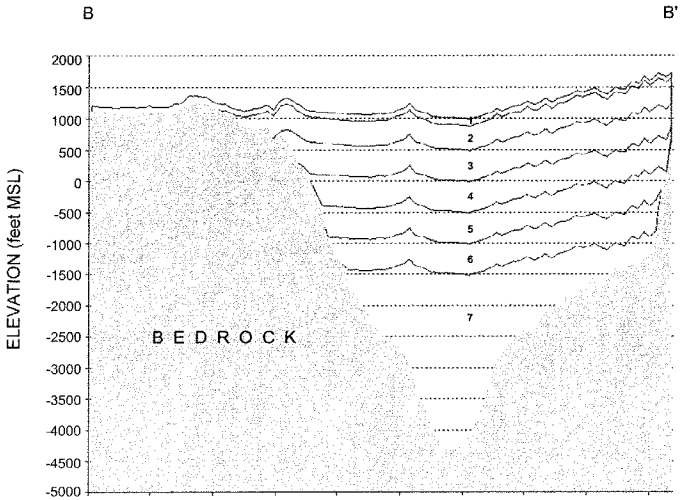
3 = MODEL LAYER 3

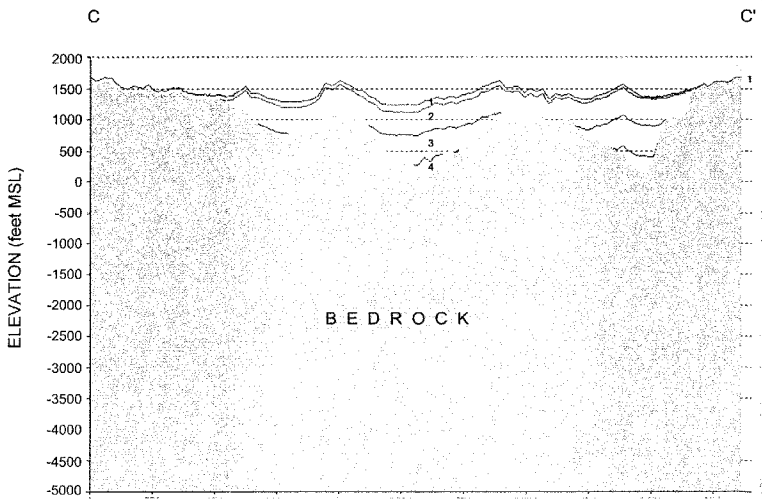
4 = MODEL LAYER 4

5 = MODEL LAYER 5

6 = MODEL LAYER 6

7 = MODEL LAYER 7





HORIZONTAL CROSS SECTION SCALE

0 feet 10,000 feet 20,000 feet

5x VERTICAL EXAGGERATION

FIGURE 3-18
SCHEMATIC CROSS SECTIONS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

SCHEMATICCROSSSECTIONS.SRF

SECTION 4

Model Calibration Process

This section describes the model calibration process. The Regional Model was calibrated according to the *Standard Guide for Calibrating a Ground-Water Flow Model Application,* published by the American Society for Testing and Materials (1996), which describes how to calibrate a model using historical data, including how to establish calibration target data, identify calibration parameters, and compare field data to model calibration results.

Following are discussions of the historical field conditions that were simulated during calibration; the goals of the calibration process; the model parameters (variables) that were adjusted during calibration; and the procedures and target data that were used to conduct the calibration process.

4.1 Calibration Conditions

Calibration of the Regional Model involved matching both steady-state and transient conditions in the Alluvial Aquifer and the Saugus Formation.

4.1.1 Steady-State Calibration

The steady-state calibration was performed for calendar years 1980 through 1985. The purpose of the steady-state model was to simulate average regional flow patterns, regional hydraulic gradients, and groundwater budgets during the initial time period to be modeled as part of the transient calibration effort. The steady-state model also provided initial groundwater elevations for the beginning of the transient model.

During the 1980 through 1985 period:

a. The average precipitation (20.15 in/yr) was approximately 2.5 inches higher than the 1950 through 2000 mean (17.35 in/yr).

b. Alluvial Aquifer pumping decreased slightly (see Table 2-1).

c. Saugus pumping remained relatively constant, between 3,800 and 5,000 AF/yr (see Table 2-2).

d. Importation of SWP water increased steadily, from 1,125 acre-feet in 1980 to 11,823 acre-feet in 1985.

e. WRP discharges into the Santa Clara River increased from approximately 7,400 AF in 1980 to approximately 9,600 AF in 1985.

f. Groundwater elevations in the Alluvial Aquifer remained relatively stable, except for a slight decline in the eastern part of the valley during 1984 and 1985, due to below-normal rainfall during those years.

g. Groundwater elevations in the Saugus Formation remained relatively stable.

Hence, even though SWP imports and WRP discharges increased during this period, groundwater elevations did not rise, instead remaining fairly stable or decreasing slightly due to the relatively stable natural hydrologic conditions during this 6-year period and the below-normal rainfall in 1984 and 1985. Consequently, this time period was deemed suitable for the steady-state portion of the model calibration effort.

4.1.2 Transient Calibration

The transient calibration was performed for calendar years 1980 through 1999 to create a model capable of simulating seasonal and long-term variations in groundwater elevations, groundwater recharge, and groundwater discharge for a historical period characterized by variable rainfall and recharge and changing land use and water use patterns. This 20-year period was chosen for the following reasons:

a. The volume of data is greater during this period than in previous years. In particular, SCWC and VWC installed several production wells in the Saugus Formation during this time period. Also, regular monitoring of groundwater levels was performed at more wells during this period than before.

b. Annual pumping volumes are well known before and after the 1970s, but are not as well known during that decade. Hence, it would be more difficult to calibrate a model during the 1970s because of the uncertainties in pumping volumes during that time.

c. Significant urban growth occurred in the valley between 1980 and 1999. This growth resulted in changes in land use and increased importation of SWP water, from 1,125 acre-feet in 1980 to 27,302 acre-feet in 1999.

d. The local hydrology and the hydrology of the SWP system varied considerably during this period, and included single-year and multi-year droughts both locally and in the SWP system. (See Section 2.6.3.3.) Specifically, the groundwater elevations in the Alluvial Aquifer and the Saugus Formation showed multi-year periods of water level decline followed by multi-year periods of water level recovery. Consequently, calibrating to this period would allow a model to predict basin conditions during and between future drought periods.

4.2 Calibration Goals

The success of the model calibration was determined by its ability to satisfy specific calibration goals that were established by the CH2M HILL project team and the Purveyors. Separate calibration goals were defined for the steady-state model and the transient model. The specific goals are given below, along with a discussion of how calibration success was measured. Calibration goals are comprised of quantitative (statistical) and qualitative criteria.

4.2.1 Calibration Goals for the Steady-State Model

a. **Groundwater Flow Directions.** Correctly simulate groundwater flow directions in the Alluvial Aquifer and Saugus Formation, as defined by regional groundwater elevation contour maps prepared by RCS (1985, 1986, 2002) for various periods in both aquifer systems. (See Figures 2-7 and 2-8.)

b. **Groundwater Elevation Residuals.** At each target well, simulate groundwater elevations to within 10 feet in the Alluvial Aquifer and 25 feet in the Saugus Formation, compared with observed average groundwater elevations during this period. The value of the modeled groundwater elevation minus the observed average groundwater elevation is called the residual error (residual). A positive residual at a given target well indicates that the model simulates too high a groundwater elevation. Conversely, a negative residual indicates that the model simulates too low a groundwater elevation.

c. **Statistics of Groundwater Elevation Residuals.** Achieve the following statistics for the residuals on a modelwide scale (i.e., for the combined group of calibration target wells):

   1. A mean residual as close to zero as possible.

   2. A mean residual that is less than 5 percent of the range in groundwater elevations measured at the target wells.

   3. A root-mean-square (RMS) error of less than 10 feet for the residuals at Alluvial Aquifer target wells and less than 25 feet for the residuals at Saugus target wells.

   4. A normalized RMS error of 10 percent or less. The normalized RMS error equals the modelwide RMS error divided by the range in groundwater elevations across the entire model domain.

   5. A normalized residual standard deviation of less than 10 percent. The normalized residual standard deviation equals the standard deviation of the residuals divided by the range in groundwater elevations across the entire model domain.

   6. Minimize the degree of spatial bias in the distribution of the residuals. Specifically, avoid creating large areas where the residuals are predominantly positive or predominantly negative. A well-calibrated model shows a scattering of negative and positive residuals within any given localized area.

d. **Groundwater Gradients.** Simulate the direction and magnitude of groundwater gradients across the model domain, including a significant horizontal gradient in the Saugus Formation that exists across the San Gabriel Fault (as measured at four multi-port monitoring wells located on the Whittaker-Bermite property, east of wells SCWC-Saugus1 and SCWC-Saugus2).

e. **Groundwater Below Ground Surface.** At nodes where streams are not present, maintain groundwater elevations below ground surface. At stream nodes, groundwater elevations should also be below ground surface in most ephemeral reaches, though a limited number of nodes can have higher groundwater elevations in the downstream ephemeral reaches, where the exact location of the transition from ephemeral to perennial conditions is variable over time and is only approximately known.

f. **Groundwater Discharge to River.** Simulate a groundwater discharge to the Santa Clara River on the order of 29,000 AF/yr, which is the estimated average baseflow during the steady-state model period (see Section 2.6.2.5).

4.2.2 Calibration Goals for the Transient Model

a. **Water Level Trends/Hydrographs.** Match observed fluctuations in groundwater elevations.

b. **Groundwater Below Ground Surface.** Maintain groundwater elevations below ground surface in the same general areas as previously discussed for the steady-state model.

c. **Total River Flow at County Line Gage.** Match the observed Santa Clara River flows measured at the County Line gage.

d. **Groundwater Discharge to River.** Match the estimated groundwater discharge rates to the Santa Clara River.

Discussions of how these calibration goals are met by the Regional Model are contained in Section 4.4.

4.3 Calibration Variables

The following variables were the subject of model calibration and testing:

a. The horizontal hydraulic conductivity (Kh) and the vertical anisotropy (R), which is the ratio of horizontal to vertical hydraulic conductivity

b. The storage coefficients

c. The relationship between rainfall and stormwater runoff in the tributary watersheds lying upstream of the groundwater basin

d. The riverbed permeabilities in gaining and losing reaches of stream systems, particularly in the ephemeral reach of the Santa Clara River and in Castaic Creek

e. ET parameters (primarily rooting depth and the maximum potential ET rate)

4.3.1 Horizontal Hydraulic Conductivity and Vertical Anisotropy

Because the Regional Model consists of over 17,000 active nodes in each of the seven model layers, the calibration process relied on the definition of zones of uniform hydraulic conductivity (K), spanning multiple nodes in a given layer and, in some areas, spanning multiple layers. Specifically, in a given layer, a geographic area was defined as a zone, and the Kh and R values were assigned to all model cells in that zone.

The number of zones and their locations were assigned in the model by primarily considering the hydrostratigraphy and the locations of target wells in the various calibration models, then considering the spatial variations in saturated thickness as summarized by RCS (2002). During the course of the calibration process, adjustments were made to the locations of the zone boundaries and the number of zones. Figures 4-1 and 4-2 show the geographic area designations for the Alluvial Aquifer and Saugus Formation, respectively. In the final calibrated Regional Model, 48 zones were used in the Alluvial Aquifer and 8 zones were used in the Saugus Formation, including a zone along the San Gabriel fault.

The values of Kh for each zone in the Alluvial Aquifer were specified at the beginning of the calibration process from the analyses of specific capacity tests (Table 2-3). In the Saugus Formation, Kh and R values were initially defined from the ASR test analysis (CH2M HILL, 2001) and, in the case of Kh values, also from slug test results on the Whittaker-Bermite property (CH2M HILL, 2003). During calibration, attempts were made to keep these values as close to the initial assigned values as possible. However, adjustments were made if changes to other parameter values were unable to bring the model into calibration.

4.3.2 Storage Coefficients

Model layer 1 was assigned a specific yield of 0.10 to simulate this layer as unconfined. The specific yield was allowed to range between values as low as 0.075 and as high as 0.15. The final Regional Model used a value of 0.10 at each node in layer 1 for both the Alluvial Aquifer and the Saugus Formation (see Section 5).

In model layers 2 through 7, which simulate portions of the Saugus Formation lying below the uppermost model layer, the storage coefficients were allowed to range between 10^{-4} and 10^{-3}, based on analyses of the ASR test results (RCS, 2001) and pumping tests at other Saugus wells (RCS, 2002).

4.3.3 Stormwater Runoff in Upstream Watersheds

See Section 3.6 and Appendix C for discussions of the SWRM, which determined the amount of stormwater generated in upstream watersheds that is available to recharge the Alluvial Aquifer.

4.3.4 Riverbed Permeabilities

The establishment of streambed permeabilities for perennial (gaining) and ephemeral (losing) stream reaches are discussed separately below.

4.3.4.1 Perennial (Gaining) Streams

The streambed conductance terms in the MicroFEM® drain and wadi packages regulate the rate of water exchange between groundwater and surface water along selected stream reaches in the valley. As discussed in Section 3.5, the wadi package is used along the perennial reach of the Santa Clara River, and the drain package is used in the river's ephemeral reach and along Castaic Creek to drain groundwater during periods of high water table conditions. For the drain and wadi packages, the streambed conductance at each node where these packages are used is defined from the following relationship:

$$C = (a/LW) * ([0.5*b_{aq}/Kv_{aq}] + [b_{stream}/Kv_{stream}]) \quad (1)$$

where at each stream node:

a = wetted area of the streambed

L = one-half of the combined lengths of the two grid segments (lines) that connect the stream node to the adjoining upstream and downstream stream nodes

W = the width of the streambed

b_{aq} = the thickness of the Alluvial Aquifer beneath the stream node

Kv_{aq} = the vertical hydraulic conductivity of the Alluvial Aquifer beneath the stream node

b_{stream} = the thickness of the riverbed sediments

Kv_{stream} = the vertical hydraulic conductivity of the riverbed sediments

The calibrated Regional Model uses values of 2 feet for b_{aq} and 10 ft/day (3.5×10^{-3} centimeters per second [cm/sec]) for Kv_{aq}.

4.3.4.2 Ephemeral (Losing) Streams

During the transient calibration phase of model development, the SWRM adjusted the streambed conductance terms for Castaic Creek and for the ephemeral reach of the Santa Clara River. Adjustments in streambed conductance values were made for the following reasons:

a. To integrate this term into the transient model calibration process

b. To account for the variations in streambed conductance that arise from:

   1. Variations in riverbed permeability along the length of the streambed
   2. Variations in riverbed permeability that can occur at a given location due to sediment scouring and redeposition processes that occur during storm runoff periods
   3. Variations in streambed conductance that arise from variations in the width of the river (greatest during storm runoff periods, smallest during low-flow periods)

The adjustment of streambed conductance values during calibration of the transient model was performed for each month and was conducted in an iterative manner by running both the SWRM and the Regional Model repeatedly until the streambed conductance terms or groundwater elevations showed no significant changes (see Appendix C).

4.3.5 Evapotranspiration Parameters

The ET rooting depth was set at 10 feet to correspond to typical rooting depths for phreatophytes such as the willow and cottonwood trees that are present in the riparian corridor along the perennial reach of the Santa Clara River. The maximum potential ET rate was set at 6 feet per year (ft/yr) during model calibration. Ground surface elevation was specified by importing USGS Digital Elevation Model files.

4.4 Calibration Procedure and Target Calibration Data

The steady-state and transient models were calibrated by running the Regional Model and comparing results to the calibration goals described in Section 4.2. The comparison of model results with calibration goals relied on the use of target data that consisted of groundwater elevation data, groundwater discharge to the river, and total flow in the river. Following are discussions of the target calibration data.

4.4.1 Groundwater Elevation Target Data

Alluvial Aquifer target wells were selected for each of the Alluvial zones shown in Figure 4-1. In the Saugus Formation, most wells were used as targets (Figure 4-2). Generally, the selected target wells were those with the greatest number of groundwater elevation measurements during the periods 1980 through 1985 for the steady-state model and 1980 through 1999 for the transient model. Some wells were measured routinely through 1985 but not through 1999, and some wells were not measured until after 1985. Therefore, the list of wells used as targets is different for the steady-state and transient models.

Figure 4-1 shows the target wells for the Alluvial Aquifer, and Figure 4-2 shows the target wells for the Saugus Formation. Table 4-1 provides location and construction information for each target well. The target wells include (1) purveyor-owned production wells; (2) production wells located at the Wayside Honor Rancho (WHR) facility; and (3) a network of non-pumping or low-pumping monitoring wells where water levels have been measured routinely by the Los Angeles County Flood Control District (LACFCD) for many years.

For the production wells, the available water level measurements have been recorded as pumping elevations and static elevations. Static elevations are collected when the well is not pumping. Model-simulated groundwater elevations at a pumping well will be higher than those measured under pumping conditions for the following reasons:

a. In the model, pumping is assigned at these wells, but the pumping nodes have much larger areas than the diameter of the borehole in which each well is completed.

b. The field measurements of groundwater elevations under pumping conditions measure lower groundwater elevations than exist in the aquifer adjacent to the borehole, due to well losses across the borehole wall and the screen or slotted pipe.

Therefore, for model calibration purposes, the calibration goal at target wells that pump was to simulate groundwater elevations as close to the static elevations as possible, while also ensuring that simulated elevations were higher than the pumping elevations. More importantly, the transient calibration effort focused on the periods with the greatest groundwater elevation changes, and the analysis specifically focused on the slopes of the hydrographs, not just the absolute magnitudes of the groundwater elevations.

In the tributary canyons east of I-5, geologic logs were unavailable for many of the LACFCD wells. The total depths and open intervals for many of these wells suggested that they were completed in the geologic units underlying the alluvium, probably due to limited saturated thickness in the alluvium, particularly in the upper reaches of each canyon. For this reason, no targets were selected in Mint Canyon or upstream of the SCWC-Clark production well in Bouquet Canyon. In Sand Canyon, only the well farthest downstream, 7188A, was deemed suitable for use as an Alluvial Aquifer target well. Along the South Fork Santa Clara River, geologic logs and well construction data indicate that all target wells are constructed in the Saugus Formation, not the alluvium. The geologic data indicate that there is very limited saturated thickness in the alluvium in this area.

4.4.2 Santa Clara River Baseflow and Total Flow

Target river flow data to which the Regional Model results were compared were the total gaged flow at the County Line gage and estimates of how much of the gaged flow consisted of groundwater discharge to the river (baseflow).

The simulated total flow at the County Line gage equaled the sum of:

a. The simulated groundwater discharge to the river as calculated by the groundwater model from all wadi and drain nodes

b. The volume of water in the streams that the Visual Basic program (described in Section 3.6 and Appendix C) calculated as surplus stream flow that would not infiltrate to the underlying Alluvial Aquifer

This simulated total flow was compared directly with County Line gage results. The simulated groundwater discharge to the river was compared with the estimated values of river baseflow described previously in Section 2.6.2.5 of this report and listed in Table 2-6. For the steady-state model, the average baseflow during the period 1980 through 1985 was approximately 29,000 AF/yr.

4.4.3 Adjustments to Model Parameters

The steady-state and transient calibration process involved the adjustment of multiple parameters. Initially, the calibration effort focused on the steady-state model, where adjustments were made to Kh and Kv values and streambed coefficients, particularly in the gaining reaches of streams, to establish groundwater elevations, gradients, and flow directions. Attention was then devoted to the transient model, where the parameters receiving adjustment were the storativity, Sy, and the stormwater infiltration rates. Adjustments to Kh and Kv values that had been established during steady-state calibration were considered during transient calibration, but adjustments to these parameters were found to be unnecessary.

Initially, these efforts to calibrate the steady-state and transient models used a fixed, specified relationship between precipitation and stormwater to define the amount of water available for potential infiltration to groundwater. As Appendix C discusses, this relationship was in the form of an empirical power-function equation developed by Turner (1986). The empirical equation uses power-function coefficients that Turner (1986) developed from measurements of the yields from 68 different watersheds throughout California. Although the equation was used throughout the calibration process, including in the final model, the steady-state and transient calibration processes indicated that the empirical power-function coefficients reported by Turner (1986) generated too much stormwater and groundwater recharge to the Santa Clarita Valley during dry years and too little stormwater and groundwater recharge during wet years. This was determined by comparing hydrographs of measured and modeled groundwater elevations and river flows. After many attempts to achieve calibration by adjusting other model parameters, it was concluded that a different set of power coefficients would need to be developed for the Santa Clarita Valley. Consequently, during the final stages of calibration, adjustments to the model focused primarily on the values of these coefficients and on the values of the streambed vertical hydraulic conductivity. Calibration was considered complete once it was determined that the calibration goals were achieved or that no further improvements to the model were possible.

Tables

TABLE 4-1
Target Wells for Calibration of the Regional Model
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Well Owner-Well Name	Location	Model Zone	Well in Steady-State Model	Well in Transient Model	Year Drilled	Status 1986	Status 2001	Well Use	Easting (feet)[a]	Northing (feet)[a]	Measuring Point Elevation (feet MSL)	Total Depth (feet bgs)	Depth to Top of Open Interval (feet bgs)	Depth to Base of Open Interval (feet bgs)	Type of Open Interval	Drilling Method	Sanitary Seal Depth (feet bgs)	Depth of Pump Intake (feet bgs)
Alluvial Aquifer West of I-5																		
NLF-B11	Santa Clara River	C1c	No	Yes	---	Active	Active	Agricultural supply	6362161	1971971	886							
NLF-B10	Santa Clara River	C1c	Yes	No	1956	Active	Active	Agricultural supply	6364235	1974541	901.4	142	30	130	Knife cut			
NLF-B7	Santa Clara River	C1c	No	Yes	1946	Active	Active	Agricultural supply	6364397	1973939	901.6	102	18	88	Knife cut			
NLF-C5	Santa Clara River	C1b	Yes	No	1939	Active	Active	Agricultural supply	6371746	1977874	960.1	139	31	133	Knife cut			
NLF-C6	Santa Clara River	C1b	No	Yes	1939	Active	Active	Agricultural supply	6371835	1978154	966	103	26	93	Knife cut			
NLF-E4	Santa Clara River	C1a	Yes	Yes	1940	Active	Active	Agricultural supply	6374844	1982371	992.5	142	50	136	Knife cut			
6995D	Santa Clara River	C1a	Yes	No	1970	Active	Active	Water levels	6379091	1983329	1018						0	
NLF-G45	Santa Clara River	B1b1	No	Yes	---	Active	Active	Agricultural supply	6381356	1982222	1030	140	40	140				
7076C	Santa Clara River	B1b1	Yes	No	---	Active	Destroyed?	Water levels	6385042	1980084	1059						0	
Alluvial Aquifer between I-5 and Soledad Canyon																		
VWC-I	Santa Clara River	B1b2	No	Yes	1945	Active	Inactive	Municipal supply	6388567	1981657	1090	171	30	165			55	120
NLF-S3	Santa Clara River	B1a	No	Yes	---	Active	Destroyed	Agricultural supply	6393334	1978292	1129	250	95	205				
VWC-N	Santa Clara River	B1a	No	Yes	1936	Active	Active	Municipal supply	6395527	1976081	1130	280	76	237	Knife cut		50	140
VWC-K2	Santa Clara River	B1a	Yes	No	1945	Active	Active	Municipal supply	6395788	1976021	1132	242	62	230	Knife cut		50	63
NLF-R	Santa Clara River	B1a	Yes	No	---	Active	Destroyed	Agricultural supply	6397463	1977860	1157	160	40	140				
7067D	Santa Clara River	B1a	No	Yes	1964	Active	Destroyed?	Water levels	6398546	1977483	1157.5						0	
VWC-Q2	Santa Clara River	B1a	No	Yes	1954	Active	Active	Municipal supply	6399032	1977459	1158	170	76	126				100
Alluvial Aquifer in Soledad Canyon																		
SCWC-Stadium	Santa Clara River	A1e1	Yes	Yes	1946	Active	Active	Municipal supply	6402385	1974713	1197	130	33	130	Knife cut	Unknown		130
VWC-T4	Santa Clara River	A1e1	Yes	No	1953	Active	Active	Municipal supply	6403350	1975164	1191	150	50	135	Knife cut		50	100
VWC-T2	Santa Clara River	A1e1	No	Yes	1952	Active	Active	Municipal supply	6403623	1975127	1201	150	50	138	Knife cut			100
LACFCD-7107C	Santa Clara River	A1d1	Yes	No	---	Active	Destroyed?	Water levels	6410792	1975622	1276						0	
SCWC-Honby	Santa Clara River	A1d1	No	Yes	1959	Active	Active	Municipal supply	6411408	1977202	1282	226	50	202	Factory	Rotary	30	130
7127D	Santa Clara River	A1d2	Yes	Yes	1974	Active	Active	Water levels	6417808	1977062	1333	157					0	
SCWC-N.Oaks West	Santa Clara River	A1d4	Yes	No	1940	Active	Active	Municipal supply	6421187	1972857	1392	136	80	118	Knife cut	Unknown		110
SCWC-N.Oaks East	Santa Clara River	A1d4	No	Yes	1940	Active	Active	Municipal supply	6421651	1972936	1398	132	81	150	Knife cut	Unknown		130
7148K	Santa Clara River	A1c1	No	Yes	---	Active	Active	Water levels	6423523	1973851	1435						0	
7158K	Santa Clara River	A1c2	Yes	No	1965 or earlier	Active	Active	Water levels	6427699	1973490	1460						0	
7168C	Santa Clara River	A1c2	Yes	Yes	---	Active	Active	Water levels	6430088	1974149	1488						0	
SCWC-Mitchell	Santa Clara River	A1c2	No	Yes	1976	Active	Active	Municipal supply	6430168	1974420	1489	262	76	246	125 Mesh	Rotary	76	162
SCWC-Sand Canyon	Santa Clara River	A1c3	Yes	No	1973	Active	Active	Municipal supply	6432953	1975589	1523	127	60	140	Factory	Rotary	60	112
7178D	Santa Clara River	A1c3	Yes	No	1950 or earlier	Active	Active	Water levels	6433648	1975837	1528						0	
SCWC-Lost Canyon 2	Santa Clara River	A1c3	No	Yes	1965	Active	Active	Municipal supply	6433582	1975573	1530	310	95	125	Factory	Rotary	30	295
7177B	Santa Clara River	A1b1	No	Yes	1949 or earlier	Active	Active	Water levels	6434745	1976476	1542						0	
7177P	Santa Clara River	A1b1	Yes	No	---	Active	Active	Water levels	6434036	1976556	1542						0	
7187C	Santa Clara River	A1b2	Yes	No	---	Active	Active	Water levels	6435847	1977582	1548						0	
7197	Santa Clara River	A1b2	Yes	Yes	1945 or earlier	Active	Destroyed?	Water levels	6437790	1977821	1579						0	
7197D	Santa Clara River	A1b2	No	Yes	---	Active	Active	Water levels	6438053	1977798	1582						0	
NCWD-Pinetree1	Santa Clara River	A1b2	No	Yes	1966	Active	Active	Municipal supply	6439881	1977964	1588	235	50	210			20	160
7197G	Santa Clara River	A1b2	Yes	No	1974 or earlier	Active	Active	Water levels	6440544	1978061	1600						0	
Alluvial Aquifer along Castaic Creek																		
VWC-D	Castaic Creek	C2b	No	Yes	1950	Active	Active	Municipal supply	6375668	1987267	1036	142	60	136	Knife cut		50	100
6993A	Castaic Creek	C2b	Yes	Yes	1958 or earlier	Active	Active	Water levels	6377865	1992457	1067						0	
6981D	Castaic Creek	C2a	Yes	Yes	1972 or earlier	Active	Active	Water levels	6376437	2000534	1127						0	
NCWD-Castaic3	Castaic Creek	C2a	No	Yes	1961	Active	Active	Municipal supply	6376475	2002309	1141	135	55	136				100
6980E	Castaic Creek	C2a	No	Yes	1962 or earlier	Active	Active	Water levels	6376282	2002242	1144						0	
6980G	Castaic Creek	C2a	Yes	No	1962 or earlier	Active	Destroyed?	Water levels	6376020	2002731	1151						0	

TABLE 4-1

Target Wells for Calibration of the Regional Model

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Well Owner-Well Name	Location	Model Zone	Well in Steady-State Model	Well in Transient Model	Year Drilled	Status 1986	Status 2001	Well Use	Easting (feet)[a]	Northing (feet)[a]	Measuring Point Elevation (feet MSL)	Total Depth (feet bgs)	Depth to Top of Open Interval (feet bgs)	Depth to Base of Open Interval (feet bgs)	Type of Open Interval	Drilling Method	Sanitary Seal Depth (feet bgs)	Depth of Pump Intake (feet bgs)
Alluvial Aquifer in Other Tributary Canyons to the Santa Clara River																		
VWC-W6	San Francisquito Canyon	B4c	Yes	Yes	1952	Active	Active	Municipal supply	6393801	1985449	1159	158	90	153	Knife cut		50	100
7066D	Bouquet Canyon	B2c	Yes	Yes	---	Active	Active	Water levels	6400238	1979734	1182						0	
7086B	Bouquet Canyon	B2c	Yes	No	---	Active	Active	Water levels	6405151	1981611	1247						0	
SCWC-Clark	Bouquet Canyon	B2c	No	Yes	1946	Active	Active	Municipal supply	6405894	1983061	1257	160	20	120	Knife cut	Unknown		110
7095	Bouquet Canyon	B2b	Yes	No	1930 or earlier	Active	Active	Water levels	6409922	1986103	1323	146					0	
7188A	Sand Canyon	A3b	No	Yes	1952	Active	Active	Water levels	6434878	1972313	1588						0	
Saugus Formation																		
VWC-160	Santa Clara River	E	Yes	Yes	1964	Active	Active	Municipal supply	6388950	1976191	1101	2000	950	2000	Louvers	Rotary	65	260
7048C	Santa Clara River	E	Yes	Yes	1981	Active	Destroyed?	Water levels	6395222	1974491	1147						0	
VWC-157	S. Fork Santa Clara River	E	Yes	Yes	1962	Active	Active	Municipal supply	6395696	1974099	1151	2008	586	2008	Vertical slots	Rotary	15	340
VWC-201	S. Fork Santa Clara River	E	No	Yes	1989	Not Built	Active	Municipal supply	6394125	1973032	1152	1690	540	1670	Louvers	Mud rotary	460	360
SCWC-Saugus1	S. Fork Santa Clara River	E	No	Yes	1988	Not Built	Inactive	Municipal supply	6397847	1973452	1162	1640	490	1620	Wire wrap screen	Reverse	450	500
SCWC-Saugus2	S. Fork Santa Clara River	E	No	Yes	1988	Not Built	Inactive	Municipal supply	6398514	1972540	1158	1612	490	1591	Wire wrap screen	Reverse	460	500
NCWD-11	S. Fork Santa Clara River	F	Yes	Yes	1973	Active	Active	Municipal supply	6399004	1968019	1187	1136	200	1075	Louvers	Reverse rotary	150	340
NCWD-13	S. Fork Santa Clara River	F	No	Yes	1990	Not Built	Active	Municipal supply	6399098	1967327	1194	1300	420	750			50	445
NCWD-12	S. Fork Santa Clara River	F	Yes	Yes	1985	Inactive	Active	Municipal supply	6399282	1965920	1206	1340	485	1280	Louvers	Reverse rotary	420	400
NCWD-10	S. Fork Santa Clara River	F	Yes	Yes	1961	Active	Inactive	Municipal supply	6399388	1965803	1207	1555	780	1544	Louvers	Rotary	114	335
5851	S. Fork Santa Clara River	F	Yes	Yes	1968	Active	Active	Water levels	6396468	1962533	1233						0	
5851A	S. Fork Santa Clara River	F	Yes	No	1968	Active	Active	Water levels	6396432	1962504	1233						0	
5842F	S. Fork Santa Clara River	A	Yes	No	1974	Active	Active	Water levels	6395286	1960869	1248						0	
NCWD7	S. Fork Santa Clara River	F	Yes	Yes	1954	Active	Inactive	Municipal supply	6401264	1962732	1251	994	520	974	Knife cut	Cable tool		306
5841	S. Fork Santa Clara River	F	Yes	No	1973	Active	Active	Water levels	6393394	1963704	1256						0	
5871D	S. Fork Santa Clara River	F	Yes	No	1948 or earlier	Active	Active	Water levels	6402392	1962734	1262						0	
7053C	San Francisquito Canyon	D	Yes	No	---	Active	Destroyed?	Water levels	6397679	1992663	1291						0	
5882	S. Fork Santa Clara River	A	Yes	No	1931 or earlier	Active	Active	Water levels	6406409	1957586	1327						0	
5873E	S. Fork Santa Clara River	A	Yes	No	1957	Active	Active	Water levels	6403977	1957147	1353						0	
NCWD-9	S. Fork Santa Clara River	A	Yes	Yes	1958	Active	Inactive	Municipal supply	6404122	1956997	1354	675	311	674	Louvers	Rotary	75	230
5831	S. Fork Santa Clara River	A	Yes	No	1962	Active	Active	Water levels	6391103	1961398	1381						0	
7053D	San Francisquito Canyon	D	Yes	No	---	Active	Active	Water levels	6398984	1990433	1402						0	
5912A	S. Fork Santa Clara River	A	Yes	No	1948 or earlier	Active	Active	Water levels	6414810	1960110	1445						0	
7043C	San Francisquito Canyon	D	Yes	No	---	Active	Active	Water levels	6392762	1994816	1528						0	

[a]Coordinates are listed in California State Plane, NAD83 Datum, Zone V.

Notes:

Wells without owner designations belong to the Los Angeles County Flood Control District (LACFCD).

-- = No data available.

N. = nouth.

S. = south.

Figures

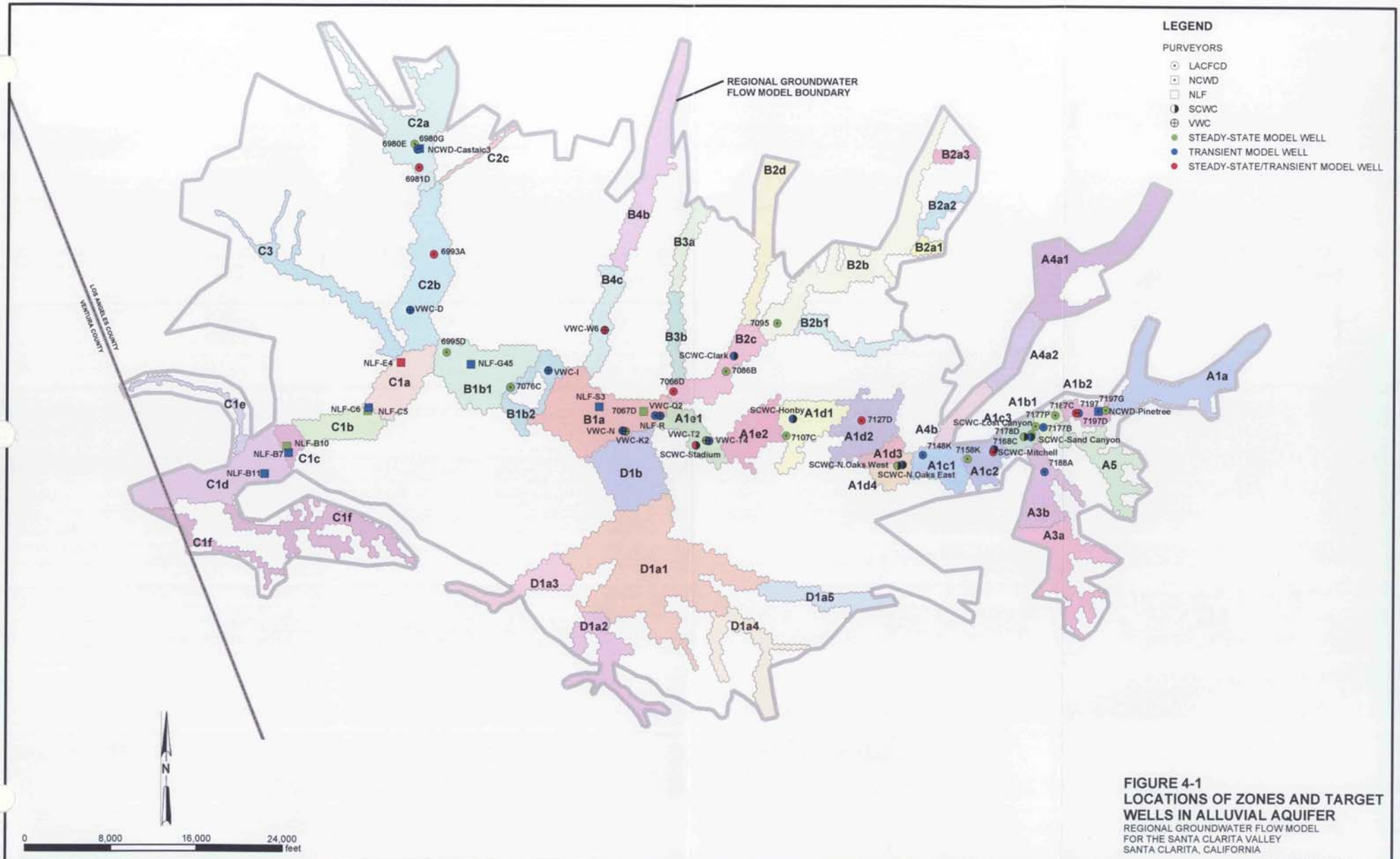


FIGURE 4-1
LOCATIONS OF ZONES AND TARGET WELLS IN ALLUVIAL AQUIFER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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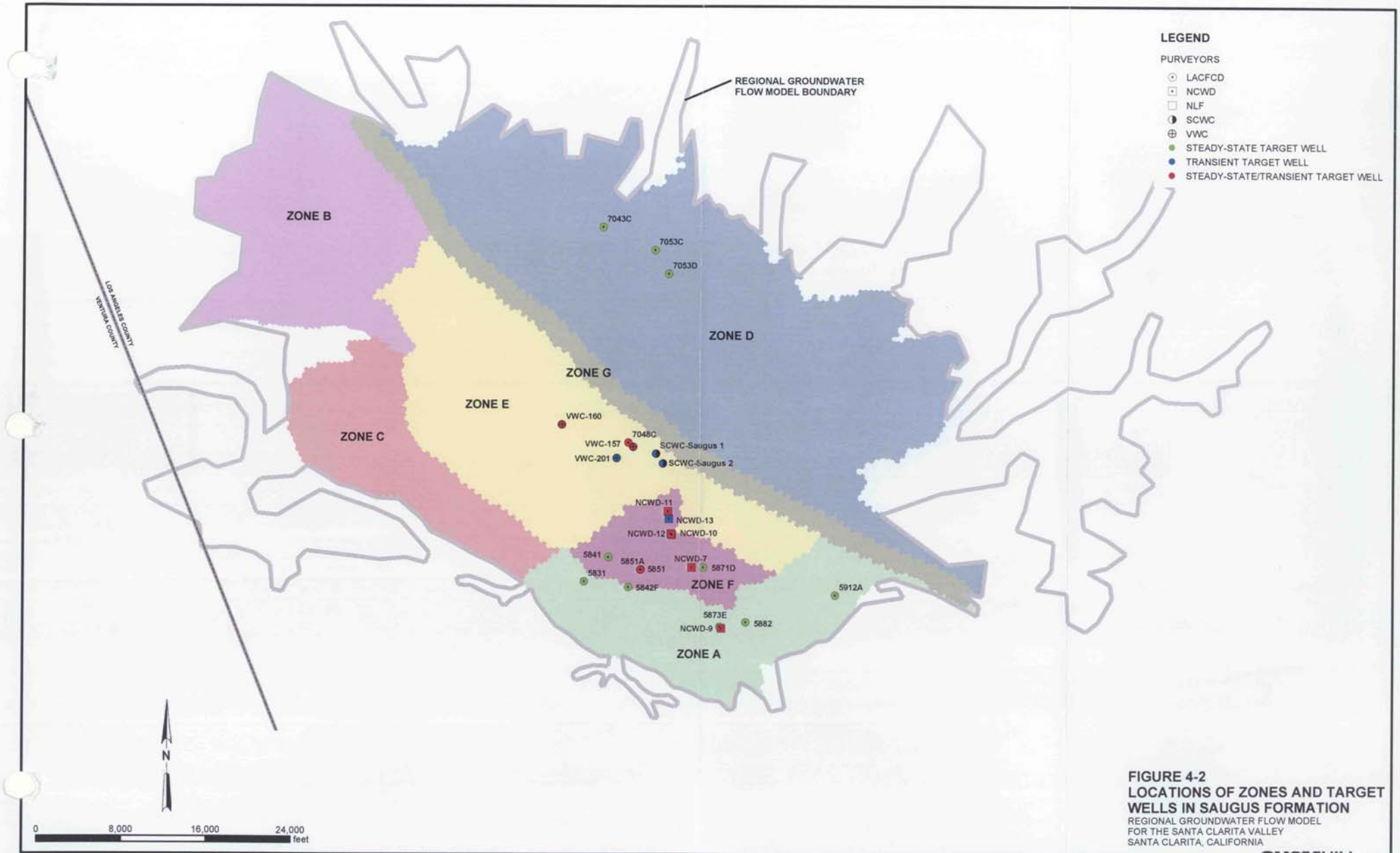

FIGURE 4-2
LOCATIONS OF ZONES AND TARGET WELLS IN SAUGUS FORMATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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SECTION 5

Calibration Results and Sensitivity Analysis

This section of the report presents the calibrated Regional Model and a sensitivity analysis of the Regional Model. Sections 5.1 and 5.2 discuss the calibration quality of the steady-state and transient models (respectively) with reference to the calibration goals discussed in Section 4.2. Section 5.3 discusses the groundwater budgets for both models. Section 5.4 describes a sensitivity analysis that further evaluated calibration quality by comparing the sensitivity of the model-predicted groundwater elevations and river flows to the values of key model parameters.

The distribution of Kh in the calibrated model is presented on Figures 5-1 through 5-7 for model layers 1 through 7, respectively. Table 5-1 summarizes the values of transmissivity, thickness, and hydraulic conductivity in the 48 alluvial zones. Table 5-2 summarizes values of the other calibrated hydraulic properties that are used in the model.

5.1 Calibration Results for the Steady-State Model

Following are discussions of how the calibrated model compares with the six calibration goals established for the 1980 through 1985 steady-state model.

5.1.1 Groundwater Flow Directions – Calibration Goal 1

Figure 5-8 shows simulated groundwater elevations and flow directions in the Alluvial Aquifer as computed by the steady-state model. The groundwater flow directions are from east to west along the Santa Clara River, which is in agreement with published contour maps for the Alluvial Aquifer (see Figure 2-7). The contours show a very flat hydraulic gradient in the lower reach of the valley containing the South Fork Santa Clara River, which also agrees with published interpretations.

Figures 5-9 through 5-14 show groundwater elevation contour maps for layers 2 through 7 of the Regional Model, which represent the Saugus Formation. Layer 3 (Figure 5-10) is situated from 500 feet bgs to 1,000 bgs and is partially or fully screened by several of the Saugus production wells that are situated in the valley containing the South Fork Santa Clara River. In this area, the model-simulated flow directions in layer 3 are in good general agreement with published interpretations (see Figure 2-8).

5.1.2 Groundwater Elevation Residuals – Calibration Goal 2

Figure 5-15 is a scatter plot comparing simulated and observed average groundwater elevations for target wells in both the Alluvial Aquifer and the Saugus Formation. For a perfect simulation, each point shown on the figure would lie on the diagonal line. The figure shows that the Alluvial Aquifer target wells lie very close to the diagonal line, indicating a very good calibration to the observed average groundwater elevations from 1980 through 1985. For the Saugus Formation, there is greater variability. Some Saugus wells plot very close to the diagonal line, while one well (5882) lies 80 feet above the line and another well

(5831) lies 80 feet below the line. These two particular wells are near the southern model boundary, where the available water level data indicate that the groundwater gradients in the Saugus are very steep compared to areas closer to the Saugus production wells. Nonetheless, the Saugus wells are generally close to the diagonal line and do not plot consistently above or consistently below the line, indicating that the Saugus Formation is closely calibrated in the steady-state model.

Table 5-3 lists the residuals for Alluvial and Saugus wells. The residuals are also plotted on Figures 5-16 through 5-19. Positive residuals indicate that the Regional Model over-predicts the groundwater elevation, and negative residuals indicate that it under-predicts the groundwater elevation. Observations regarding the residuals are as follows:

a. Figure 5-16 shows the magnitudes of the groundwater elevation residuals for the 21 target wells in the Alluvial Aquifer that lie along the Santa Clara River. The plot shows the target wells in order from the downstream end of the valley (left side) to the upstream limit of the valley (right side). The plot shows that 13 of the 21 wells have residuals in the range of –5 to +5 feet, and that only one well (7158K) does not meet the 10-foot residual criterion for Goal 2. The plot also shows little, if any, spatial bias in the direction of the residuals; specifically, long reaches of the river do not show consistently positive or consistently negative residuals. Consequently, the groundwater elevations are very well calibrated along the Santa Clara River.

b. Figure 5-17 shows an equivalent plot for Alluvial Aquifer wells located in three of the tributary canyons. In these areas, where gradients are steep, the modeled groundwater elevations are generally within 10 to 11 feet of the average measured elevations. The plot indicates a tendency to slightly under-predict groundwater elevations, particularly in the upper-most reach of Bouquet Canyon, but the residuals generally meet the criterion for Goal 2.

c. Figures 5-18 and 5-19 show similar residual plots for production wells and for LACFCD monitoring wells, respectively, in the Saugus Formation. Three of the seven production wells meet the 25-foot residual criterion for Goal 2, and three of the monitoring wells meet this criterion. Both plots indicate a tendency to under-predict static groundwater elevations, particularly in four wells that are near the outer limits of the Saugus Formation (wells NCWD-9, 5831, 7043C, and 7053D). However, the water levels in these four wells appear to be anomalously high, compared with the water levels in surrounding wells. Consequently, the water level data indicate that these wells (particularly the three LACFCD wells) are constructed in perched Saugus zones lying above the regional Saugus aquifer system, and the negative residuals at these wells correspond to the anomalously high groundwater elevations. Excluding these four wells, three of the six production wells and five of the ten LACFCD monitoring wells meet the Goal 2 criterion, indicating that the steady-state calibration of the Saugus Formation is adequate, particularly because the focus of the model calibration effort is transient calibration, which is discussed in Section 5.2.

5.1.3 Statistics of Groundwater Elevation Residuals – Calibration Goal 3

Table 5-4 lists the residual statistics for target wells in both aquifer systems. The table shows statistics for the same wells listed in Table 5-3 and shown on Figures 5-16 through 5-19,

except for Saugus wells 5831, 7043C, and 7053D. Table 5-4 shows that the residual statistics for the Alluvial Aquifer generally meet the criteria specified in Goal 3. For the Saugus Formation, the statistics meet the mean residual criterion, but the statistics for the square of the residuals are slightly above the criteria of (1) less than 25 feet for RMS error or (2) 10 percent or less for normalized RMS error. The Regional Model as a whole, however, with the Alluvial Aquifer and Saugus Formation combined, meets all Goal 3 criteria.

5.1.4 Groundwater Gradients – Calibration Goal 4

In the Alluvial Aquifer, the results for the first three calibration goals indicate that the steady-state model simulates groundwater gradients quite well, and therefore meets Goal 4.

For the Saugus Formation, the residuals for the NCWD wellfield in the South Fork Santa Clara River are consistently negative. However, the residual at the upgradient end of the wellfield at NCWD-7[5] is similar in magnitude to the average residual at the downgradient end of the wellfield at NCWD-10 and NCWD-11. Consequently, the gradients in this area are simulated reasonably well. Simulated gradients from the NCWD wellfield to the downgradient well VWC-160 are slightly low, as suggested by the more negative residuals in the NCWD wellfield and the less negative residual at VWC-160.

Additionally, recent water level data from the Whittaker-Bermite property indicate that the gradients are well simulated within the Saugus Formation in that area, which lies east and northeast of NCWD's wellfield. Table 5-5 shows the calculations of the model-simulated and measured groundwater gradients between wells MP-1 and MP-2, which are both on the downthrown side of the San Gabriel fault, and between MP-2 and MP-3, which are located on the downthrown side and upthrown side of the fault, respectively. These calculations are based on three rounds of manual water level measurements that were taken from January through October in 2003. Between wells MP-1 and MP-2, the gradients are almost perfectly matched. However, across the San Gabriel fault, the modeled gradient is approximately half as large as the measured gradient because the simulated groundwater elevation is low at MP-3.

Several attempts were made during model calibration to reduce the Saugus permeability to very low levels across the fault, but no further increases in MP-3 water levels could be obtained. The calibrated Regional Model uses a permeability along the fault that is between 100 and 1,000 times lower than the permeability of adjoining Saugus areas. Although the Regional Model was unable to simulate as high a groundwater elevation as has been measured recently at MP-3, it does simulate a substantial drop in groundwater elevations across the San Gabriel fault, which is consistent with the understanding of the limited hydraulic connection across the fault (see Section 2.4.2 and Figure 2-9). Therefore, the Regional Model is well calibrated across the fault because it simulates the permeability differences that exist on each side of the fault and also simulates the very limited movement of groundwater across the fault that is indicated by the significant difference in groundwater elevations that has been measured in the multi-port wells on each side of the fault.

[5] Well NCWD-9 is located farther upgradient, but has been used only sparingly since 1987.

5.1.5 Groundwater Below Ground Surface – Calibration Goal 5

Groundwater elevations simulated by the steady-state model are below ground surface at all non-stream nodes and in each tributary stream. Along the Santa Clara River, a small number of nodes showed groundwater elevations above the streambed in the western portion of Soledad Canyon, and also at and immediately upstream of Round Mountain, a Saugus outcrop that likely lies at shallow depths beneath the river itself. The reach of the river west of I-5 was calculated to be predominantly gaining (groundwater above ground surface). However, the Regional Model predicts that the river is losing over a reach extending between approximately 0.75 mile upstream to 0.5 mile downstream of the location where the river crosses over the western limit of the Saugus Formation. In this area, the riverbed has a gentler slope than in adjoining areas, and the riverbed does not lie beneath the water table in this particular reach.

5.1.6 Groundwater Discharge to River – Calibration Goal 6

The model-simulated groundwater discharge to the river was 28,600 AF/yr, which closely agrees with the 29,000 AF/yr value estimated from the hydrograph separation process described in Section 2.6.2.5.

5.2 Calibration Results for the Transient Model

Following are discussions of how the calibrated Regional Model compares with the four calibration goals established for the 1980 through 1999 transient model.

5.2.1 Groundwater Elevation Trends/Hydrographs – Calibration Goal 1

Trends in groundwater elevations are discussed for the following areas:

a. The Alluvial Aquifer along the Santa Clara River, west of I-5, as shown on Figure 5-20

b. The Alluvial Aquifer along the Santa Clara River, between I-5 and Soledad Canyon, as shown on Figure 5-21

c. The Alluvial Aquifer along the Santa Clara River in Soledad Canyon, as shown on Figure 5-22

d. The Alluvial Aquifer along Castaic Creek, as shown on Figure 5-23

e. The Alluvial Aquifer in other tributary canyons to the Santa Clara River, as shown on Figure 5-24

f. The Saugus Formation, where targets are located along the South Fork Santa Clara River, as shown on Figure 5-25

As discussed in Section 4.4.1, the calibration goal at target production wells was to simulate groundwater elevations that were higher than the pumping elevations and as close as possible to the static elevations. Therefore, the hydrographs show the model-simulated groundwater elevations, the measured static groundwater elevations, and, for production wells, the measured pumping groundwater elevations.

5.2.1.1 Alluvial Aquifer West of I-5

Modeled and measured groundwater elevations both show long-term stability, with no significant increases or decreases during the 1980 through 1999 transient calibration period. The Regional Model simulates somewhat greater seasonal variation in groundwater elevations than is suggested by the field measurements. However, the field measurements were collected infrequently. In general, the Regional Model is well calibrated in this area because of the close match between simulated and measured groundwater elevations and because it simulates the long-term stability of groundwater elevations in this area.

5.2.1.2 Alluvial Aquifer Between I-5 and Soledad Canyon

North of the Santa Clara River, near the mouth of San Francisquito Canyon, the Regional Model simulates the observed trends in static groundwater elevations at wells NLF-S3 and VWC-I during the period that data are available. The groundwater elevation trends are particularly well simulated at VWC-I starting in mid-1996, when the water level measurement frequency increased at this well.

Just upstream and along the south side of the river, the Regional Model simulates the trends in static water levels at well VWC-N very closely throughout the 20-year simulation period. The Regional Model also simulates the trends in static water levels quite well at well VWC-Q2, near the mouth of Soledad Canyon. In this same area, monitoring well 7067D simulates groundwater elevations that are somewhat lower than measured elevations, and the 40-foot fluctuation in simulated water levels at this well is of a generally similar magnitude as the observed fluctuation of 50 feet.

5.2.1.3 Alluvial Aquifer In Soledad Canyon

At wells throughout Soledad Canyon, the Regional Model closely simulates the regional decline in groundwater elevations during the late 1980s and early 1990s. The simulated and measured declines are especially close for wells in the eastern portion of this area, such as SCWC-North Oaks, SCWC-Mitchell, SCWC-Lost Canyon 2, and NCWD-Pinetree1.

Although the sharp increases in groundwater elevations in 1992 and 1993 are modeled well, these same wells (in the eastern half of Soledad Canyon) are unable to maintain high enough groundwater elevations during short dry periods that occur intermittently from 1993 through 1999. During this period, wells further to the west, such as SCWC-Stadium, VWC-T2, SCWC-Honby, and 7127D show better matches between modeled and measured groundwater elevations. Many model runs were performed to try to maintain higher water levels in eastern Soledad Canyon, but no substantial improvements could be made, suggesting that the lack of stream gage data at the Lang gage during this period may be responsible for the discrepancies.

A visual inspection of the former Lang gage station was conducted on July 17, 2003 during the model calibration process. The equipment that records the depth of water in the river was observed to be approximately 3 to 4 feet above the bed of the river at the time of the inspection. Although high river flows are known to have occurred since the time the gage was abandoned, it is unlikely that the bed elevation would have been lowered 3 or 4 feet by the net sediment scouring and redeposition processes that occur during high river flows. This observation means there likely was more flow occurring in the river prior to October

1989 than was recorded by this gage. This in turn means that measured and estimated flows during the period 1980 through 1999 are likely too low in the Regional Model, which would explain the model's simulation of too rapid a decline in water levels after high river flows recharge the aquifer. In summary, the design of the gage and the absence of data after October 1989 are the likely reasons that the Regional Model has difficulty maintaining sufficiently high groundwater elevations during dry periods in the eastern portion of the Alluvial Aquifer.

5.2.1.4 Alluvial Aquifer Along Castaic Creek

In the upper reaches of the Castaic Creek valley, the Regional Model simulates the measured groundwater elevation trends very well during the drought at wells NCWD-Castaic3, 6980E, and 6980G, though this evaluation is somewhat uncertain during the early 1980s due to infrequent data collection. However, these same wells show too much recovery during the initial post-drought recovery period in 1992, and they also show a small rise in groundwater elevations from 1993 through 1999 that is not indicated by the field measurements.

Farther downstream, the Regional Model closely matches the measured groundwater elevation trends at well 6993A well until the last few years of the drought, when groundwater elevations do not drop sufficiently. Well VWC-D (farther downstream) is modeled even better, but also shows a bit too much fluctuation during the mid- and late 1990s.

5.2.1.5 Alluvial Aquifer in Other Tributary Canyons to the Santa Clara River

At production well VWC-W6 in the lower reaches of San Francisquito Canyon, the Regional Model appears to simulate the measured groundwater elevations well, except for a possibly insufficient decline in early 1992 at the conclusion of the regional drought.

In Bouquet Canyon, the Regional Model closely simulates the measured groundwater elevation changes at the SCWC-Clark production well, although the groundwater elevations are a bit high throughout the simulation. The groundwater elevation trends are also well simulated farther downstream at monitoring well 7066D, though the groundwater elevations are somewhat under-predicted throughout the simulation.

In Sand Canyon, the simulation at monitoring well 7188A is good, although there is some uncertainty at the end of the drought due to the lack of data collection during 1990 and 1991.

5.2.1.6 Saugus Formation

In general, the Regional Model simulates the trends in groundwater elevations quite well at each Saugus production and monitoring well. Simulated and measured static groundwater elevations agree particularly well in the NCWD wellfield at the observation well (5851) and each NCWD production well.

Farther downgradient, the model tends to slightly over-predict groundwater elevations in the VWC and SCWC production wells (VWC-157, VWC-201, SCWC-Saugus1, and SCWC-Saugus2) and slightly under-predict groundwater elevations in the lone monitoring well (7048-C). However, the Regional Model closely simulates the groundwater elevation trends

at each of these locations, which is the primary consideration for evaluating the quality of the transient calibration process in the Saugus Formation.

5.2.2 Groundwater Below Ground Surface – Calibration Goal 2

This goal was met at each target in the transient model. Of the 44 transient model target wells, 11 had simulated groundwater elevations within 5 feet of ground surface during the wettest periods of the model simulation. Three of these wells were located in the Castaic Valley (6980E, 6981D, and NCWD-Castaic3), one was in lower Sand Canyon (7188A), one was in Bouquet Canyon (SCWC-Clark), and six were in Soledad Canyon (VWC-T2, 7127D, SCWC-Mitchell, SCWC-Lost Canyon 2, 7177B, and NCWD-Pinetree1).

5.2.3 Total River Flow at County Line Gage – Calibration Goal 3

Figure 5-26 compares the modeled and measured total flows of the Santa Clara River at the County Line gage. The figure contains both a linear plot and a semi-logarithmic plot to better illustrate how the modeled and measured flows compare during low flow periods in the river.

Figure 5-26 also shows that the Regional Model adequately replicates seasonal cycles of low and high river flows. Prior to 1992, peak flows during the wettest months tend to be somewhat underestimated, probably because of under-predicted flow in the streams rather than insufficient groundwater discharge to the river. From 1992 through 1997, peak flows match well, but they are again underestimated in 1998 and 1999.

Seasonal low flows, during the summer months, are slightly over-predicted. In years such as 1990, the model over-estimates river flows by approximately 100 to 200 acre-feet per month. In other years, the Regional Model over-estimates the river flows by as much as 1,000 acre-feet per month. To evaluate this further, the estimated and model-simulated groundwater discharges to the river were compared, as discussed below.

5.2.4 Groundwater Discharge to River – Calibration Goal 4

Figure 5-27 compares the model-simulated groundwater discharges to the river with the discharges that have been estimated from hydrograph separation techniques (see Section 2.6.2.5). Because of uncertainty in the amount of treated water that infiltrates the streambed, Figure 5-27 displays a range for the estimated values, varying according to how much of the Saugus WRP treated water is estimated to infiltrate to groundwater as it travels down the Santa Clara River. For the purposes of this comparison, it was estimated that the infiltration could be negligible (blue line) and would be unlikely to exceed 75 percent of the Saugus WRP discharge (green line).

Figure 5-27 shows that the Regional Model simulates the patterns of groundwater discharges well. The Regional Model predicts lower groundwater discharge rates during high flow/high water table periods than were estimated from the hydrograph separation technique, but model uncertainty may not be the cause of this difference. It is equally, if not more, likely that the difference is due to the significant uncertainties associated with the hydrograph separation process during periods of high river flows. Specifically, as discussed in Section 2.6.2.5, it is difficult to determine how much of the receding flow after peak flow

events is due to groundwater discharges versus continued stormwater drainage from within the basin or from upstream watersheds.

Figure 5-27 also shows that the Regional Model tends to predict higher rates of groundwater discharge during dry periods than estimated from the County Line gage. This is consistent with the Regional Model's over-prediction of total river flows, but anecdotal observations at the former gaging station site during low flow periods indicate that the river sometimes carved small channels that diverted a portion of the flow away from the gage, where it could not be measured. Consequently, the differences between modeled and measured total river flows and measured versus estimated groundwater discharges result from uncertainties in both the Regional Model and the gage data.

5.3 Groundwater Budget

Table 5-6 summarizes the groundwater budget for the 1980 through 1985 steady-state model. The values in the table are the average groundwater recharge and discharge rates in AF/yr during this period. As shown in the table, the majority of the recharge occurs from direct rainfall and stormwater flows, with irrigation and Castaic Lake underflow each comprising a very small portion of the total basin recharge. Groundwater discharge during this time period was approximately one-third pumping and one-third discharge to the Santa Clara River, with the rest consisting of subsurface outflow and ET. The table shows that ET is an important part of the groundwater budget, 15 percent of the total groundwater discharge in the basin.

Table 5-7 summarizes the groundwater budget for each year of the 20-year transient model simulation period (1980 through 1999). Figures 5-28 and 5-29 show the annual groundwater recharge and groundwater discharge rates, respectively. Figure 5-30 shows the change in groundwater storage each year, and Figure 5-31 shows the cumulative change in groundwater storage during the simulation period.

As is evident from Figure 5-28, recharge from precipitation and streamflows varies considerably from year to year, ranging from less than 15,000 AF/yr in the driest years to over 100,000 AF/yr in wetter years. In fact, for the five wettest years during this period, the model estimates that groundwater recharge ranged between 175,000 AF/yr and 270,000 AF/yr. In contrast, total groundwater discharges have been less variable (Figure 5-29), ranging from approximately 61,000 AF/yr at the end of the drought in the late 1980s through early 1990s to 116,000 acre-feet during 1998. Table 5-7 and Figure 5-29 together show that this variability in groundwater discharge does not follow the year-to-year pumping patterns, but instead is caused by year-to-year fluctuations in ET and groundwater discharges to the river. These fluctuations, in turn, correlate well with groundwater recharge patterns. For example, groundwater discharge rates increase during or immediately after significant rainfall years in 1983, 1992 through 1993, 1995, and 1998, and subsequently decrease in response to below-normal precipitation in the ensuing 1 to 2 years. This indicates that the predominant factors influencing changes in storage and groundwater discharge are the local rainfall recharge and stream recharge patterns from year to year, with anthropogenic influences (pumping and irrigation) having a smaller effect on the groundwater system. This is reinforced by Figures 5-30 and 5-31, which show that changes in groundwater storage volumes reflect year-to-year variations in regional rainfall.

5.4 Sensitivity Analysis

Sensitivity analyses were performed on the calibrated Regional Model to evaluate whether further changes in the values of key model parameters would improve the calibration quality of the model. The sensitivity analyses focused on the transient model. Following is a description of the design of the analyses and the findings.

5.4.1 Method of Sensitivity Analysis

Analysis focused on identifying the sensitivity of the transient model to Kh and Kv for both aquifer systems, the permeability of the bed of the Santa Clara River, and, to a lesser degree, the ET parameters.

To perform the analysis, one model variable, or group of variables, was varied upward or downward, and the model was run again. The amount by which each model variable was adjusted upward or downward was based on the range of values that was considered to be plausible for the variable, according to the data analysis that was conducted in support of development of the hydrogeologic conceptual model for the valley, which is described in Section 2 of this report. The following pairs of sensitivity runs were performed:

a. Adjusting the Kh. This parameter was multiplied and divided by a factor of 1.5 in all model layers. The R (Kh:Kv) was left unchanged for these runs, but the change in Kh caused a change in Kv values.

b. Adjusting the R upward or downward by a factor of 4.0. This caused changes to Kv, but not to Kh.

c. Adjusting the storage parameters. In model layer 1, the Sy was adjusted from the calibrated model value of 0.10 to 0.075 and 0.15. In model layers 2 through 7, the storativity was adjusted from the calibrated model value of 5×10^{-4} to values of 1×10^{-4} and 1×10^{-3}. The reductions to Sy and storativity were run simultaneously in a single model run, and the increases in Sy and storativity were run simultaneously in a single model run.

d. Adjusting the riverbed leakage terms at drain and wadi nodes in the Santa Clara River and Castaic Creek. These terms were multiplied and divided by a factor of 10.

e. Adjusting the ET parameters in a way that produced less ET. In one run, the maximum evaporation depth was changed from 10 feet to 5 feet. In another run, the maximum evaporation rate was changed from 6 ft/yr to 3 ft/yr.

5.4.2 Sensitivity Analysis Results

The results of the focused sensitivity analysis are presented as time-series plots of water levels and groundwater discharges to the river. Results are first presented for the aquifer hydraulic parameters (Kh, R, Sy, and storativity), then for the riverbed permeability and ET terms.

5.4.2.1 Sensitivity of Groundwater Elevation Trends to Aquifer Parameters

Figures 5-32 through 5-38 show the sensitivity of Alluvial Aquifer groundwater elevations in the transient model to variations in Kh, R, and Sy. Figures 5-39 through 5-43 show the same information for three Saugus production wells and two Saugus monitoring wells. The results and the conclusions that can be drawn from them are:

a. Alluvial wells in the western part of the basin (NLF-B7 and NLF-G45) show slight sensitivity to the choice of Kh, and little sensitivity to R and Sy. Lower Kh values would degrade the calibration quality of the Regional Model, whereas the tested ranges of the other parameters would have little effect on calibration quality.

b. Further east, VWC-N shows greater sensitivity to each parameter, though it is relatively insensitive to lower Kh values. Lower Kh values or changes to R values would not degrade calibration quality, whereas other parameter changes could potentially degrade the calibration.

c. Results are similar in Soledad Canyon at SCWC-Stadium, SCWC-North Oaks East, and NCWD-Pinetree1. Higher Kh values substantially degrade the calibration quality of the transient model at each of these wells.

d. The transient model was slightly to moderately sensitive to the choice of Alluvial Aquifer Kh in Castaic Creek at well VWC-D. In this area, it showed little sensitivity to R or Sy in the Alluvial Aquifer. The results suggest that higher K values could slightly improve the calibration.

e. Water levels at Saugus production wells along the lower reaches of the South Fork Santa Clara River (VWC-201 and SCWC-Saugus2) are sensitive to the choice of R, moderately sensitive to the choice of Kh, and comparatively insensitive to storativity. The transient model is more sensitive to Kh and storativity at nearby monitoring well 7048C than at the pumping wells. The plots generally indicate the model is well calibrated, although small decreases in Kh might slightly improve the calibration quality.

f. Similar results are seen for production well NCWD-11 and monitoring well 5851 farther upstream in the South Fork Santa Clara River valley. At NCWD-11, the R appears to be particularly well calibrated, as lower values cause groundwater elevations to fluctuate insufficiently, and higher values cause too much fluctuation, and in some cases, model-simulated water levels that are below pumping levels. Changes to Kh would not improve the model, and could in fact degrade it at the monitoring well.

5.4.2.2 Sensitivity of Groundwater Elevation Trends to River and Evapotranspiration Parameters

Figures 5-44 through 5-50 show the sensitivity of Alluvial Aquifer groundwater elevations in the transient model to variations in the riverbed K for drain and wadi nodes and to decreases in the two ET parameters, extinction depth and maximum potential ET rate. Figures 5-51 through 5-55 show the same information for the three Saugus production wells and two Saugus monitoring wells discussed in Section 5.4.2.1. The results and the conclusions that can be drawn from them are:

a. Alluvial wells in the western and central parts of the basin (NLF-B7, NLF-G45, and VWC-N) and along Castaic Creek (VWC-D) are sensitive to the choice of the riverbed K for the drain and wadi nodes. Reduced conductivity values notably increase the groundwater elevations at some wells, while higher values somewhat decrease groundwater elevations. The plots suggest that changes to this term would not improve calibration quality and could substantially degrade the calibration at some of these wells. Further east, in Soledad Canyon, the Regional Model is relatively insensitive to riverbed K in the gaining reaches of the Santa Clara River.

b. Reductions in drain and wadi riverbed K increase groundwater elevations by raising groundwater elevations in the Alluvial Aquifer, to which the Saugus discharges. Decreased riverbed permeability backs up water in the Alluvial Aquifer, and hence in the Saugus Formation. Changes to riverbed permeability do not improve Saugus calibration.

c. Groundwater levels in both the Alluvial Aquifer and the Saugus Formation are insensitive to the choice of ET parameters.

5.4.2.3 Sensitivity of Groundwater Discharge to the River to Changes in Aquifer Parameters

Figures 5-56 shows the sensitivity of discharges of Alluvial Aquifer groundwater to the river to changes in K, R, and Sy. The plots show that the model-calculated discharge to the river is sensitive to Kh, but not to R or Sy. A reduction in Alluvial Aquifer Kh would improve the calibration quality during seasonal or longer dry periods, but at the expense of degrading the calibration during the rainfall season for all but the wettest years. Increasing the Kh would slightly increase the predicted discharges during seasonal or longer dry periods.

5.4.2.4 Sensitivity of Groundwater Discharge to the River to Changes in River and Evapotranspiration Parameters

Figure 5-56 also shows the sensitivity of discharges of Alluvial Aquifer groundwater to the river to changes in riverbed K for drain and wadi nodes and to decreases in the two ET parameters, extinction depth and maximum potential ET rate. Figure 5-56 shows that a lower riverbed permeability would improve calibration during seasonal and longer dry periods, but notably degrade calibration during all rainfall periods. Figure 5-56 shows that reducing the ET extinction depth from 10 feet to 5 feet has little effect on model-calculated discharge to the river, while reducing the maximum ET rate slightly increases the model-calculated discharge.

5.5 Conclusion

The process of calibrating the Regional Model to a 20-year period of groundwater elevation and streamflow data has resulted in a model that is suitable for its intended applications, which are evaluating groundwater management strategies, groundwater sustainability, artificial recharge options, and restoration of contaminated water supplies. The primary attributes of the model's calibration that makes this tool appropriate for its intended uses are:

a. Its ability to simulate historical trends in groundwater elevations and river flows during a 2-decade period that reflects increased urbanization, increased SWP water imports (from outside the valley), and associated changes in land use and water use.

b. Its ability to simulate trends in smaller geographic areas of interest within the valley (for example, near the Whittaker-Bermite property).

c. Its use of an integrated model of the watershed (the SWRM) to define the amount of rainfall and stormwater that is potentially available to recharge the groundwater system.

The calibration process has resulted in a Regional Model that closely simulates, on a monthly basis, total flows in the river and estimated volumes of groundwater discharging to the river. The calibration process has also resulted in a Regional Model that closely simulates the short-term and long-term time-varying trends in groundwater elevations throughout the valley, which is necessary for evaluating groundwater management strategies. The close calibration of the groundwater elevation trends and absolute groundwater elevations in both the Alluvial Aquifer and the Saugus Formation near the Whittaker-Bermite property also renders the Regional Model suitable for particle-tracking analyses, to support the design of a long-term pumping and groundwater treatment plan that will restore impaired water supplies while also preventing contamination in unimpacted portions of the aquifer.

Tables

TABLE 5-1
Alluvial Aquifer Parameters in Calibrated Regional Model
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Model Zone	Location	T (ft^2/day)	Kh (ft/day)	Average Alluvium Thickness (feet)
A1a	Santa Clara River below Lang gage	9,000 to 25,500	300	30 to 85
A1b2	Santa Clara River below A1a	31,500	350	90
A1b1	Santa Clara River below A1b2	31,500	350	90
A1c3	Santa Clara River below A1b1	36,000	400	90
A1c2	Santa Clara River below A1c3	49,500	550	90
A1c1	Santa Clara River below A1c2	49,500	550	90
A1d4	Santa Clara River below A1c1	49,500	550	90
A1d3	Santa Clara River below A1d4	16,500	550	30
A1d2	Santa Clara River below A1d3	60,500	550	110
A1d1	Santa Clara River below A1d2	49,500	550	90
A1e2	Santa Clara River below A1d1	63,250	550	115
A1e1	Santa Clara River below A1e2	63,250	550	115
B1a	Santa Clara River at South Fork mouth	54,375 to 79,750	375 to 550	145
B1b2	Santa Clara River below B1a	22,500	375	60
B1b1	Santa Clara River below Bb2	63,250	550	115
C1a	Santa Clara River below B1b1	71,500	550	130
C1b	Santa Clara River below C1a	60,500	550	110
C1c	Santa Clara River below C1b	60,500	550	110
C1d	Santa Clara River below C1c	60,500	550	110
D1b	Lower South Fork Santa Clara River	12,600	105	120
D1a1	Upper South Fork Santa Clara River	5,775	105	55
D1a2	Gavin Canyon	15	0.75	20
D1a3	Pico Canyon	15	0.75	20
D1a4	Newhall Canyon	15	0.75	20
D1a5	Placerita Canyon	200	10	20
A3a	Upper Sand Canyon	1,750	175	10
A3b	Lower Sand Canyon	5,250	105	50
A4a1	Upper Mint Canyon	2,800	140	20
A4a2	Central Mint Canyon	2,100	105	20
A4b	Lower Mint Canyon	13,125	175	75
A5	Oak Spring Canyon	8,750	175	50
B2a1	Unnamed tributary canyon	10,500	105	100
B2a2	Vasquer Canyon	10,500	105	100
B2a3	Texas Canyon	10,500	105	100

TABLE 5-1
Alluvial Aquifer Parameters in Calibrated Regional Model
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Model Zone	Location	T (ft^2/day)	Kh (ft/day)	Average Alluvium Thickness (feet)
B2b1	Plum Canyon	10,500	105	100
B2b	Upper Bouquet Canyon	2,625 to 12,600	25 to 90	105
B2c	Lower Bouquet Canyon	22,050	245	90
B2d	Haskell Canyon	6,825	105	65
B3a	Lower Dry Canyon	6,300	105	60
B3b	Upper Dry Canyon	6,300	105	60
B4b	Upper San Francisquito Canyon	6,300	105	60
B4c	Lower San Francisquito Canyon	10,500	105	100
C1e	San Martinez Canyon	5,250	105	50
C1f	Potrero and Salt Canyons	5,250	105	50
C2a	Upper Castaic Creek valley	25,200	315	80
C2b	Lower Castaic Creek valley	35,000	350	100
C2c	Charlie Canyon	10,500 to 17,500	175	60 to 100
C3	Hasley Canyon	3,150	30	105

Notes:

The zones are based on alluvial storage units defined by RCS (1986, 2002).
However, they have been further subdivided in certain areas to facilitate model calibration.

See Figure 4-1 for the locations of the alluvial storage units.

TABLE 5-2
Aquifer Hydraulic Parameters Used in the Regional Model
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Parameter	Aquifer	Value	Comment
Kh	Alluvium	Variable	See Figure 5-1 and Table 5-1.
	Saugus	Variable	See Figures 5-2 through 5-7.
R (Kh:Kv)	Alluvium	10:1	Derived during model calibration process.
	Saugus	50:1 to 100:1	
Sy	Alluvium and Saugus outcrops	0.10	Derived during model calibration process.
Storativity	Saugus below model layer 1	5×10^{-4}	Derived during model calibration process.
Santa Clara River and Castaic Creek streambed thicknesses	Alluvium	2 feet	Assumed thickness of streambed sediments in gaining river reaches.
Santa Clara River and Castaic Creek streambed Kv	Alluvium	10 ft/day (3.5×10^{-3} cm/sec)	Derived during model calibration process.
ET extinction depth	Alluvium and Saugus	10 feet	Corresponds to typical rooting depth for phreatophytes along Santa Clara River.
Potential ET rate	Alluvium and Saugus	6 ft/yr	Estimated maximum water use by phreatophytes along Santa Clara River.

Notes:
cm/sec = centimeters per second
ET = evapotranspiration

TABLE 5-3

Residual Errors for 1980 through 1985 Steady-State Calibration Model

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Aquifer	Owner	Well Name	Number of Measurements	Measured Groundwater Elevation (feet msl)	Modeled Groundwater Elevation (feet msl)	Residual (Modeled - Measured) (feet)	Residual^2 (ft^2)
Alluvium	NLF	B10	5	890.70	889.51	-1.19	1.42E+00
	NLF	C5	14	940.61	945.04	4.44	1.97E+01
	NLF	E4	4	977.18	977.84	0.67	4.45E-01
	LACFCD	6995D	17	1003.04	998.75	-4.29	1.84E+01
	LACFCD	7076C	5	1037.16	1027.58	-9.58	9.18E+01
	VWC	K2	2	1113.00	1114.36	1.36	1.84E+00
	NLF	R	4	1137.50	1129.94	-7.56	5.72E+01
	VWC	T4	14	1180.20	1187.69	7.49	5.61E+01
	SCWC	Stadium	15	1186.27	1184.41	-1.86	3.44E+00
	LACFCD	7107C	51	1258.45	1256.45	-2.00	4.00E+00
	LACFCD	7127D	66	1315.83	1320.11	4.28	1.83E+01
	SCWC	N.Oaks West	45	1378.61	1373.49	-5.12	2.62E+01
	LACFCD	7158K	13	1427.48	1444.48	17.00	2.89E+02
	LACFCD	7168C	13	1464.85	1465.79	0.94	8.85E-01
	LACFCD	7178B	12	1495.78	1493.56	-2.21	4.90E+00
	SCWC	Sand Canyon	60	1504.32	1503.73	-0.59	3.47E-01
	LACFCD	7178D	12	1499.21	1509.63	10.42	1.09E+02
	LACFCD	7177P	11	1523.64	1514.99	-8.65	7.47E+01
	LACFCD	7187C	16	1526.06	1534.57	8.51	7.24E+01
	LACFCD	7197	13	1560.34	1556.41	-3.93	1.55E+01
	LACFCD	7197G	3	1577.00	1584.72	7.72	5.96E+01
	LACFCD	6993A	12	1042.95	1032.18	-10.77	1.16E+02
	LACFCD	6981D	3	1092.00	1092.24	0.24	5.66E-02
	LACFCD	6980G	10	1110.77	1107.87	-2.90	8.43E+00
	VWC	W6	5	1146.80	1139.03	-7.77	6.04E+01
	LACFCD	7066D	13	1154.92	1158.65	3.72	1.39E+01
	LACFCD	7086B	9	1227.33	1216.15	-11.19	1.25E+02
	LACFCD	7095	11	1297.96	1277.59	-20.38	4.15E+02
Saugus	LACFCD	5841	14	1114.98	1104.27	-10.71	1.15E+02
	LACFCD	5842F	13	1154.65	1111.16	-43.49	1.89E+03
	LACFCD	5851	45	1137.58	1109.08	-28.50	8.12E+02
	LACFCD	5851A	42	1140.77	1109.09	-31.68	1.00E+03
	LACFCD	5871D	13	1138.03	1117.18	-20.85	4.35E+02
	LACFCD	5873E	3	1286.67	1243.22	-43.44	1.89E+03
	LACFCD	5882	11	1251.99	1318.26	66.26	4.39E+03
	LACFCD	5912A	10	1424.13	1441.47	17.34	3.01E+02
	LACFCD	7048C	47	1110.32	1099.48	-10.84	1.17E+02
	LACFCD	7053C	9	1266.52	1267.60	1.08	1.16E+00

TABLE 5-4

Statistics of Residual Errors for 1980 through 1985 Steady-State Calibration Model

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Statistic	Alluvial Aquifer	Saugus Formation	Combined System	Criterion for Goal 3
Target Groundwater Elevations				
Number of Target Wells	28	10	38	---
Maximum Groundwater Elevation	1,577	1,424	1,577	---
Minimum Groundwater Elevation	891	1,110	891	---
Range in Groundwater Elevations	686	314	686	---
Statistics for Residuals				
Mean Residual	-1.19	-10.48	-3.63	As close to zero as possible
Mean Residual / Range in Groundwater Elevations	-0.2%	-3.3%	-0.5%	5%
Standard Deviation of Residuals	7.62	31.39	17.86	---
Standard Deviation of Residuals / Range in Groundwater Elevations	1.1%	10.0%	2.6%	10%
Statistics for Residual^2 Values				
Sum of Residual^2 Values	1,664	10,954	12,617	---
Average of Residual^2 Values	59	1,095	332	---
Root-Mean-Square Error (RMS)	8	33	18	10 feet for Alluvial, 25 feet for Saugus
RMS / Range in GW Elevations	1.1%	10.5%	2.7%	10%

Note:

An entry of --- means no criterion was established.

TABLE 5-5

Comparison of Modeled and Measured Horizontal Hydraulic Gradients for Multi-Port Monitoring Wells Near the San Gabriel Fault

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

	MP-3	MP-2	MP-1	MP-2
Modeled Groundwater Elevation (feet)	1,225.52	1,092.02	1,084.78	1,092.02
Measured Groundwater Elevation (feet)	1,304.46	1,074.28	1,066.99	1,074.28
Residual Error (feet)	-78.94	17.74	17.79	17.74
Easting (feet)	6,406,801	6,405,215	6,399,944	6,405,215
Northing (feet)	1,971,284	1,968,850	1,970,850	1,968,850
Distance Between Wells		2,905.13		5,637.68
Difference in Modeled Groundwater Elevations		133.50		-7.24
Difference in Measured Groundwater Elevations		230.18		-7.29
Modeled Horizontal Gradient		-4.60E-02		1.28E-03
Measured Horizontal Gradient		-7.92E-02		1.29E-03
Modeled Gradient / Measured Gradient		0.58		0.99

Notes:

Wells MP-1 and MP-2 are located on the west (downthrown) side of the fault.

Well MP-3 is located on the east (upthrown) side of the fault.

Measured groundwater elevations are the average of measurements from January through July of 2003.

Wells MP-1 and MP-2 are in model layer 4; well MP-3 is in model layer 2.

TABLE 5-6

Groundwater Budget for 1980 through 1985 Steady-State Model

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Total Recharge	**AF/yr**	**Percent**
Rainfall	35,000	44.8
Streams	38,200	48.8
Irrigation	3,300	4.2
Subsurface Inflow (Castaic)	1,700	2.2
Total	**78,200**	**100.0**

Total Discharge	**AF/yr**	**Percent**
Discharge to Santa Clara River	28,600	36.6
Evapotranspiration	12,000	15.3
Subsurface Outflow	6,600	8.4
Pumping	31,000	39.6
Total	**78,200**	**100.0**

TABLE 5-7

Annual Water Budgets Calculated by the Calibrated Regional Model for 1980 through 1999

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Precipitation Infiltration	Infiltration of Applied Water	Streambed Infiltration	Castaic Dam Underflow	Total Recharge	Pumping	Groundwater Discharge to Streams	ET	Subsurface Outflow at County Line	Total Discharge	Change in Groundwater Storage	Cumulative Change in Groundwater Storage
1980 to 1981	41,003	3,375	43,226	1,705	89,310	35,542	30,507	15,387	6,691	88,128	1,181	1,181
1981 to 1982	12,102	3,871	13,148	1,700	30,821	35,209	22,304	9,214	6,641	73,368	-42,547	-41,365
1982 to 1983	52,415	3,022	35,134	1,700	92,270	24,918	25,583	11,157	6,695	68,353	23,917	-17,448
1983 to 1984	183,342	2,657	79,681	1,700	267,380	23,169	51,128	26,020	7,017	107,333	160,047	142,598
1984 to 1985	1,316	3,606	10,714	1,705	17,341	30,645	32,258	19,609	6,647	89,158	-71,817	70,781
1985 to 1986	2	3,279	9,082	1,700	14,063	28,963	25,369	10,629	6,572	71,533	-57,470	13,311
1986 to 1987	43,258	3,211	26,471	1,700	74,641	28,658	27,557	12,354	6,668	75,236	-595	12,716
1987 to 1988	11,915	2,991	9,694	1,700	26,299	27,085	24,434	8,601	6,566	66,686	-40,386	-27,670
1988 to 1989	27,949	3,075	17,106	1,705	49,835	27,571	23,518	8,752	6,613	66,454	-16,619	-44,289
1989 to 1990	0	3,393	7,899	1,700	12,993	30,415	21,004	6,676	6,520	64,614	-51,621	-95,911
1990 to 1991	0	3,787	9,092	1,700	14,579	31,652	18,151	4,711	6,530	61,043	-46,464	-142,375
1991 to 1992	51,315	3,397	28,933	1,700	85,345	41,067	19,924	6,963	6,647	74,600	10,745	-131,630
1992 to 1993	131,293	3,850	60,449	1,705	197,296	37,567	27,043	14,114	6,906	85,629	111,666	-19,964
1993 to 1994	113,547	3,773	64,341	1,700	183,361	39,741	34,976	22,598	6,875	104,191	79,170	59,207
1994 to 1995	813	4,415	13,436	1,700	20,365	44,120	21,612	12,839	6,586	85,157	-64,793	-5,586
1995 to 1996	114,663	4,517	60,647	1,700	181,527	42,009	32,426	21,314	6,887	102,637	78,890	73,305
1996 to 1997	46,312	5,205	30,512	1,705	83,734	45,574	25,888	17,092	6,762	95,317	-11,583	61,721
1997 to 1998	17,485	5,267	16,277	1,700	40,729	47,051	21,488	12,791	6,667	87,997	-47,268	14,453
1998 to 1999	138,991	4,758	90,634	1,700	236,084	42,043	41,283	26,213	6,959	116,498	119,585	134,039
1999 to 2000	26	5,343	13,714	1,700	20,783	46,867	24,335	15,943	6,607	93,752	-72,969	61,070
Minimum	0	2,657	7,899	1,700	12,993	23,169	18,151	4,711	6,520	61,043	-72,969	-142,375
Maximum	183,342	5,343	90,634	1,705	267,380	47,051	51,128	26,213	7,017	116,498	160,047	142,598
Average	49,387	3,840	32,010	1,701	86,938	35,493	27,539	14,149	6,703	83,884	3,053	5,907
Median	34,476	3,689	21,789	1,700	62,238	35,376	25,476	12,815	6,657	85,393	-14,101	6,949

Note:

All flow volumes are listed in AF/yr.

Figures

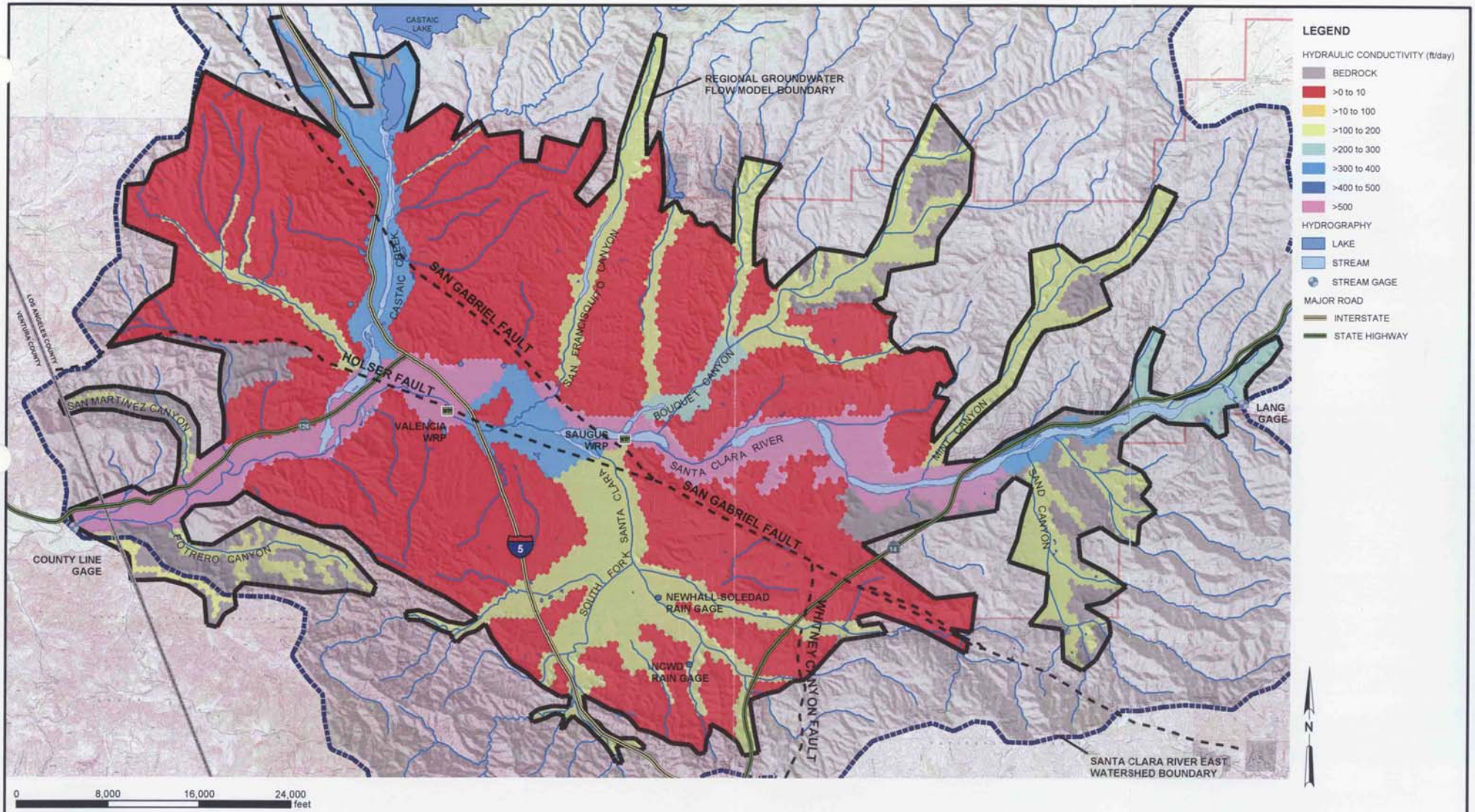

FIGURE 5-1
HYDRAULIC CONDUCTIVITY LAYER 1
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG036.MXD FIG05-01.PDF 01/28/2004 19:28:25

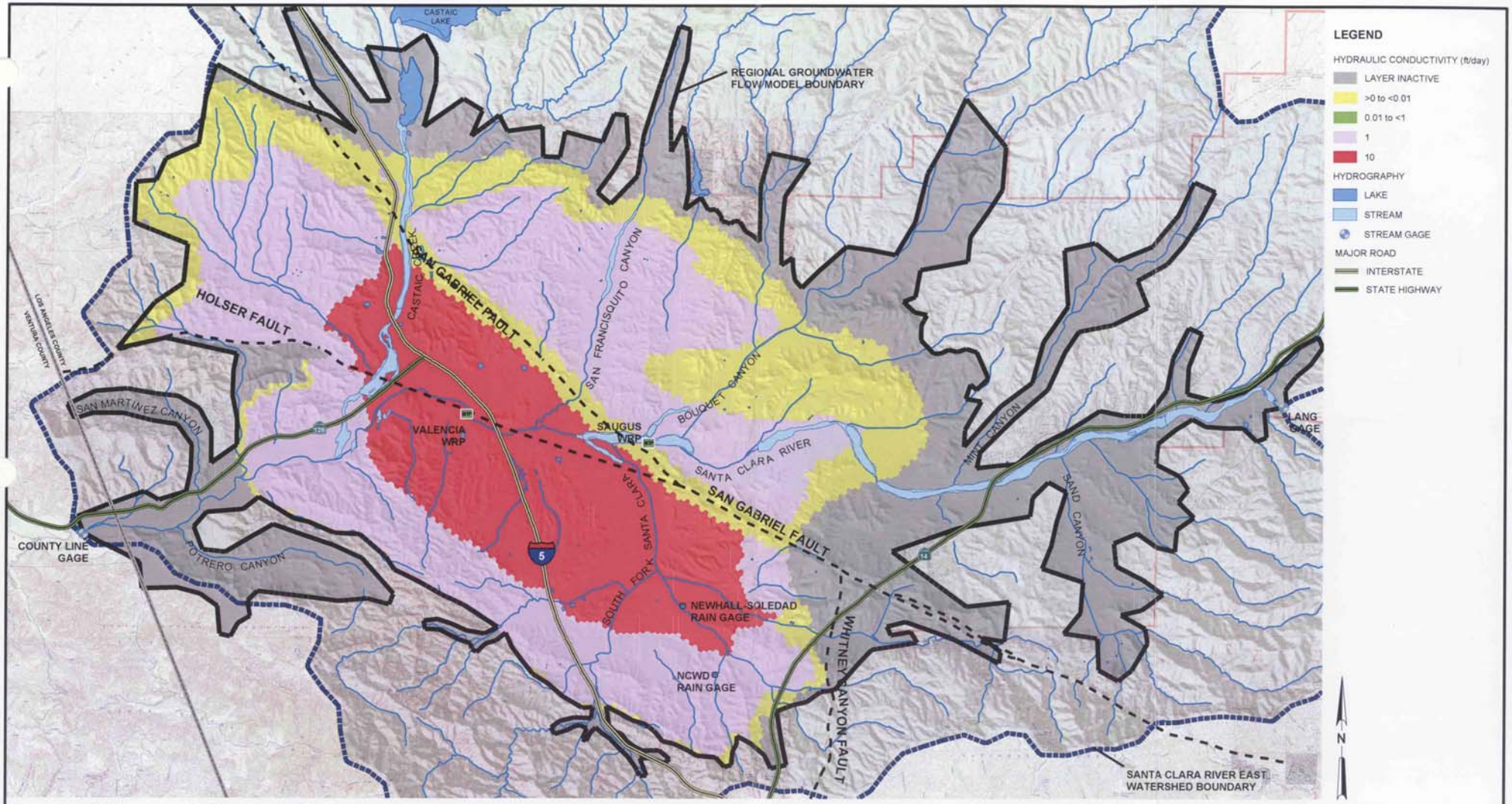

FIGURE 5-2
HYDRAULIC CONDUCTIVITY LAYER 2
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG037.MXD FIG05-02.PDF 01/22/2004 17:55:45

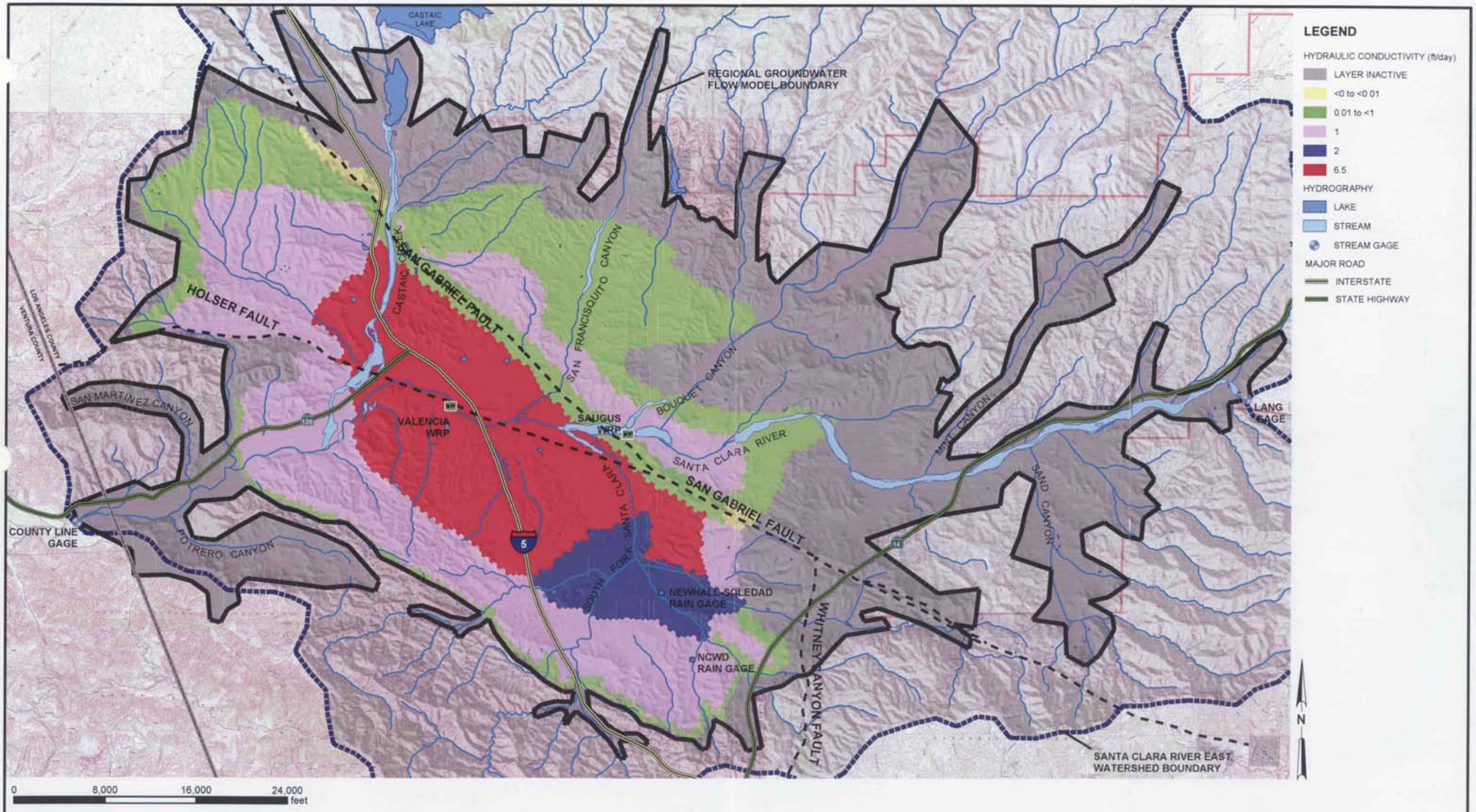

FIGURE 5-3
HYDRAULIC CONDUCTIVITY LAYER 3
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG039.MXD FIG05-03.PDF 01/22/2004 18:08:34

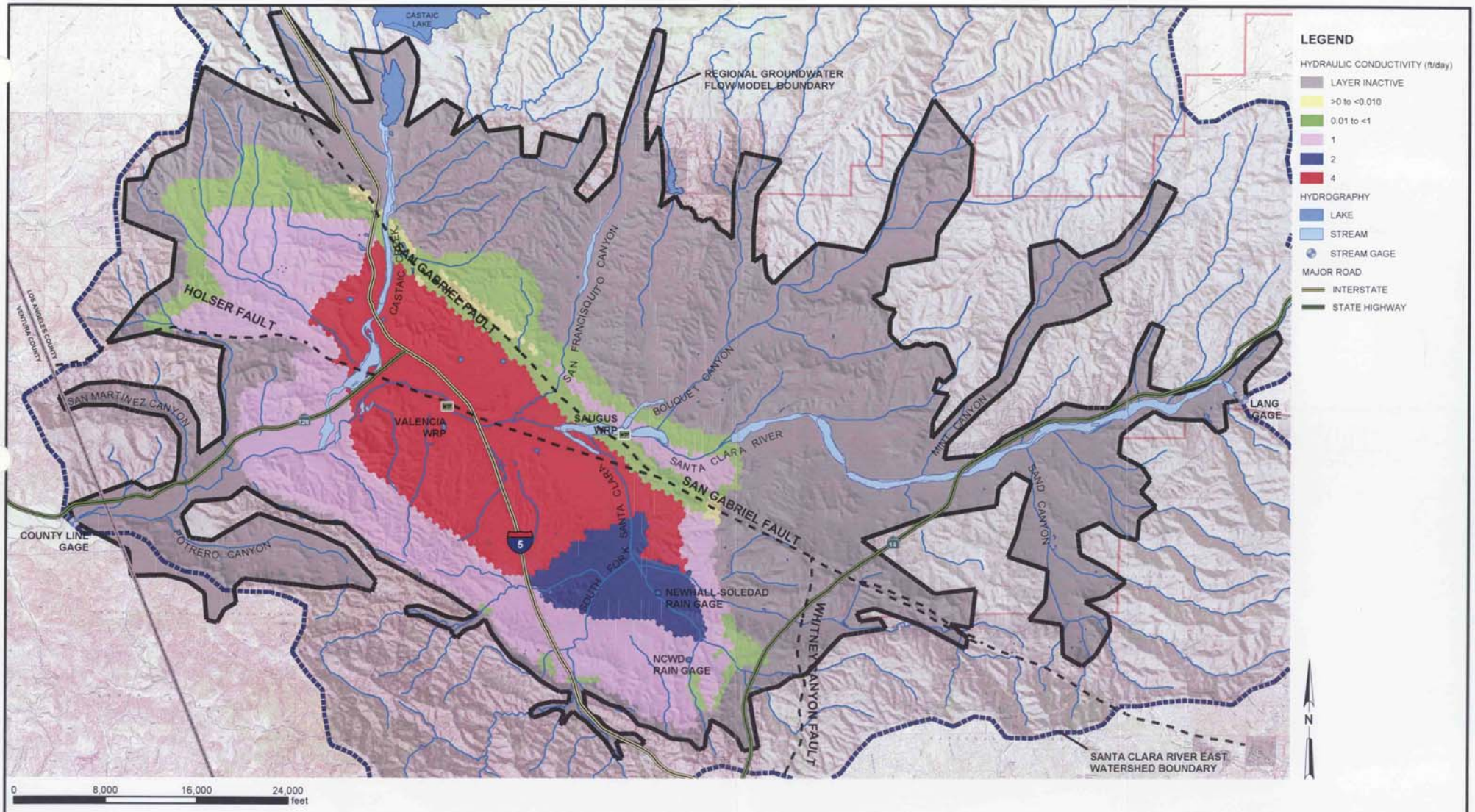

FIGURE 5-4
HYDRAULIC CONDUCTIVITY LAYER 4
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG040.MXD FIG05-04.PDF 01/22/2004 18:16:22

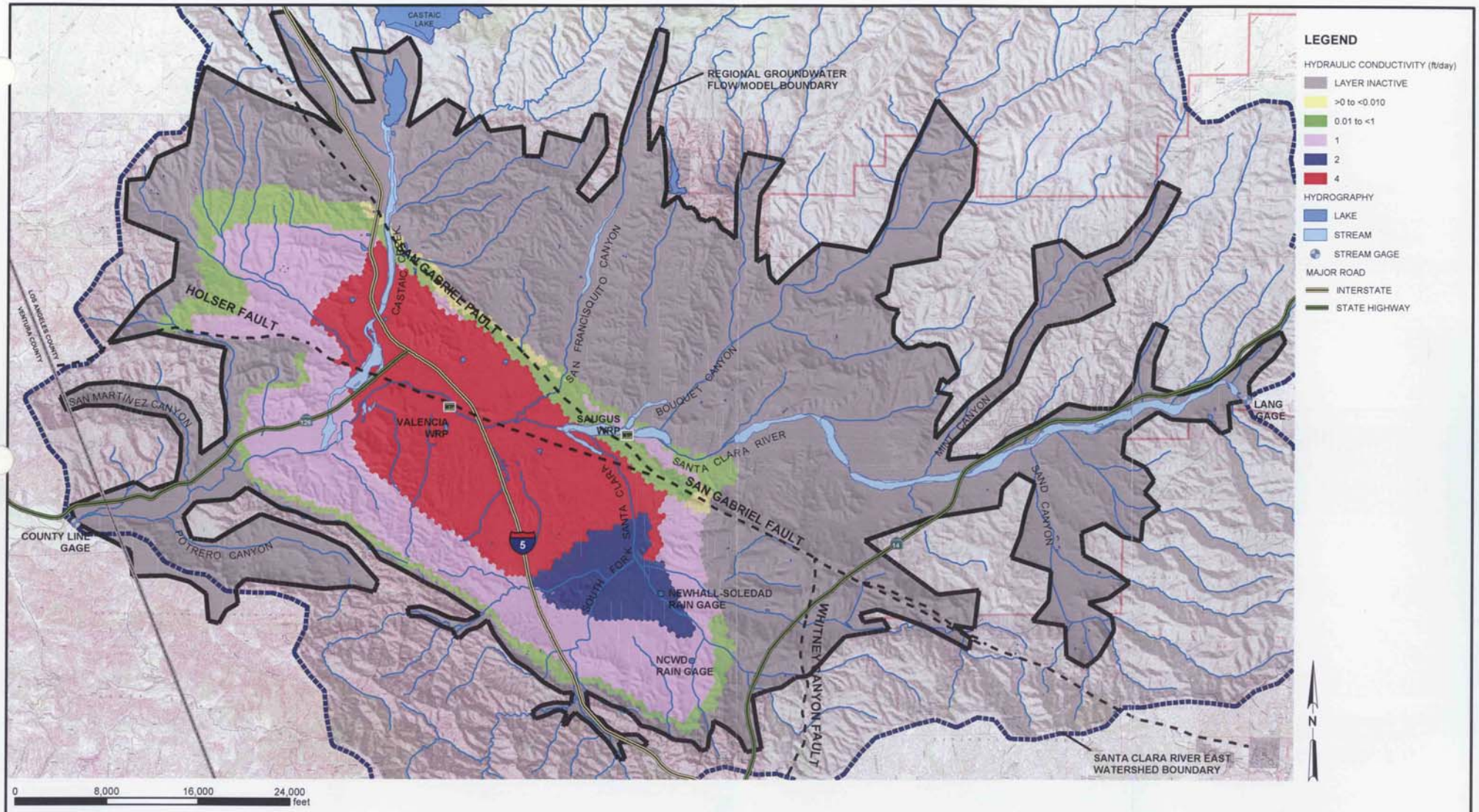

FIGURE 5-5
HYDRAULIC CONDUCTIVITY LAYER 5
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG041.MXD FIG05-05.PDF 01/22/2004 18:16:22

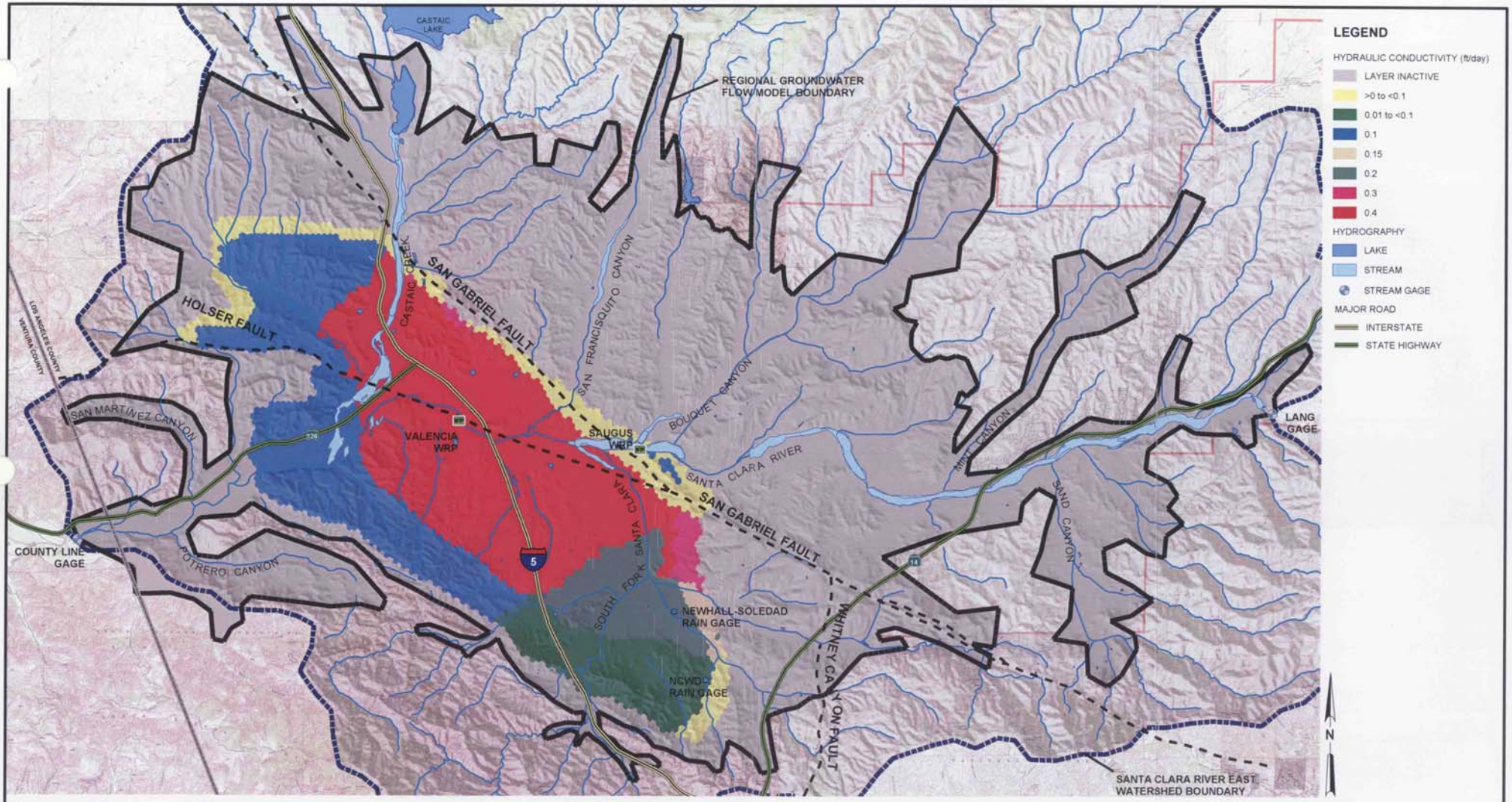

FIGURE 5-6
HYDRAULIC CONDUCTIVITY LAYER 6
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG038_.MXD FIG05-06.PDF 01/22/2004 18:47:29

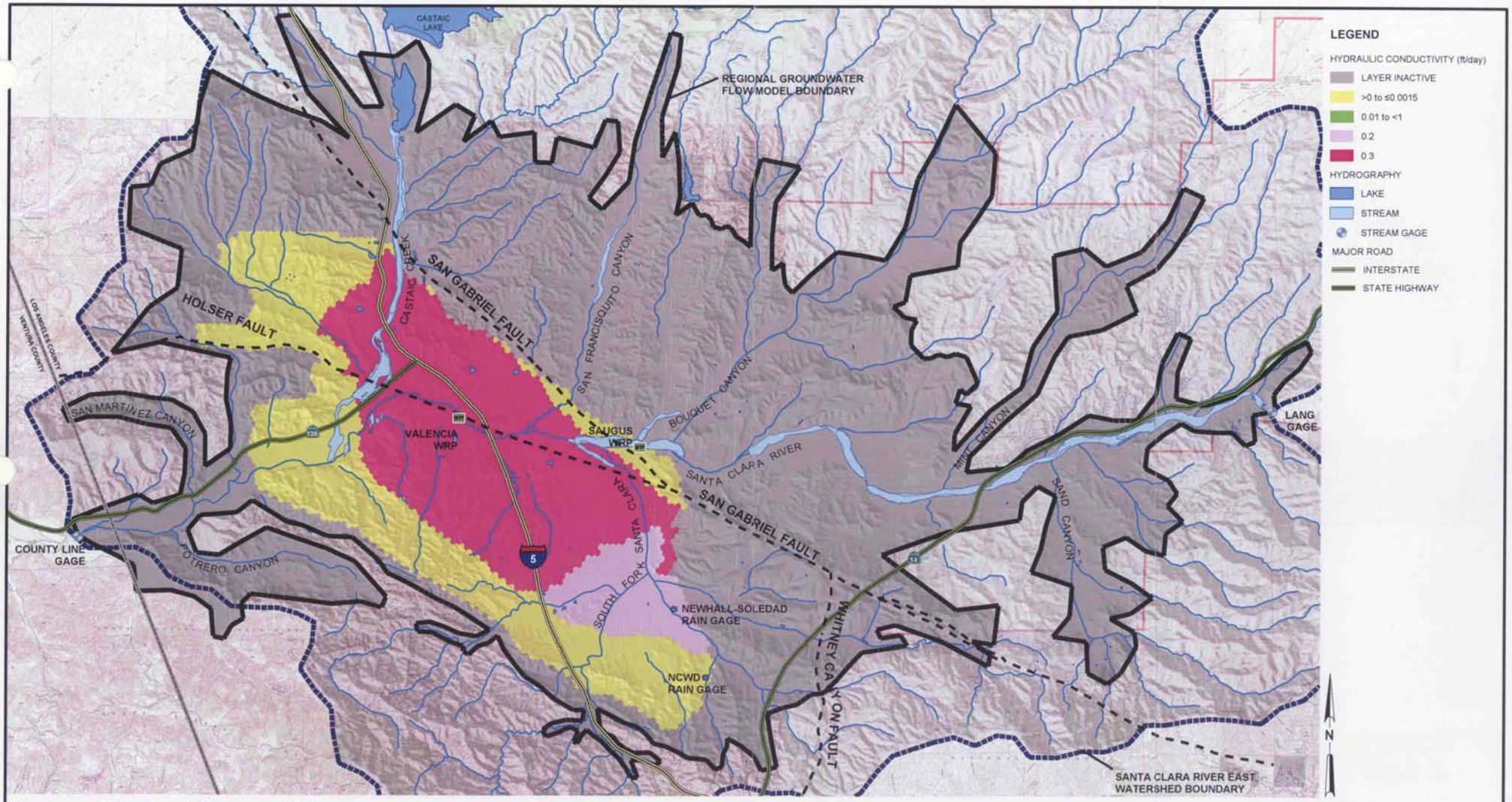

FIGURE 5-7
HYDRAULIC CONDUCTIVITY LAYER 7
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\RDD31002540\55\SANTACLARITA_MOU\FIGURES\MXD\FIG042.MXD FIG05-07.PDF 01/22/2004 18:22:27

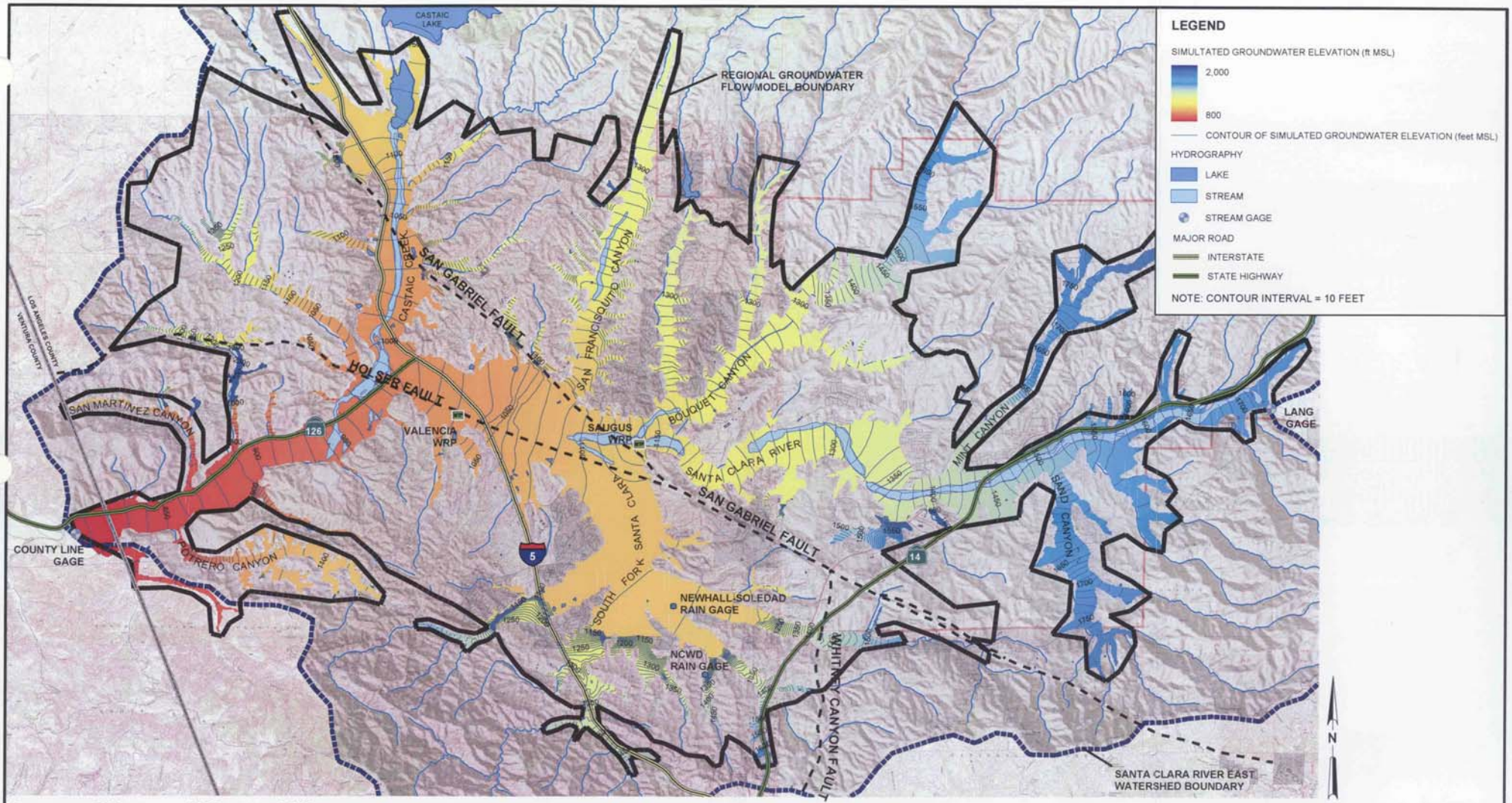

FIGURE 5-8
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR ALLUVIAL AQUIFER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG052.MXD FIG05-8.PDF 02/03/2004 08:46:47

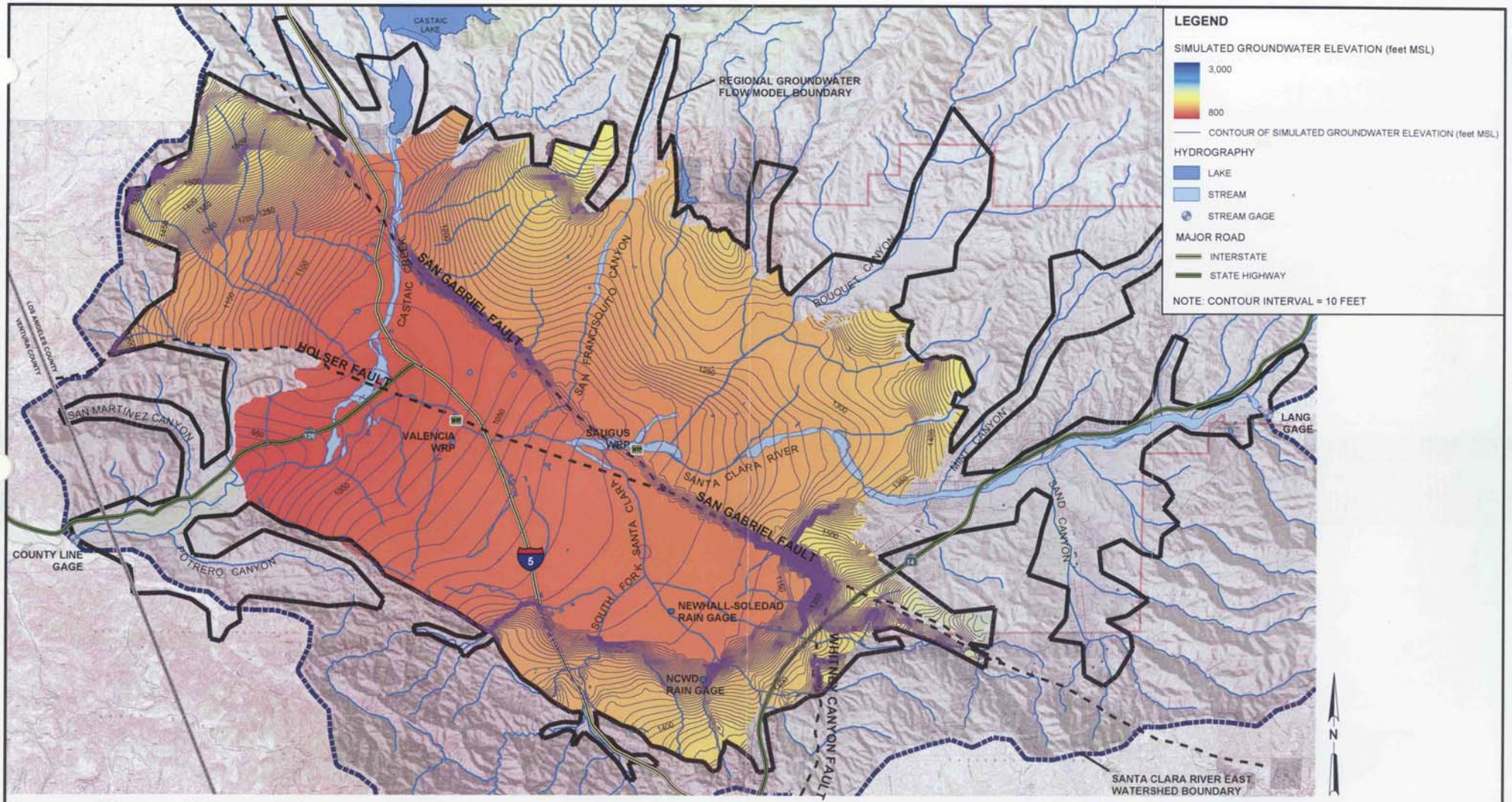

FIGURE 5-9
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 2
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG046.MXD FIG05-9.PDF 02/02/2004 10:58:01

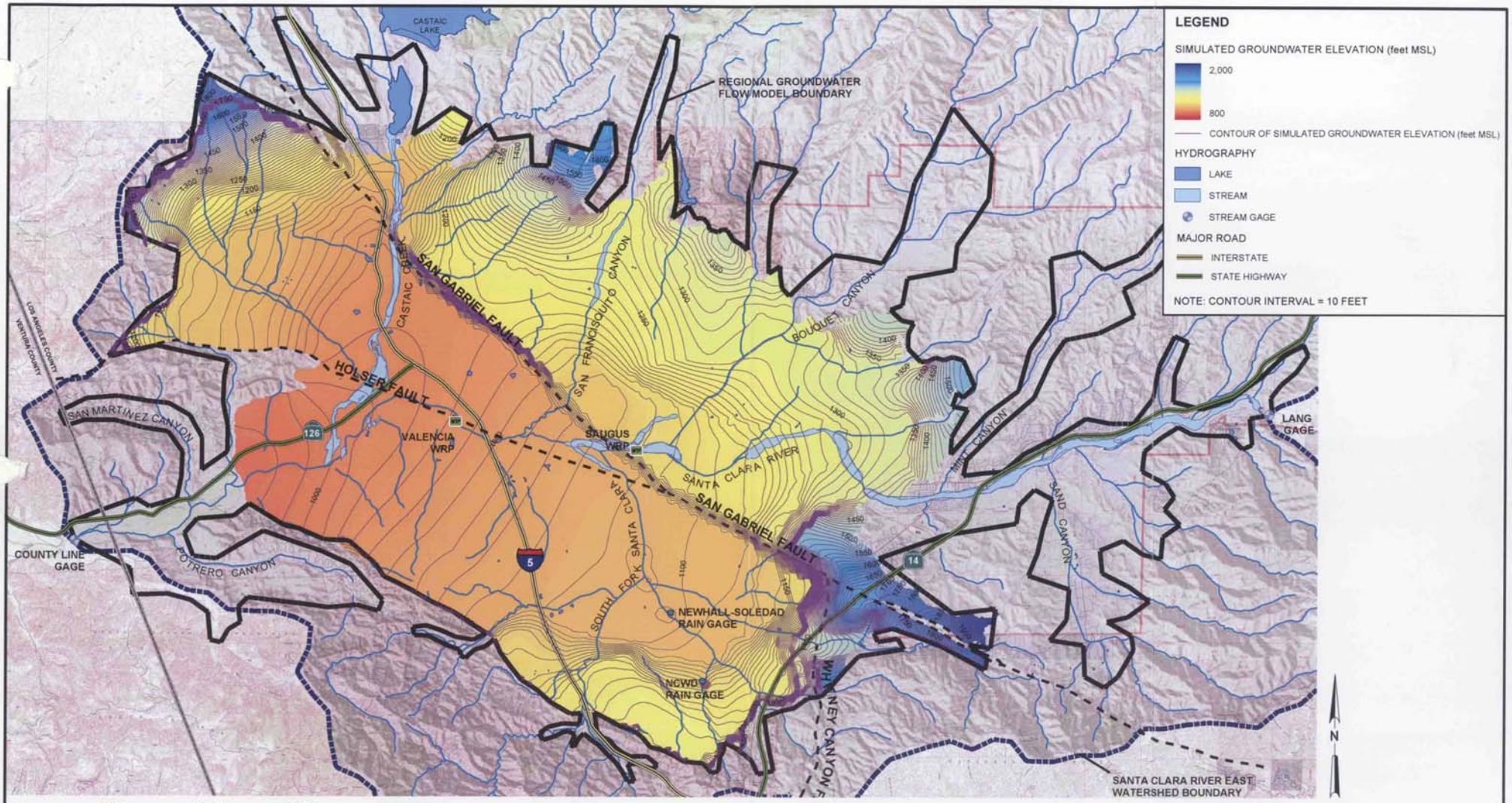

FIGURE 5-10
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 3
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG045.MXD FIG05-10.PDF 02/02/2004 10:42:32

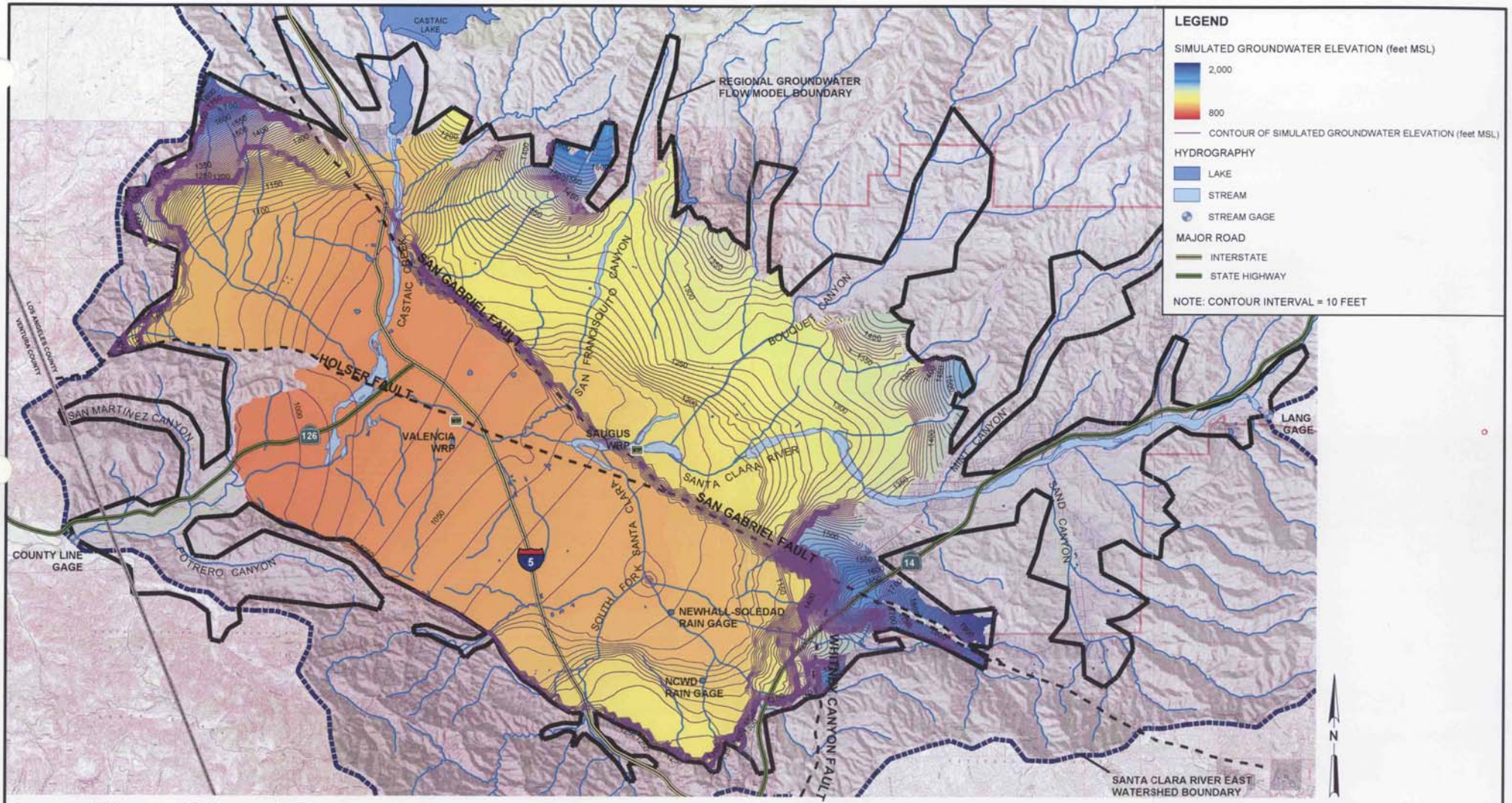

FIGURE 5-11
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 4
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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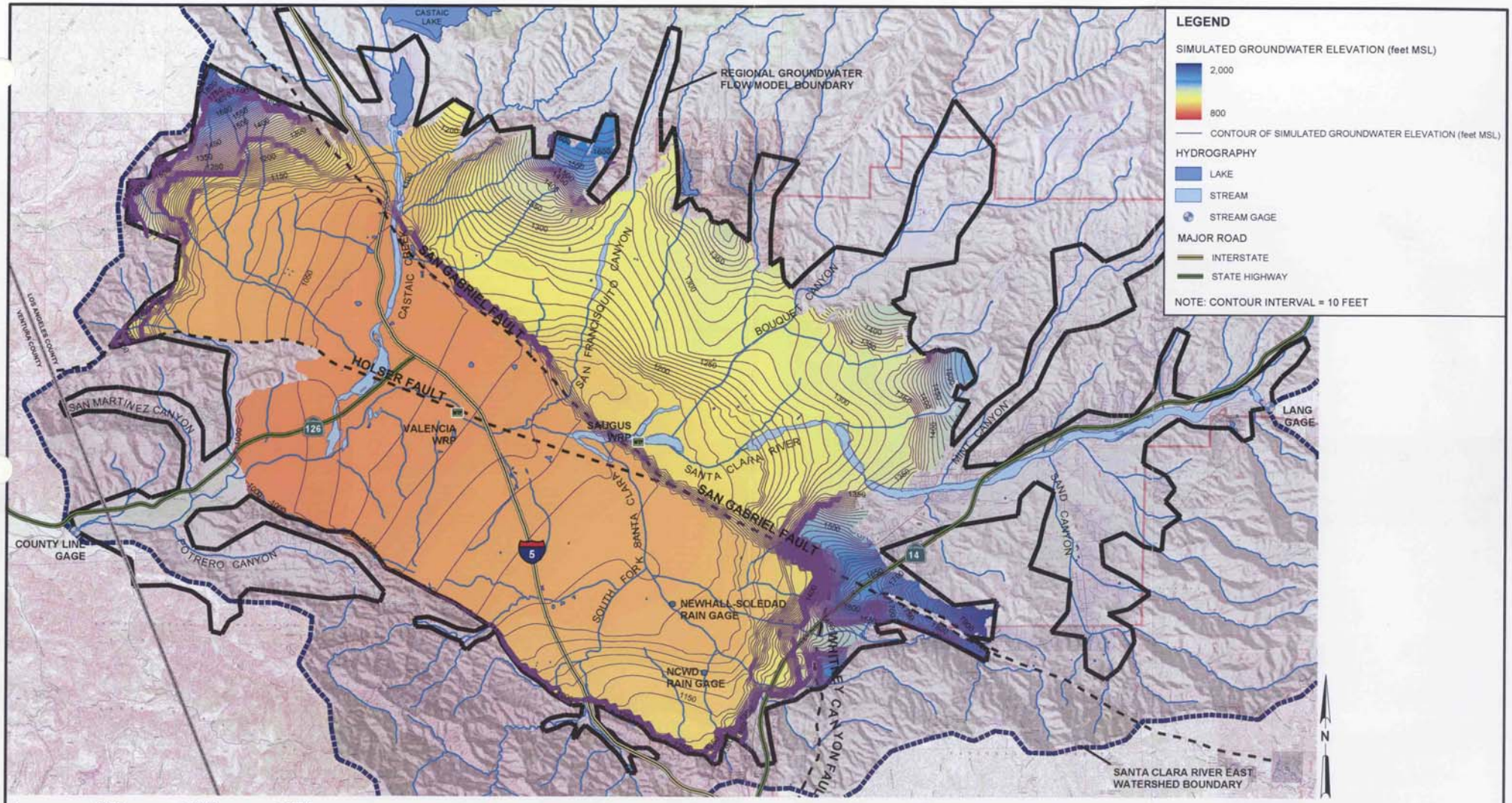

FIGURE 5-12
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 5
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG048.MXD FIG05-12.PDF 02/02/2004 11:04:46

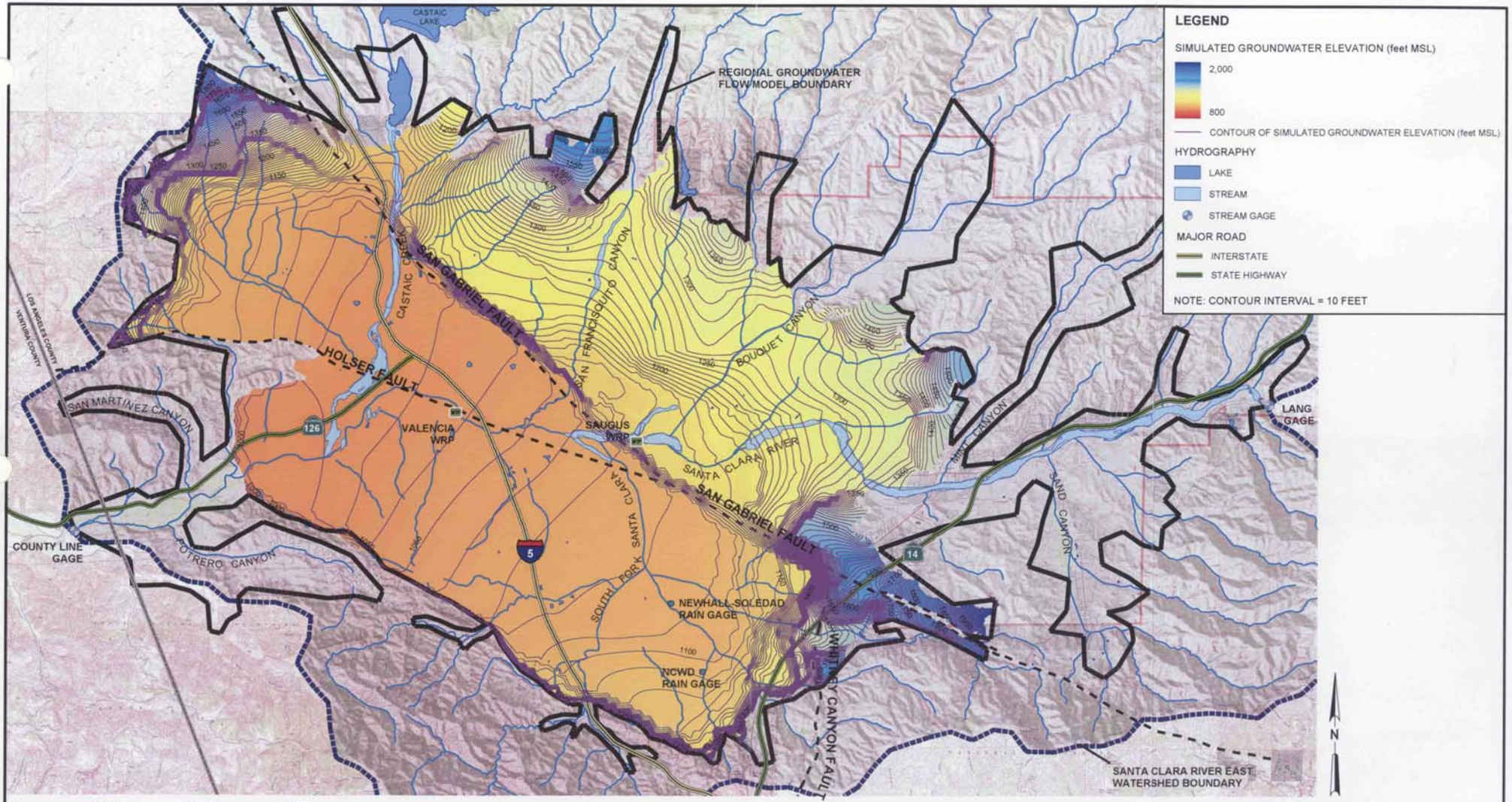

FIGURE 5-13
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 6
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG051.MXD FIG05-13.PDF 02/02/2004 11:11:08

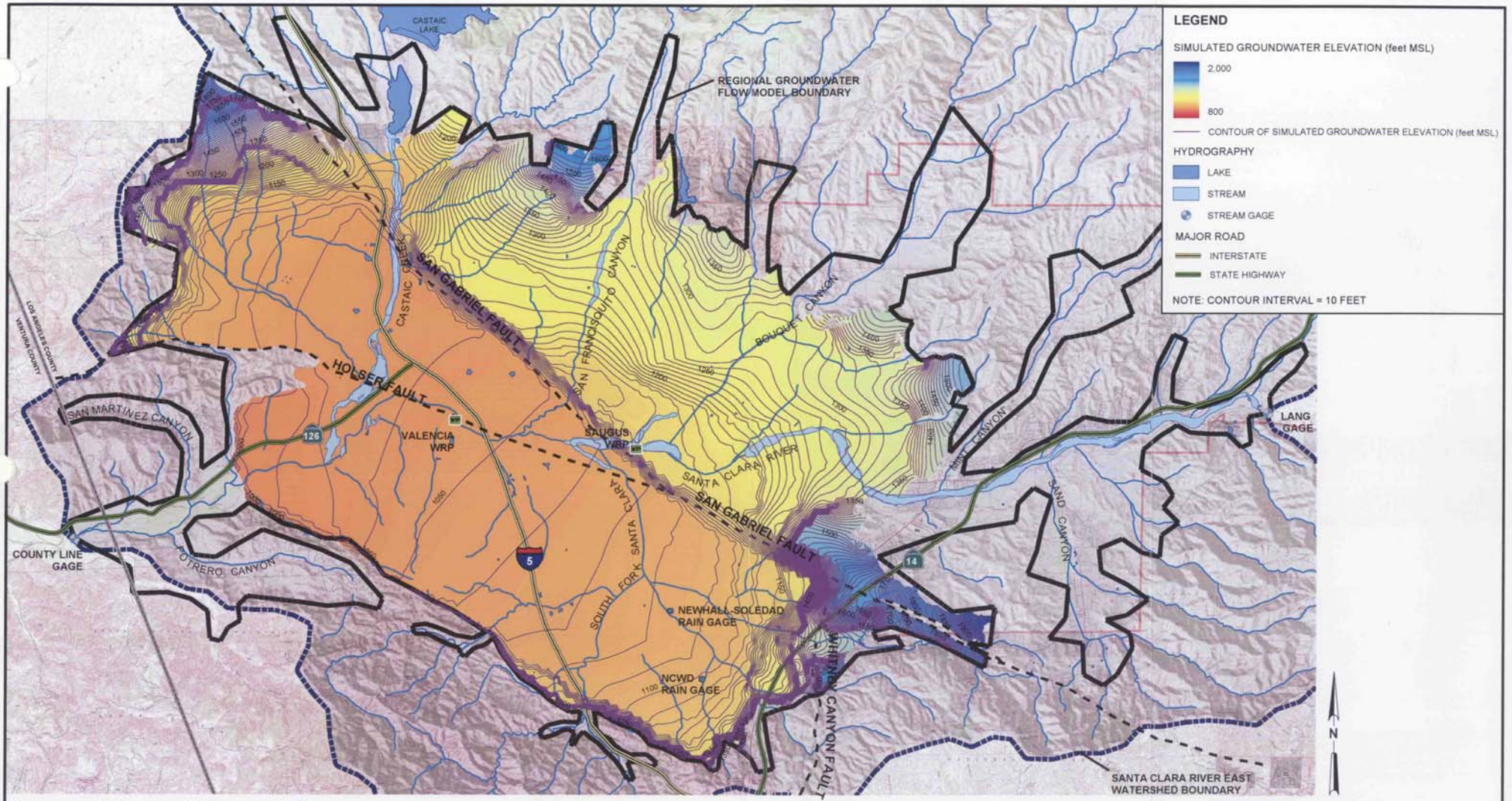

FIGURE 5-14
STEADY-STATE 1980-1985 GROUNDWATER ELEVATION CONTOURS FOR SAUGUS FORMATION IN MODEL LAYER 7
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIG050.MXD FIG05-14.PDF 02/02/2004 11:18:17

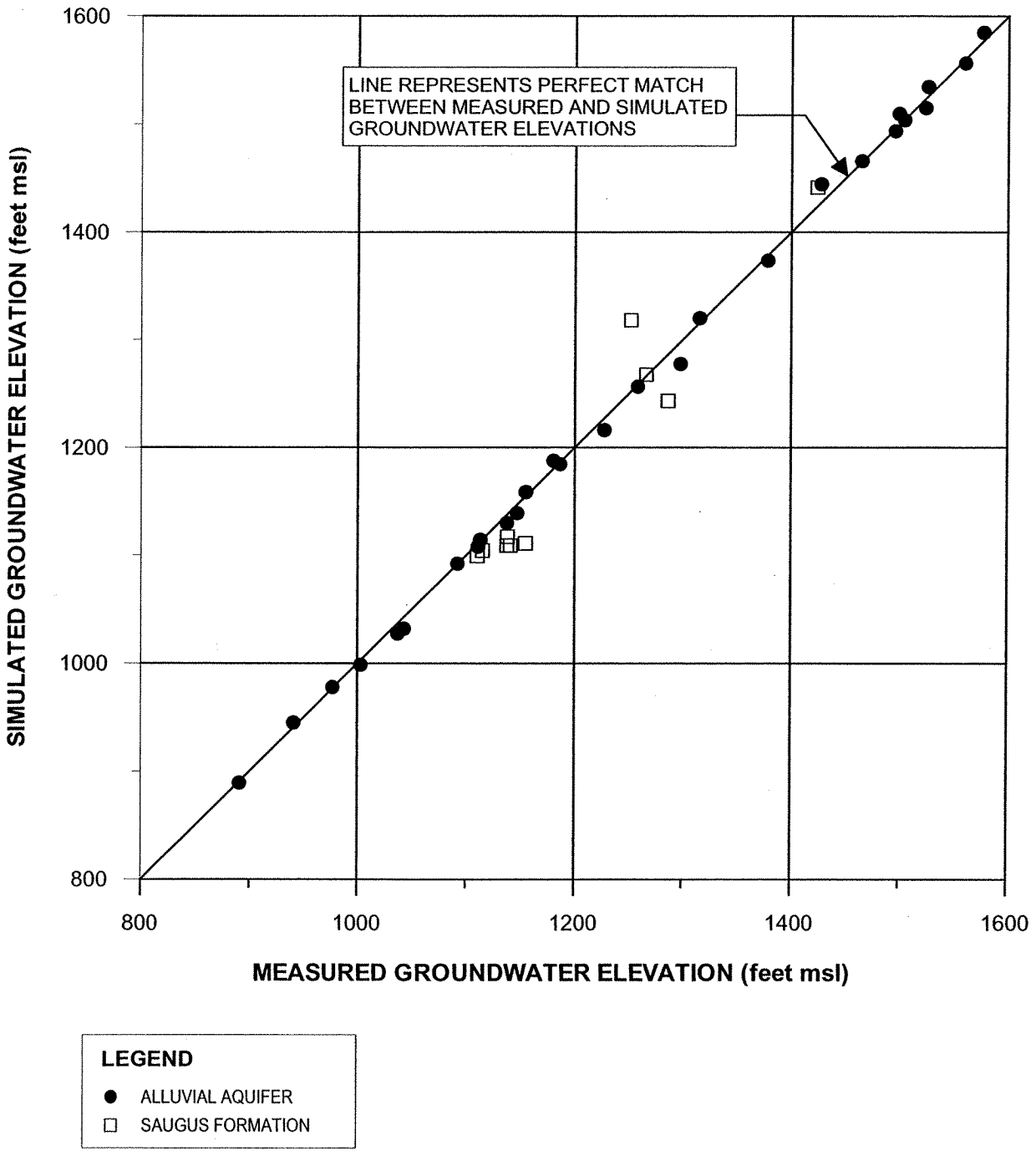

FIGURE 5-15
SIMULATED VERSUS MEASURED GROUNDWATER ELEVATIONS FOR THE STEADY-STATE MODEL
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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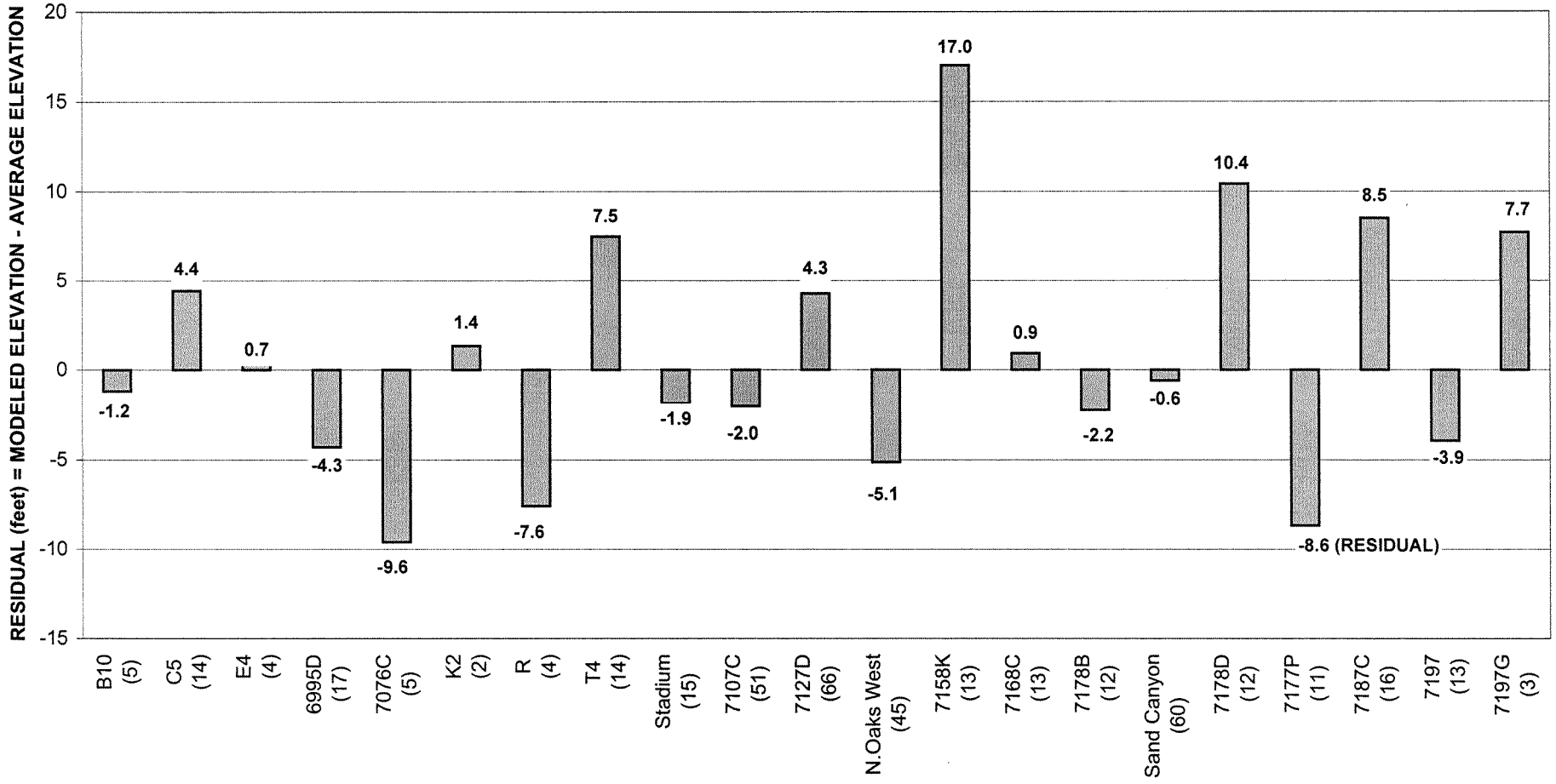

FIGURE 5-16
STEADY-STATE MODEL ERROR FOR ALLUVIAL AQUIFER TARGET WELLS ALONG THE SANTA CLARA RIVER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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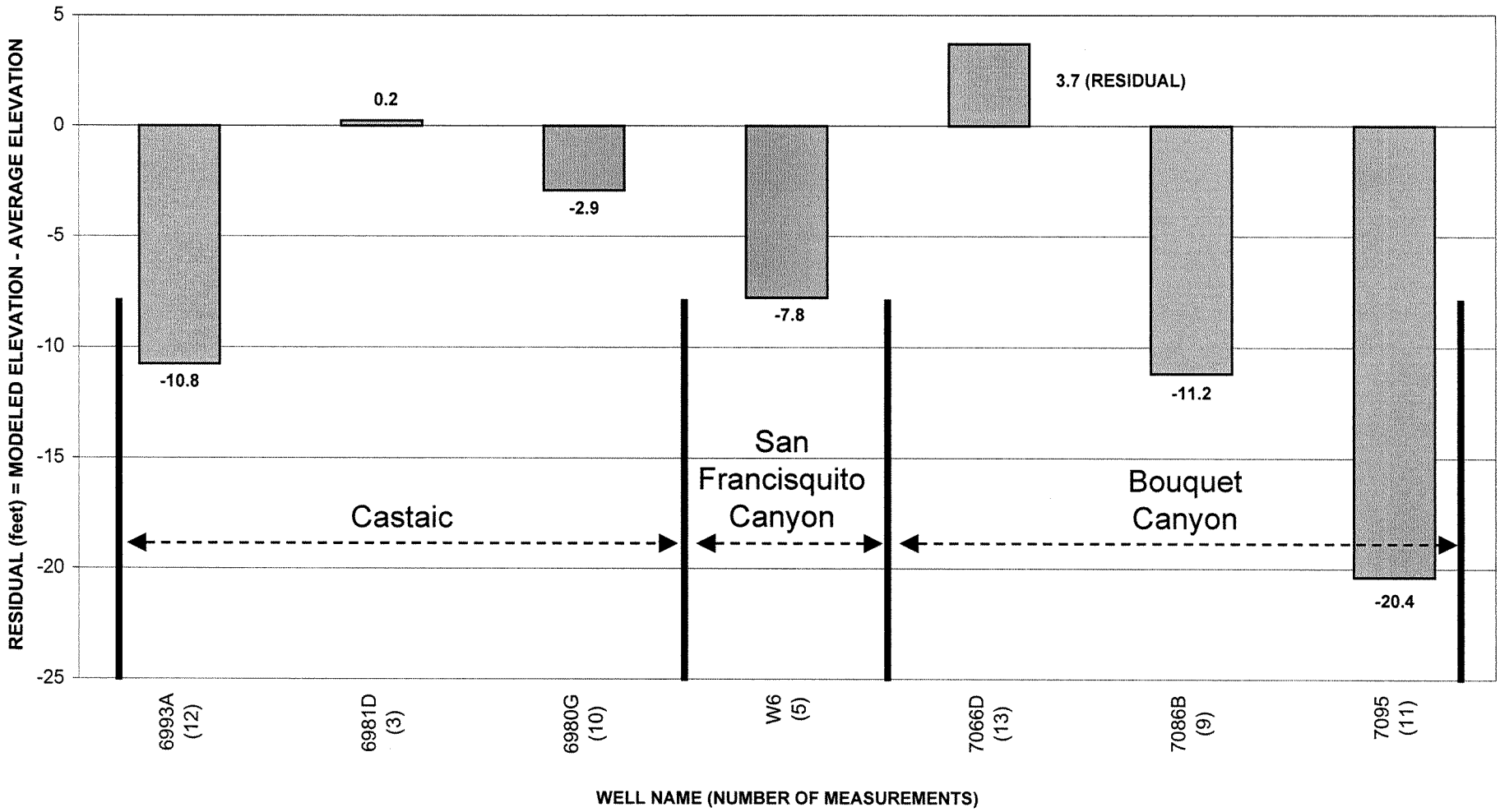

FIGURE 5-17
STEADY-STATE MODEL ERROR FOR ALLUVIAL AQUIFER TARGET WELLS AWAY FROM THE SANTA CLARA RIVER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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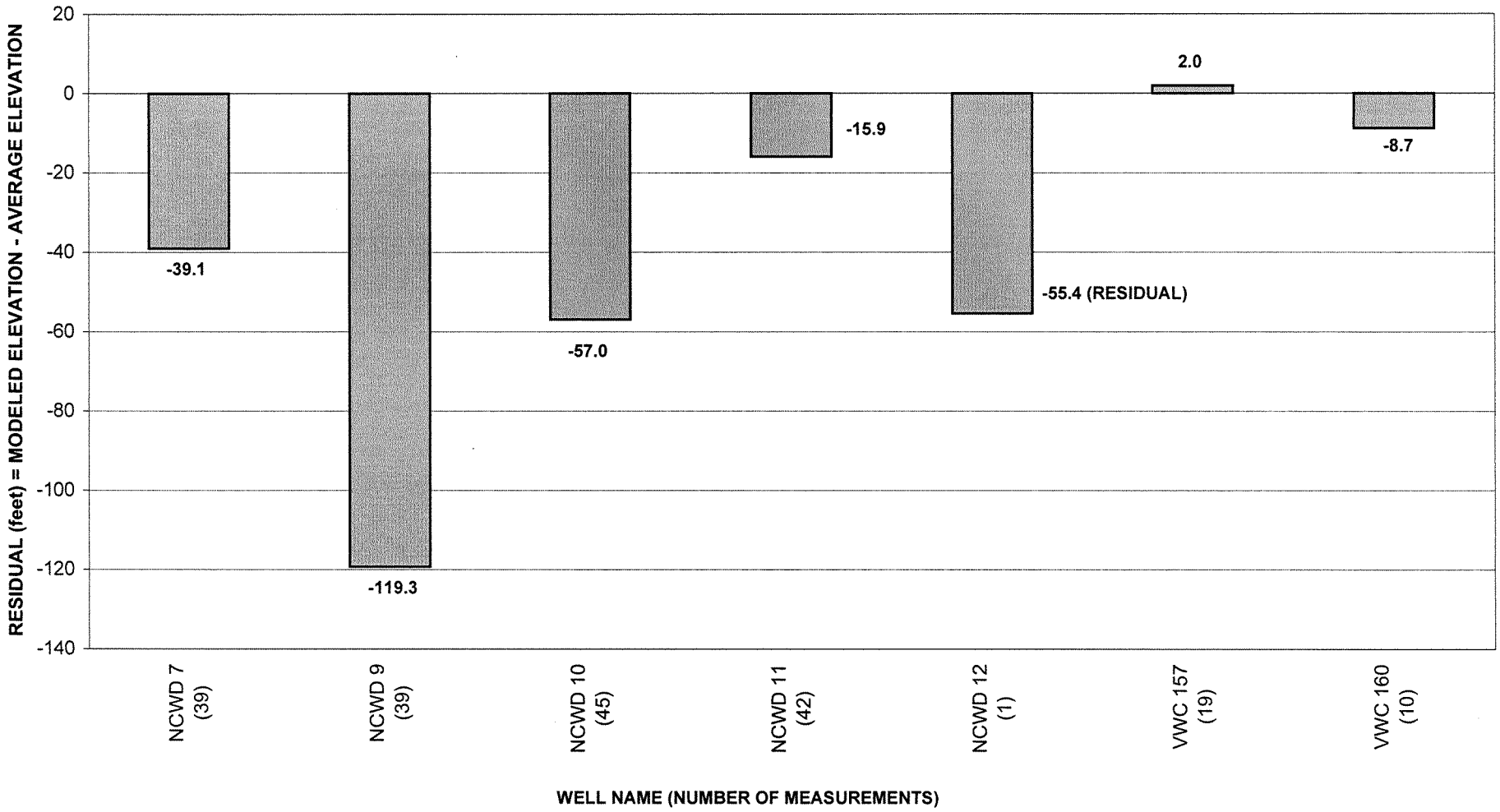
178973-403.xls/Fig 5-17



NOTE:
ALL WELLS SHOWN ON THIS PLOT ARE LOCATED IN THE SOUTH FORK SANTA CLARA RIVER VALLEY

FIGURE 5-18
STEADY-STATE MODEL ERROR FOR SAUGUS FORMATION PRODUCTION WELLS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

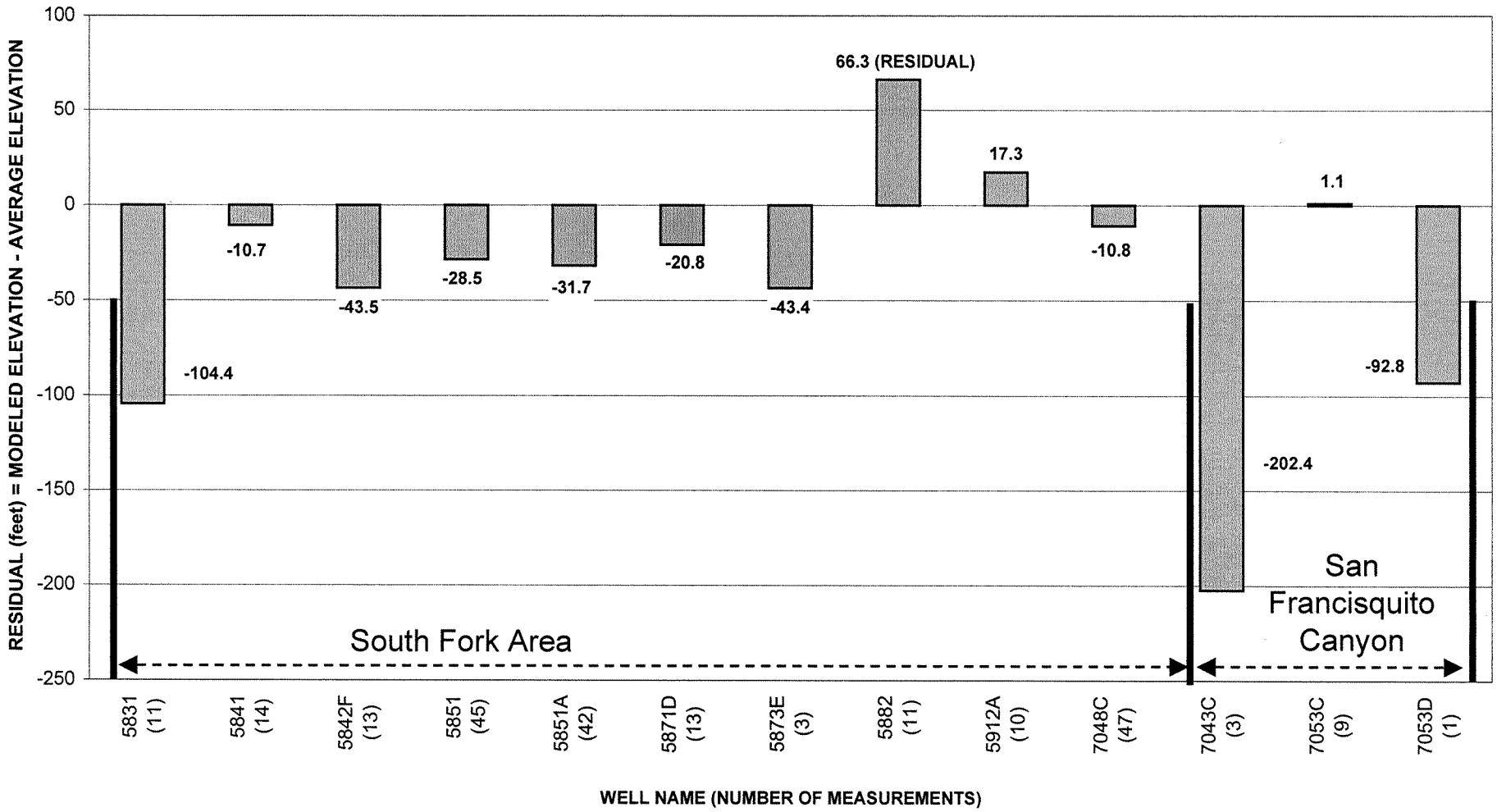


FIGURE 5-19
STEADY-STATE MODEL ERROR FOR SAUGUS FORMATION OBSERVATION WELLS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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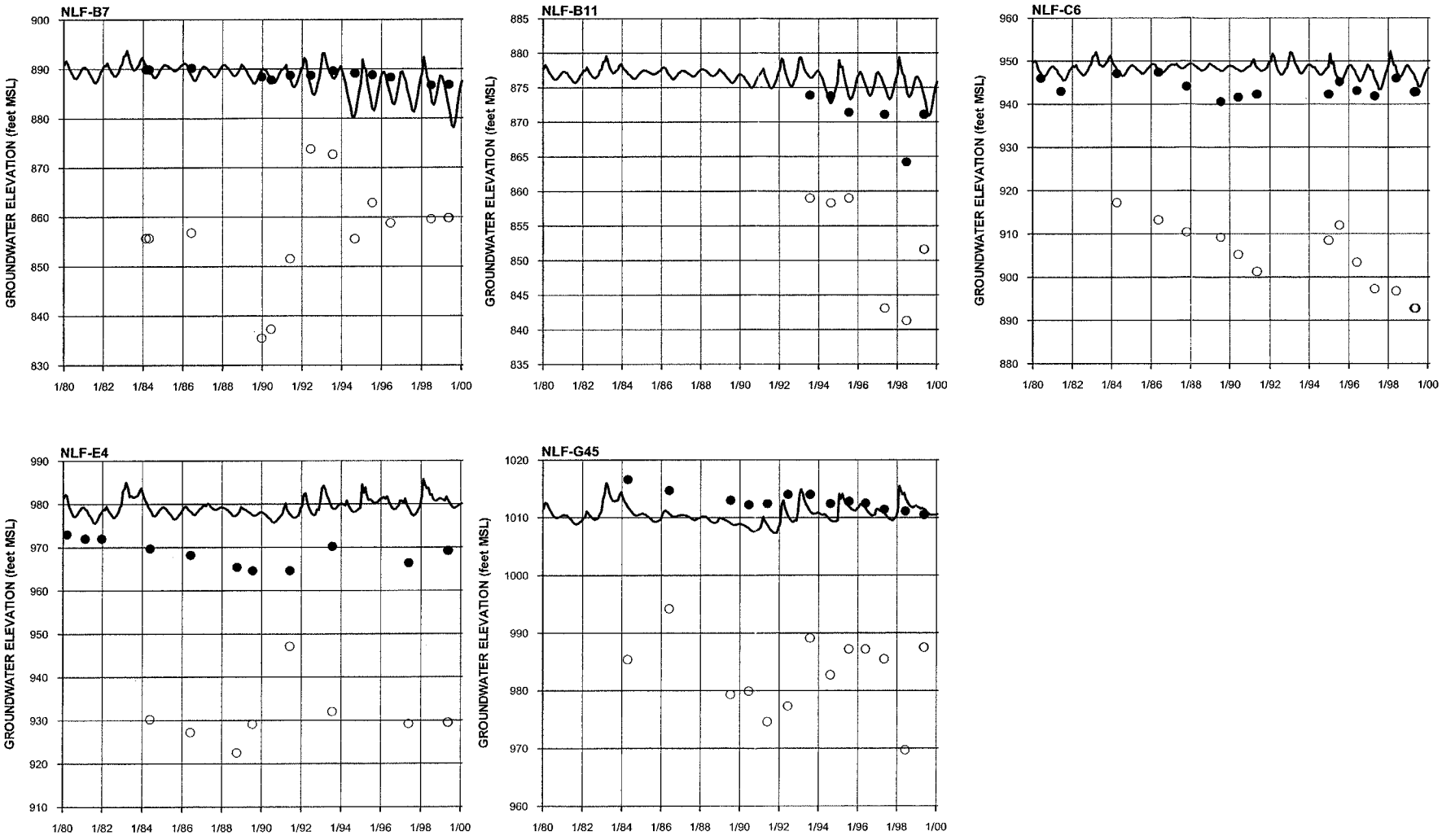
178973-403.xls/Fig 5-19



NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

FIGURE 5-20
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS WEST OF INTERSTATE 5
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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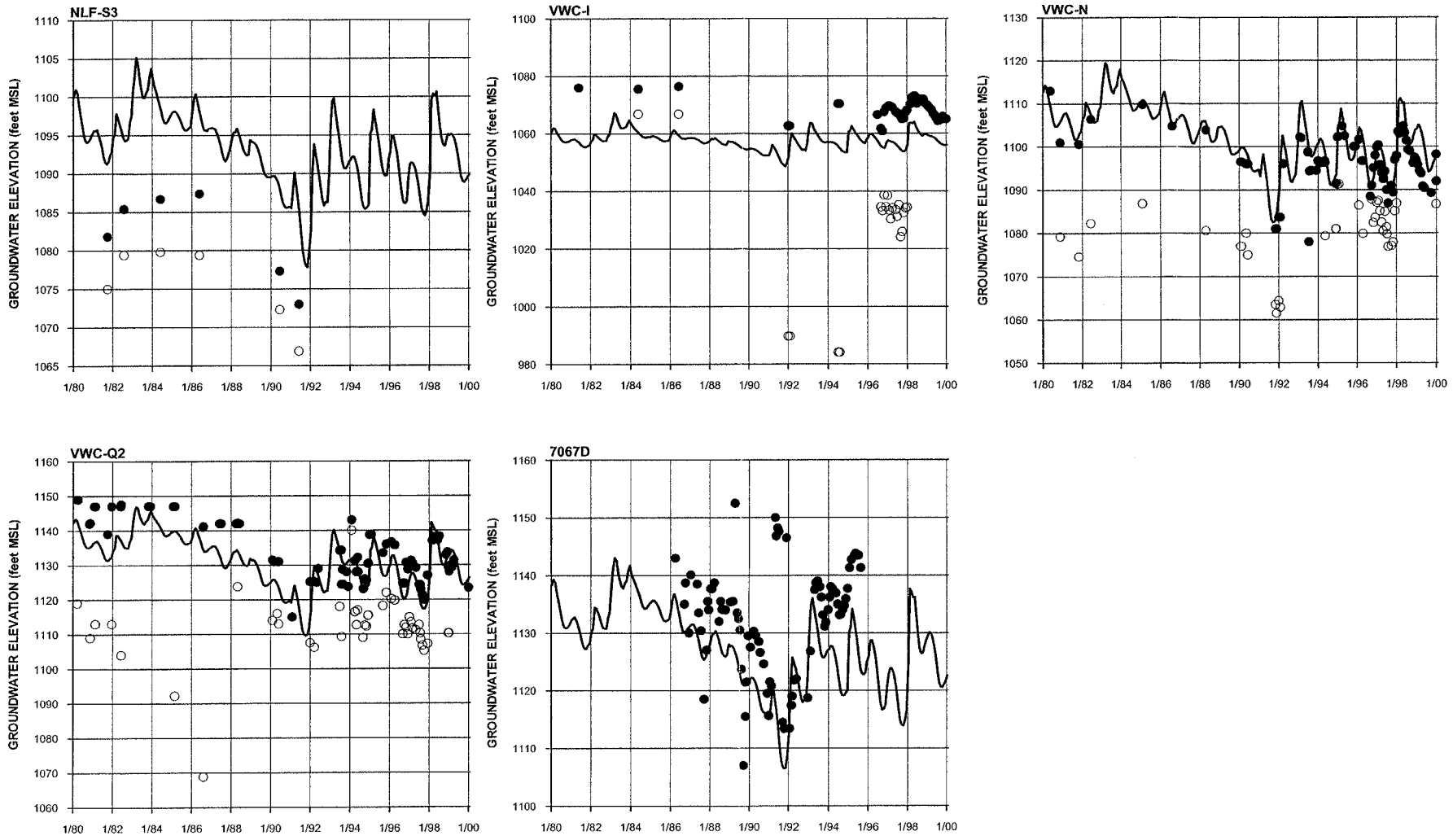
175570-310.GRF



NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

FIGURE 5-21
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS BETWEEN INTERSTATE 5 AND SOLEDAD CANYON

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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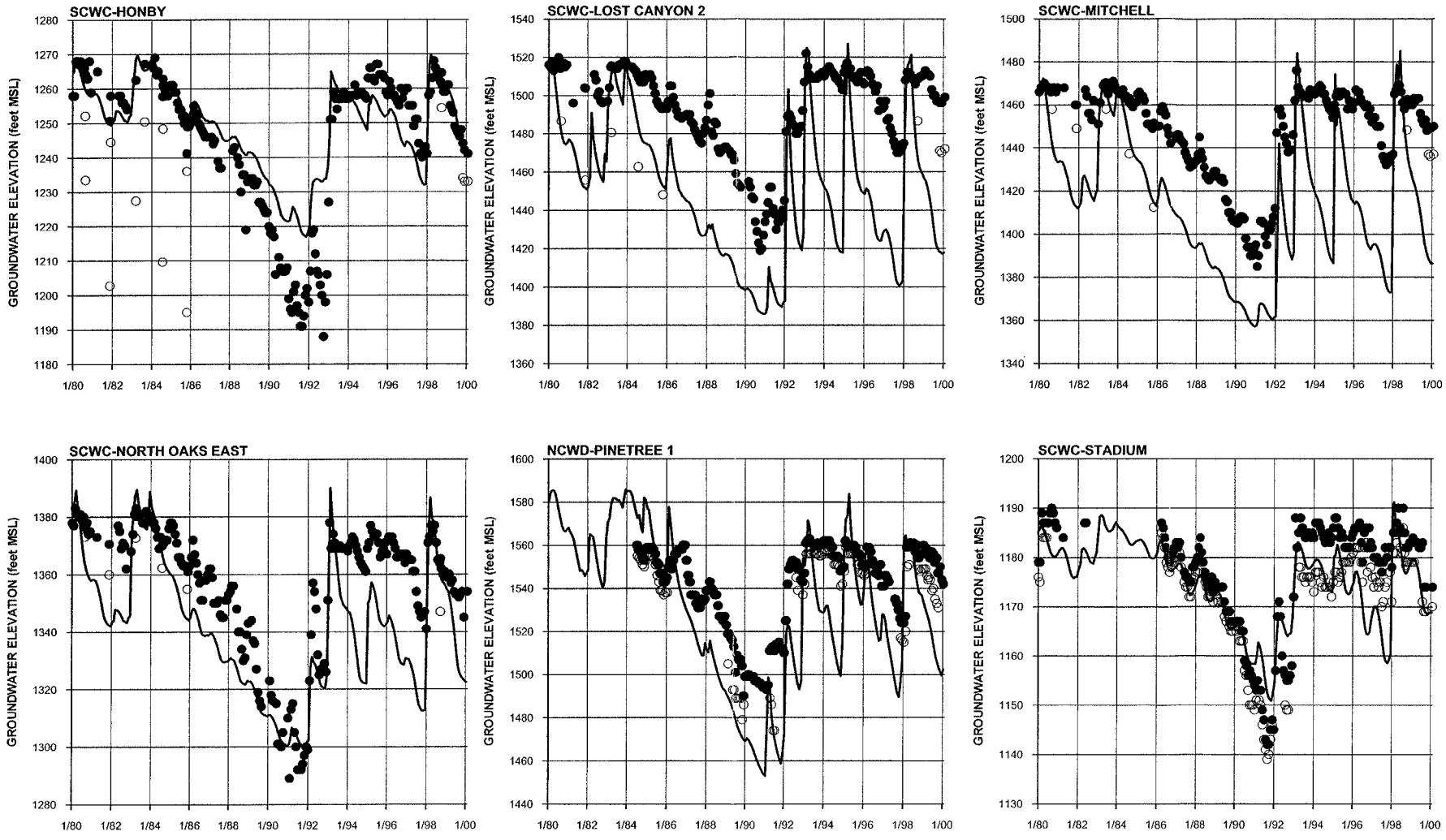
175570-312.GRF



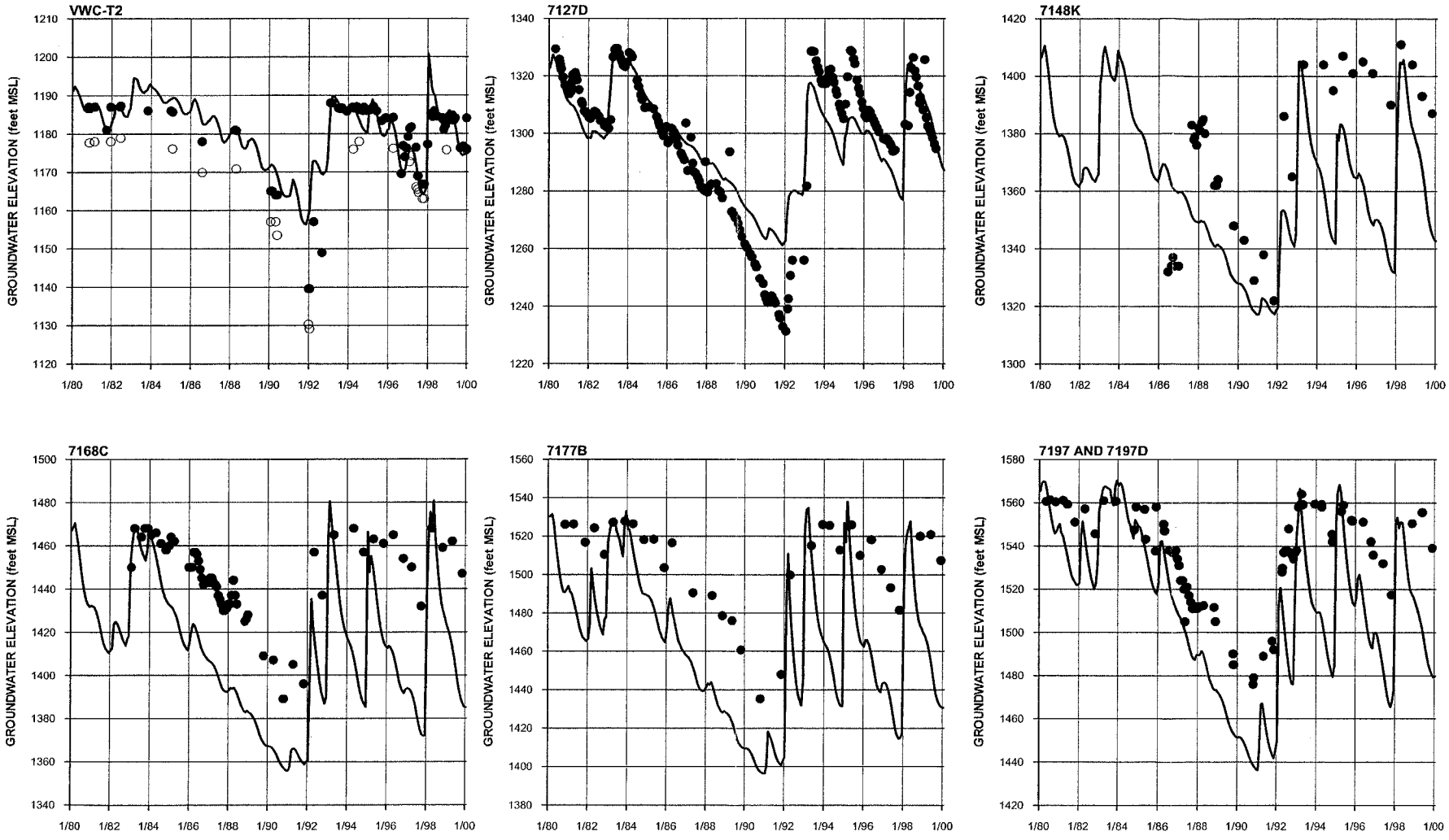
NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

178973-313.GRF

FIGURE 5-22
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS IN SOLEDAD CANYON (PAGE 1 OF 2)

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL



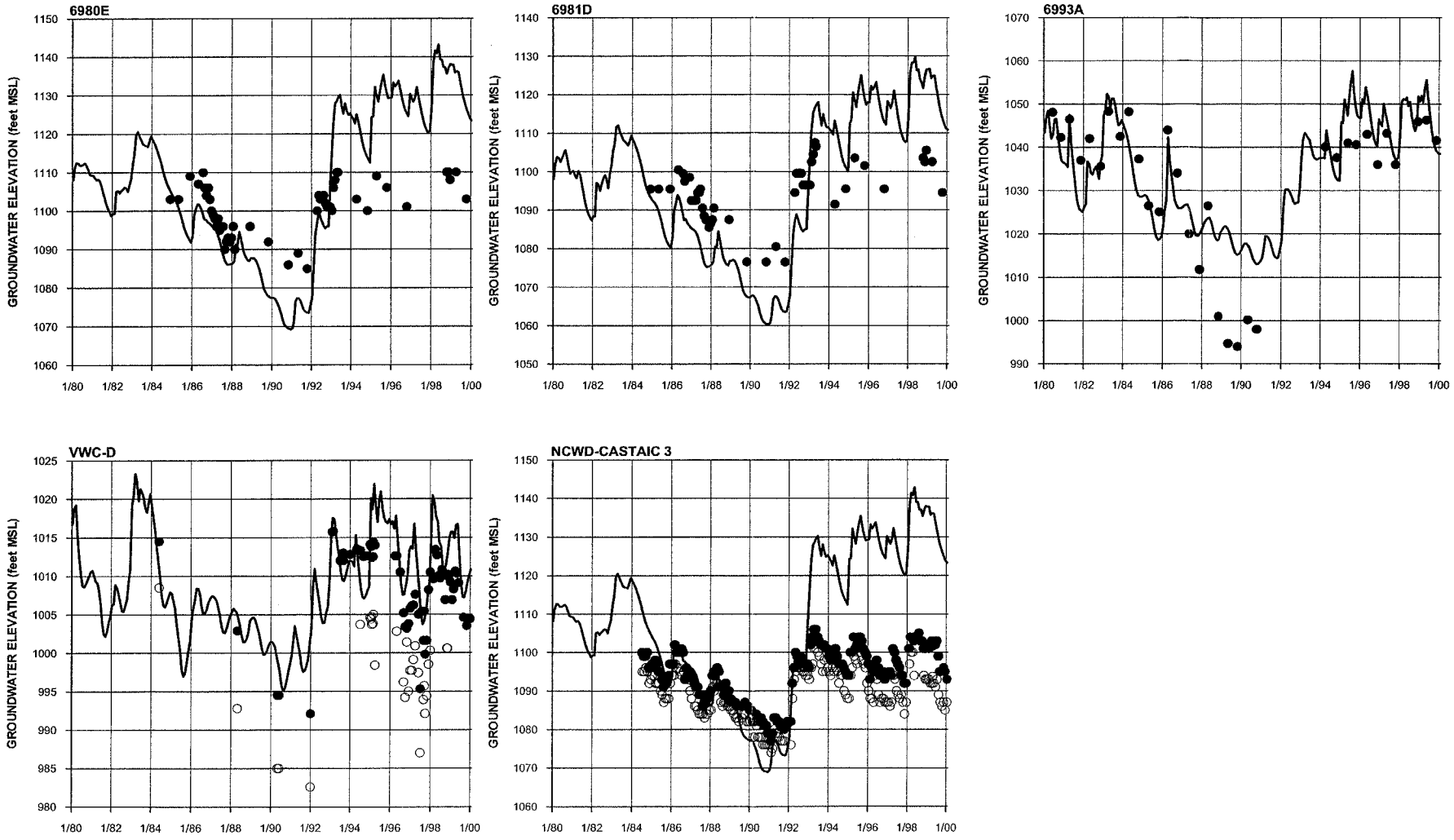
NOTE: SEE FIGURE 2-3 FOR LOCATION OF WELLS.

178973-314.GRF

FIGURE 5-22
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS IN SOLEDAD CANYON (PAGE 2 OF 2)

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL



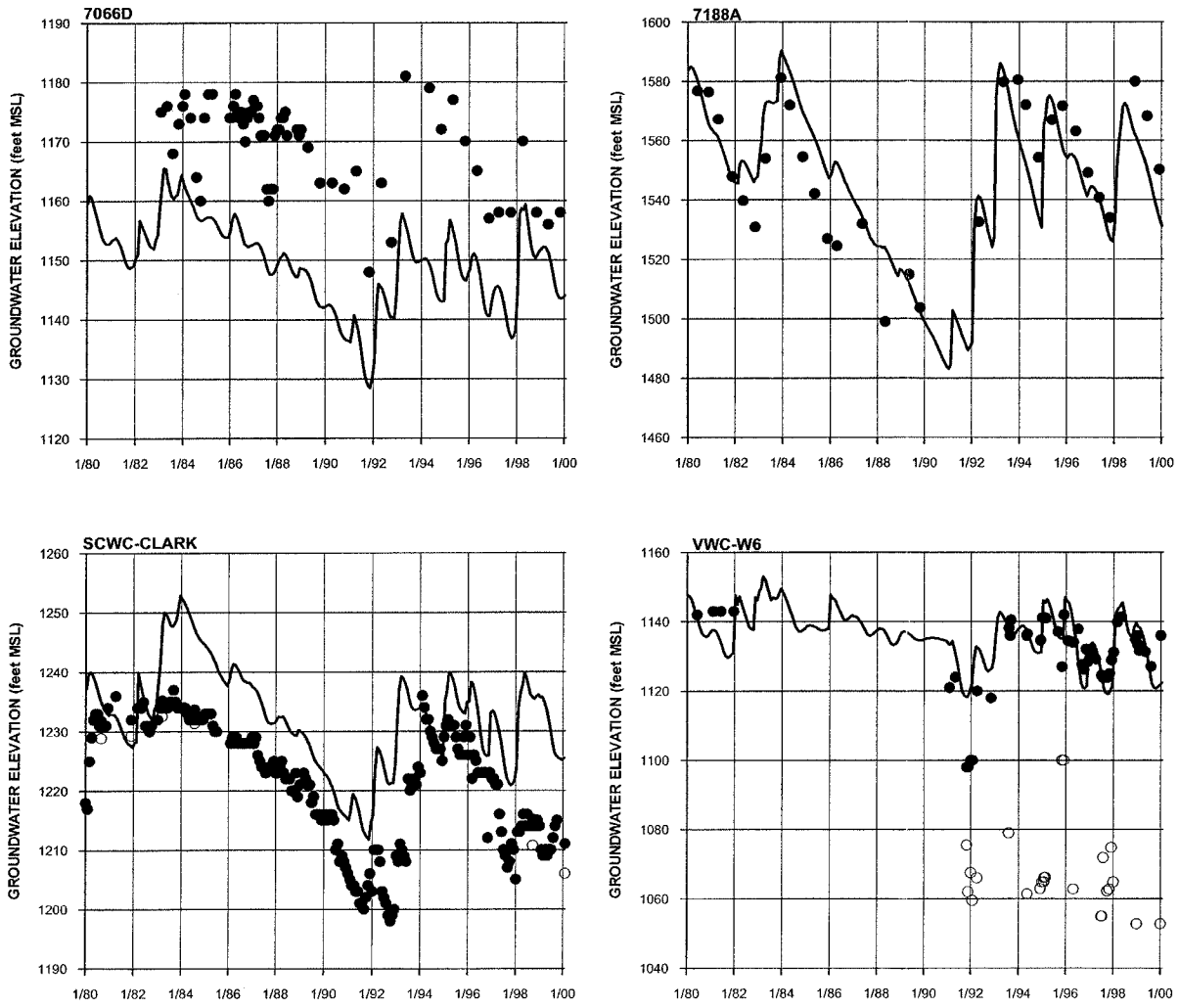
NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

175570-315.GRF

FIGURE 5-23
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS ALONG CASTAIC CREEK

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL



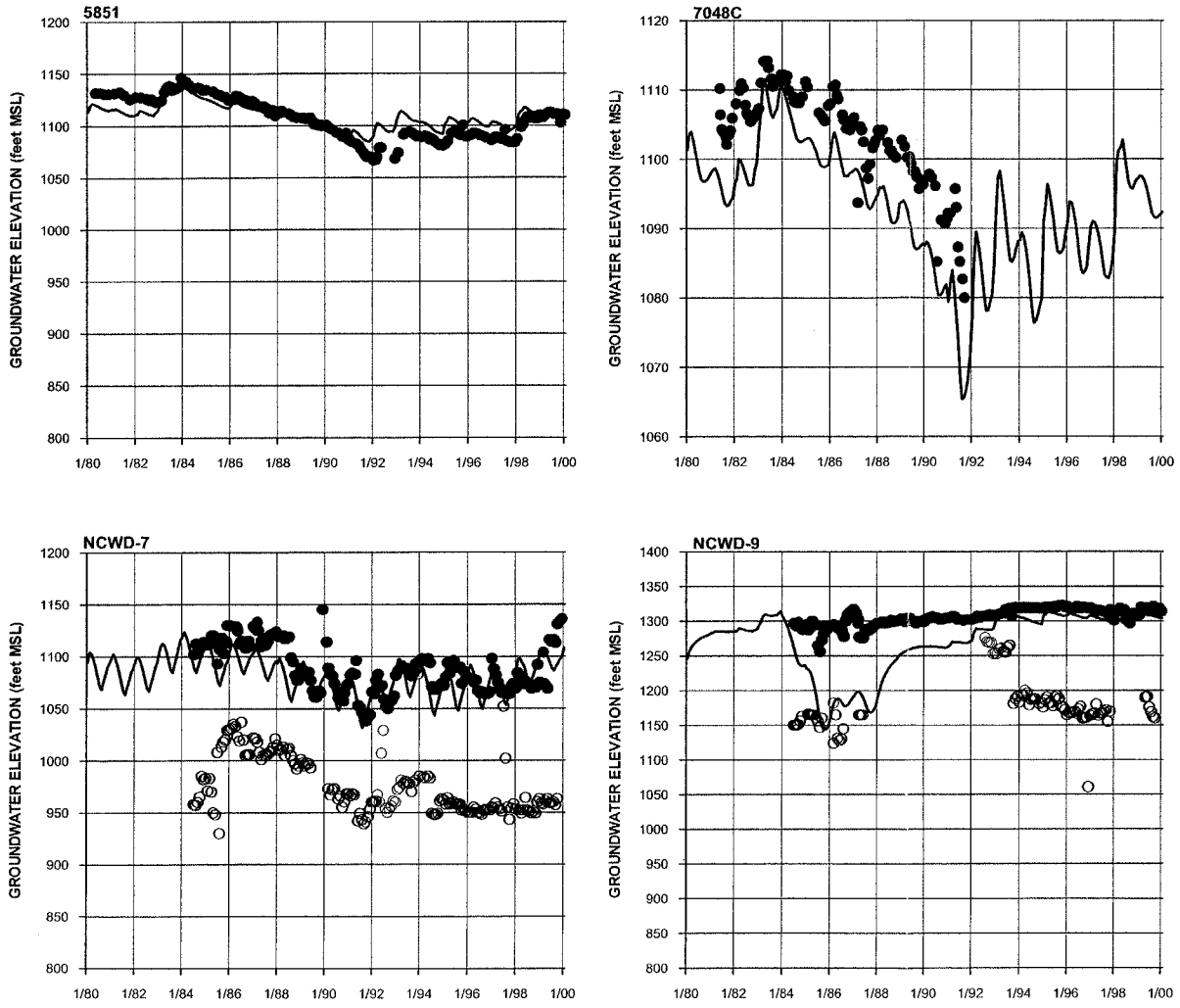
NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

175570-316.GRF

FIGURE 5-24
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN ALLUVIAL AQUIFER WELLS IN OTHER TRIBUTARY CANYONS TO THE SANTA CLARA RIVER

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL



NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

FIGURE 5-25
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN SAUGUS FORMATION WELLS (PAGE 1 0F 3)
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

175570-319.GRF

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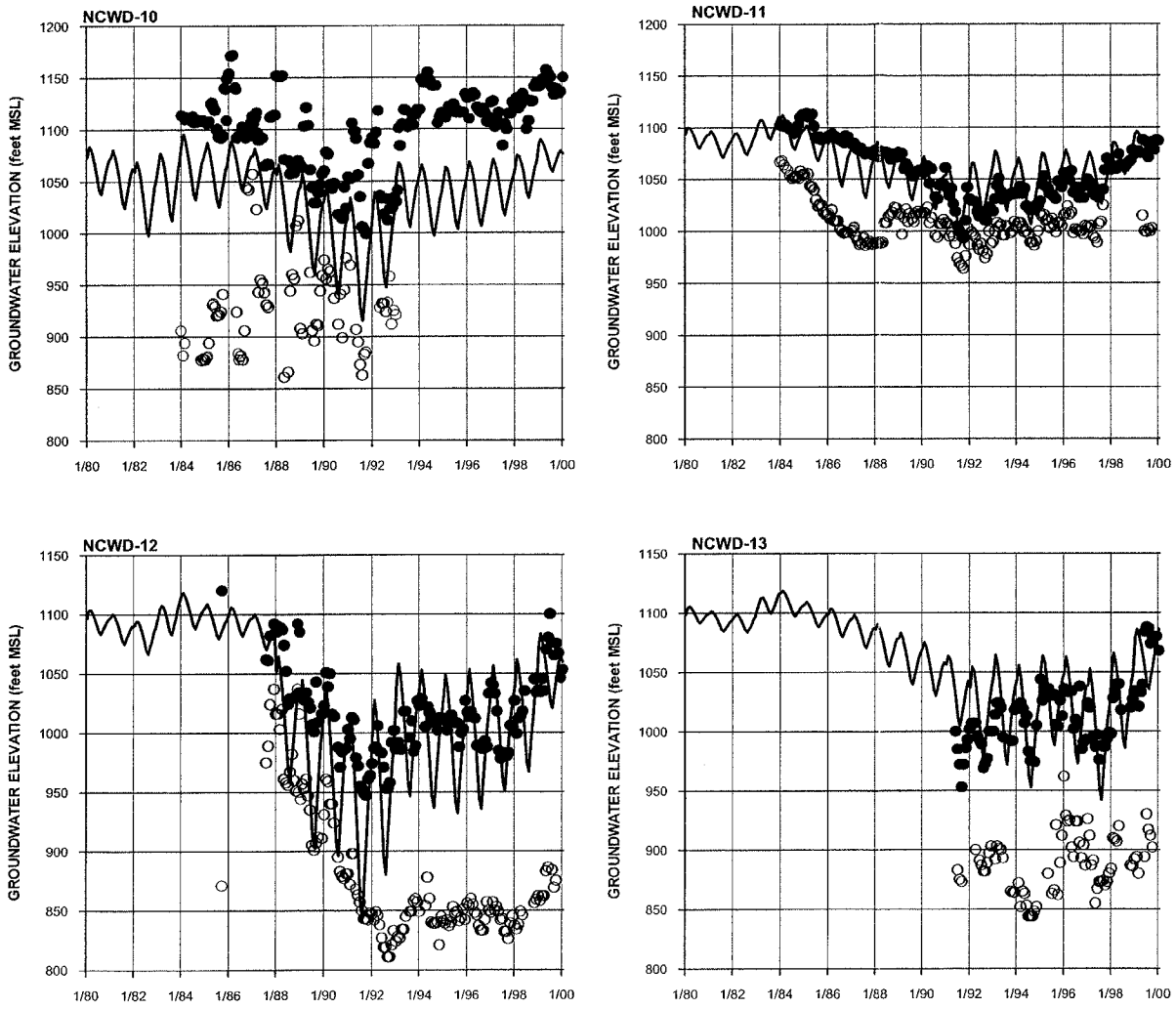


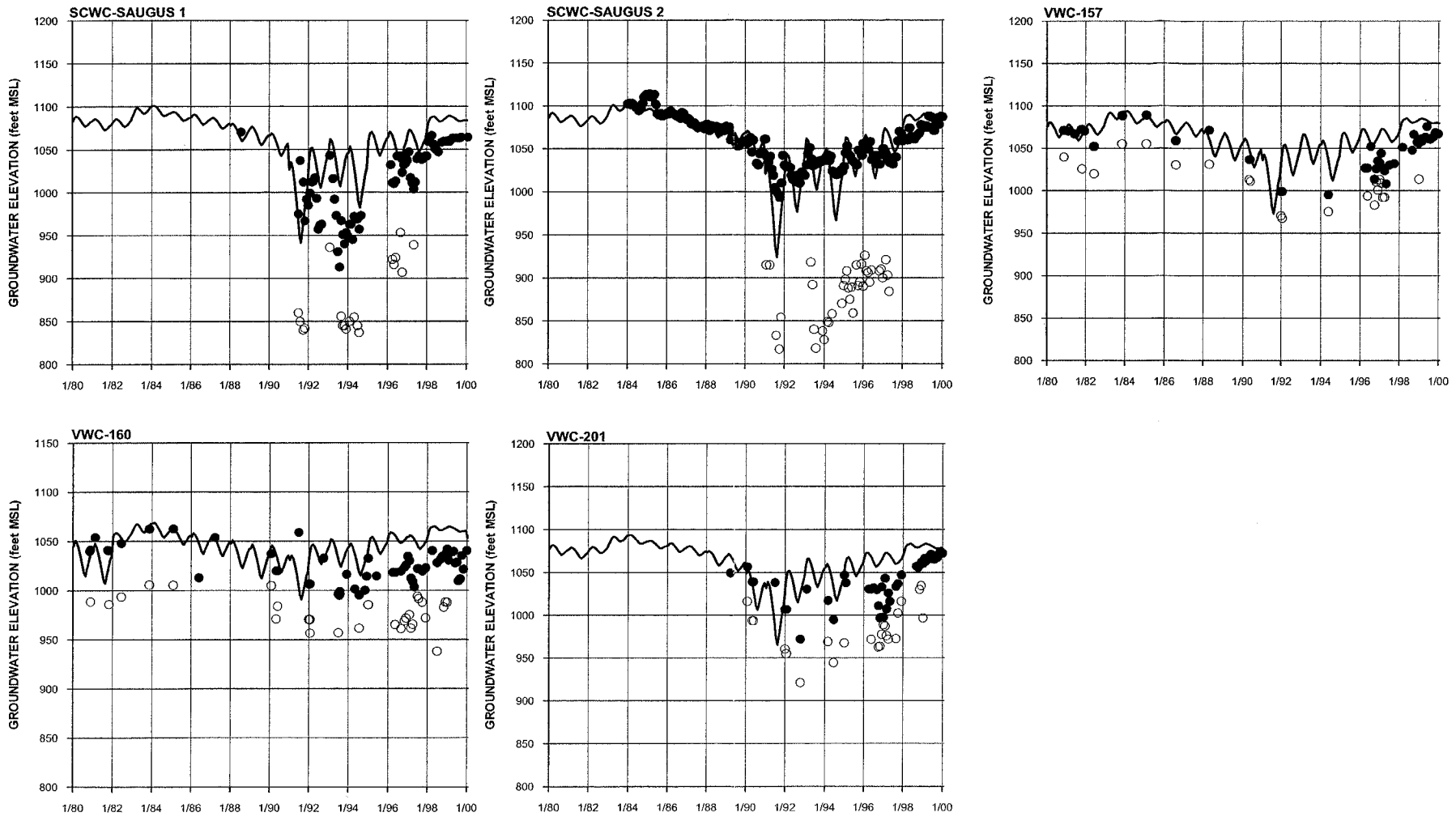
NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

175570-317.GRF

FIGURE 5-25
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN SAUGUS FORMATION WELLS (PAGE 2 0F 3)

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL



NOTE: SEE FIGURE 2-3 FOR LOCATIONS OF WELLS.

175570-318.GRF

FIGURE 5-25
SIMULATED AND MEASURED GROUNDWATER ELEVATIONS IN SAUGUS FORMATION WELLS (PAGE 3 0F 3)

REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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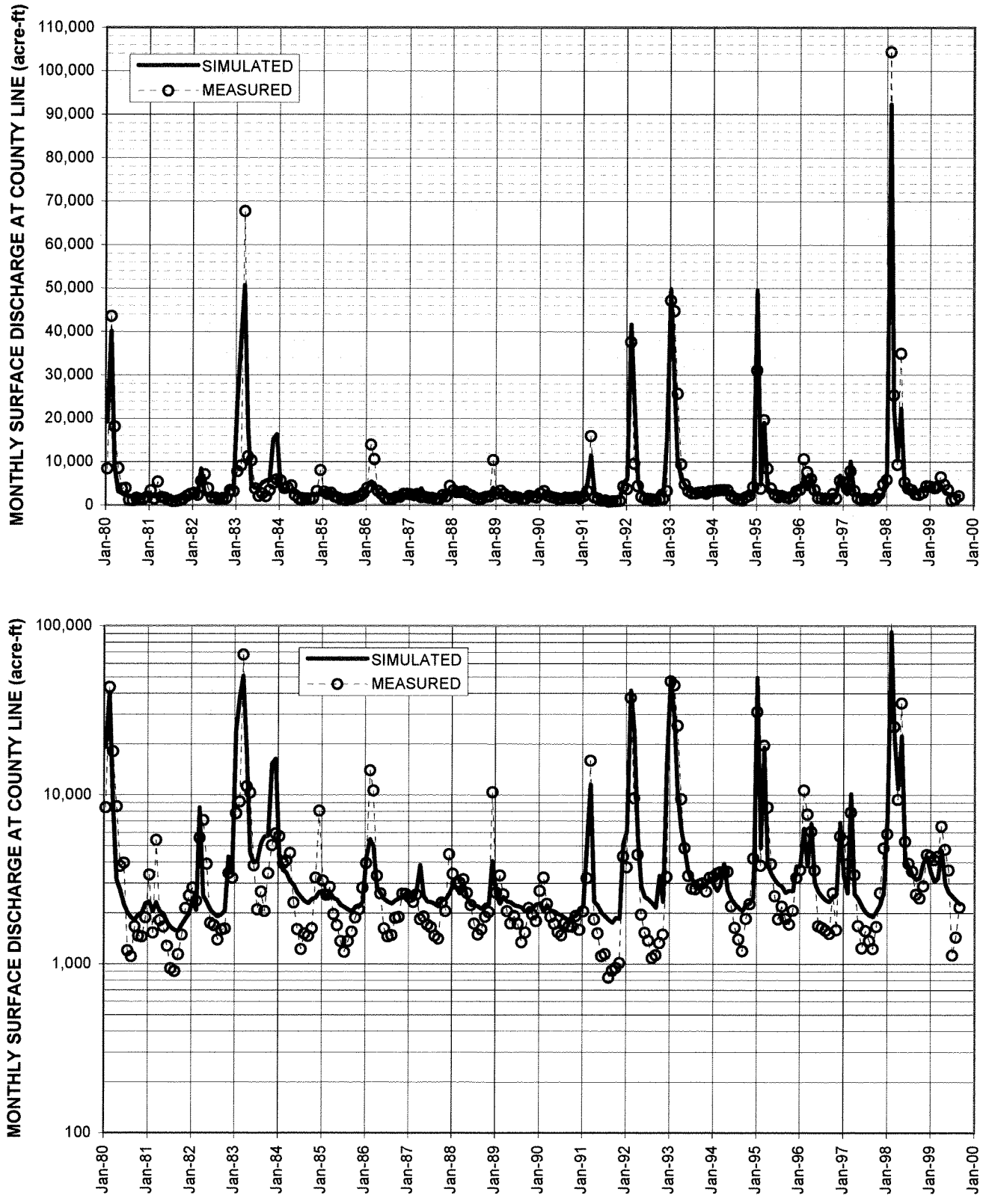

FIGURE 5-26
SIMULATED VERSUS MEASURED HYDROGRAPHS OF SANTA CLARA RIVER FLOW AT COUNTY LINE
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

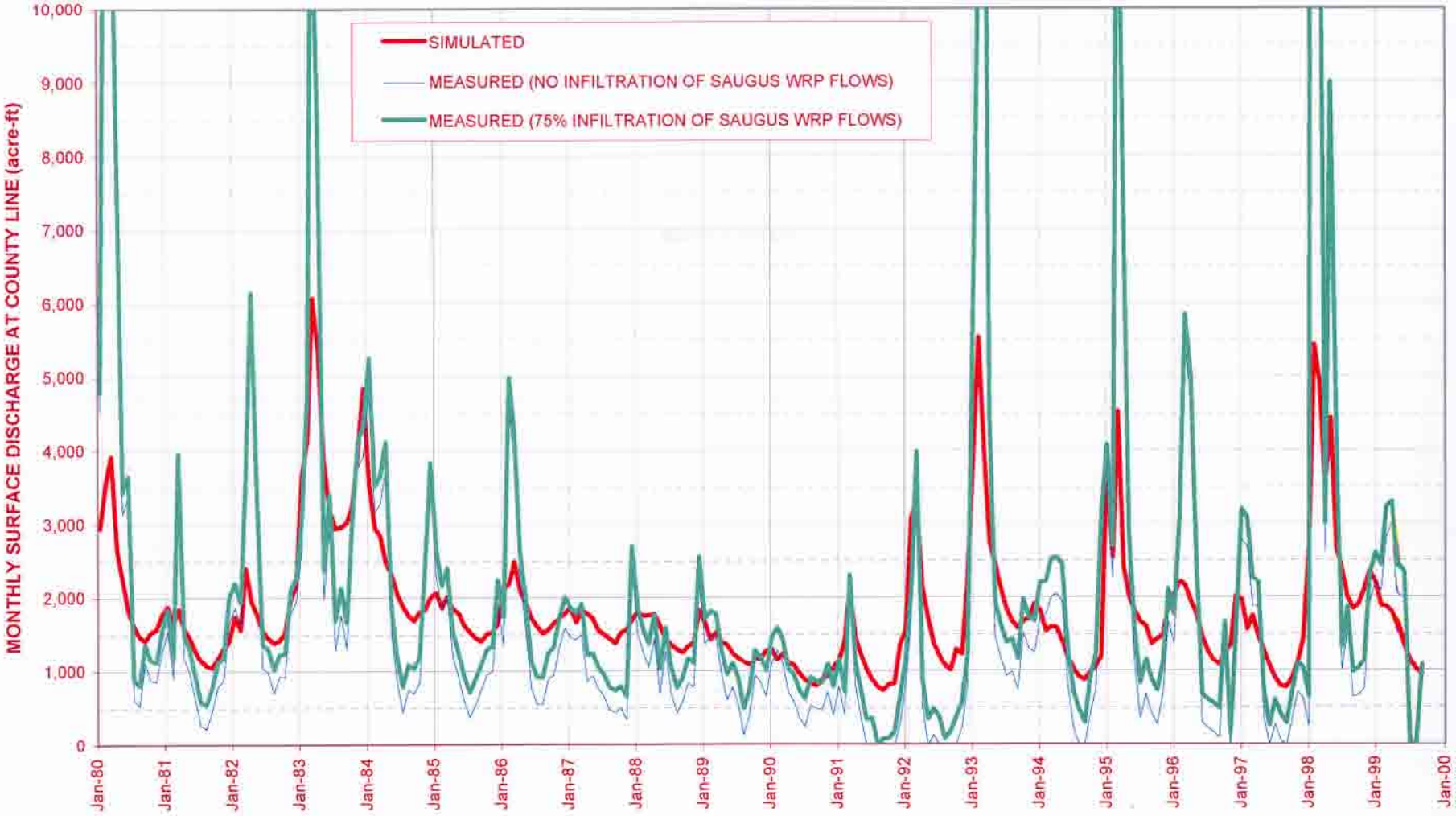

FIGURE 5-27
SIMULATED VERSUS MEASURED HYDROGRAPH OF GROUNDWATER DISCHARGE TO SANTA CLARA RIVER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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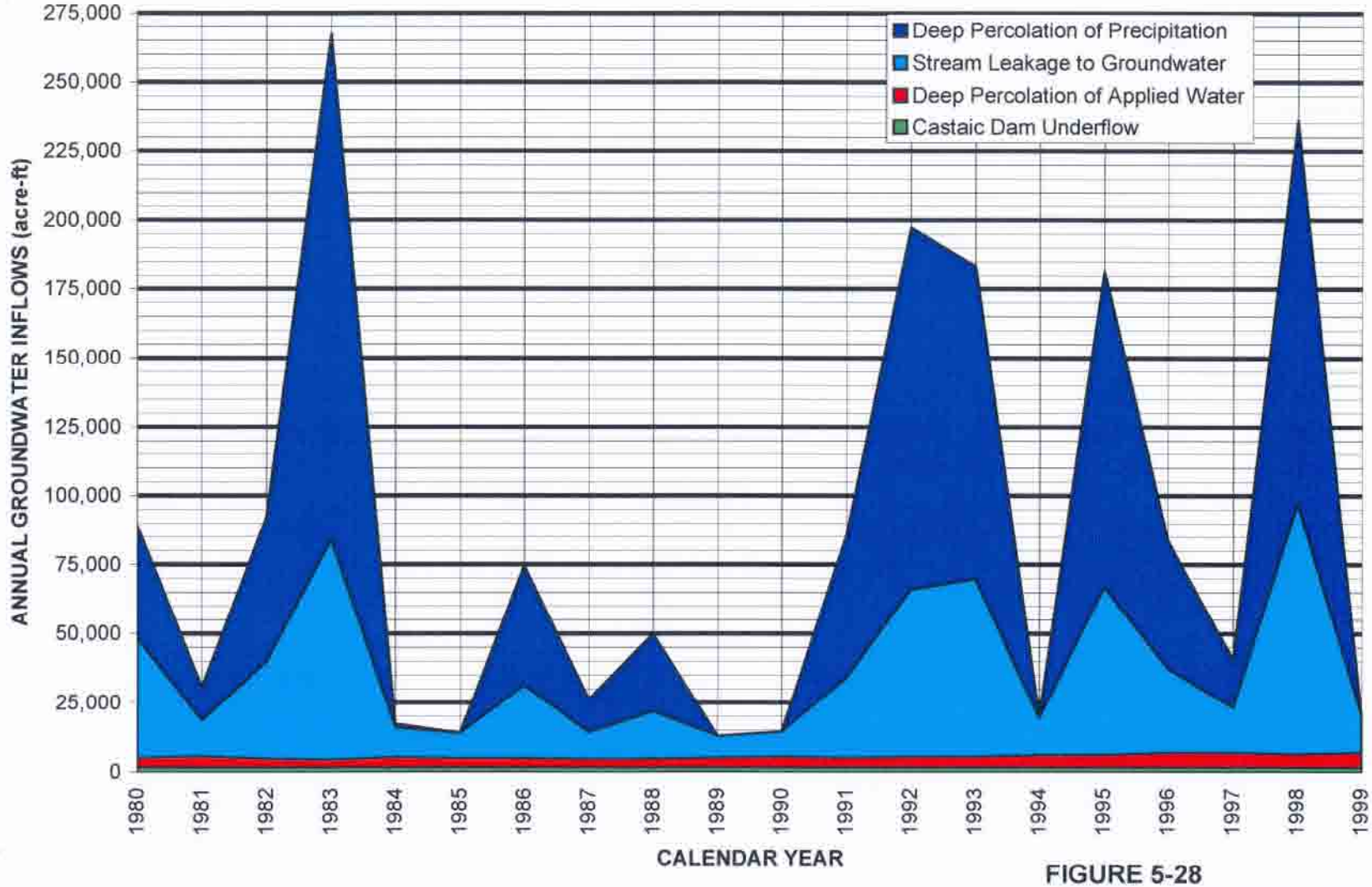

FIGURE 5-28
ANNUAL GROUNDWATER INFLOWS
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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04/04/2004
178973-410.xls/Fig 5-28

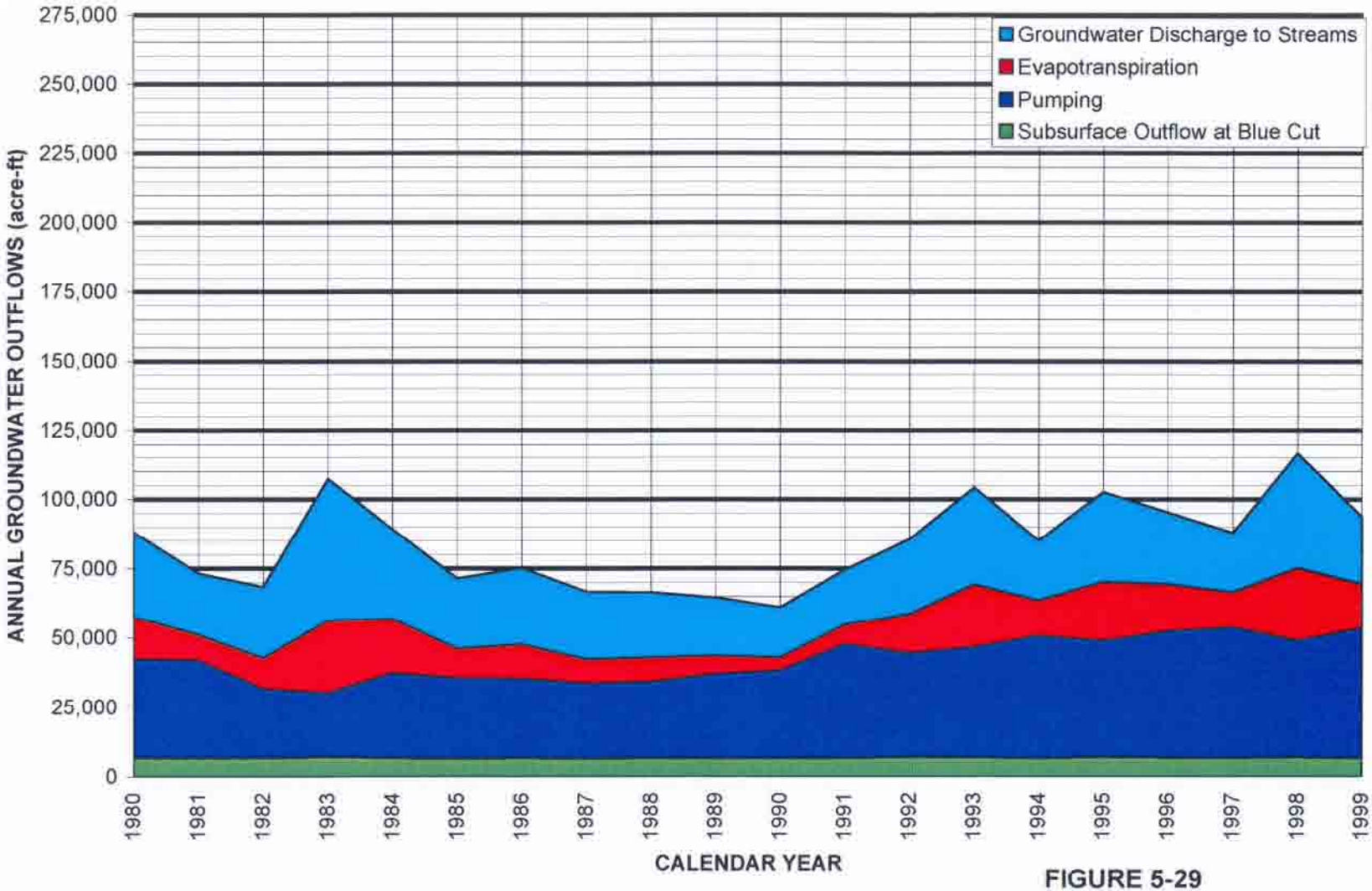

FIGURE 5-29
ANNUAL GROUNDWATER OUTFLOWS
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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04/04/2004
178973-410.xls/Fig 5-29

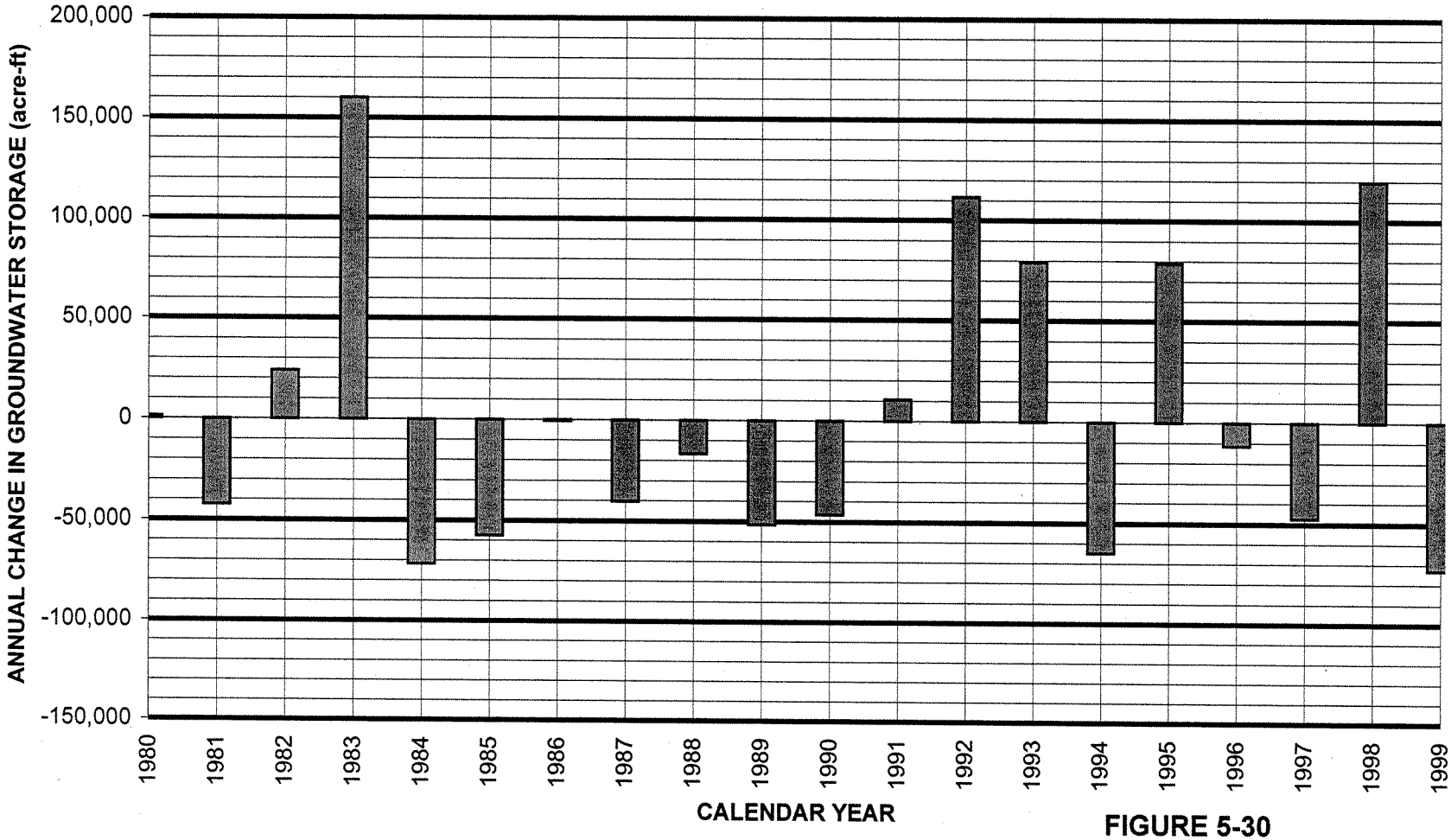

FIGURE 5-30
ANNUAL CHANGE IN GROUNDWATER STORAGE
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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04/04/2004
178973-410.xls/Fig 5-30

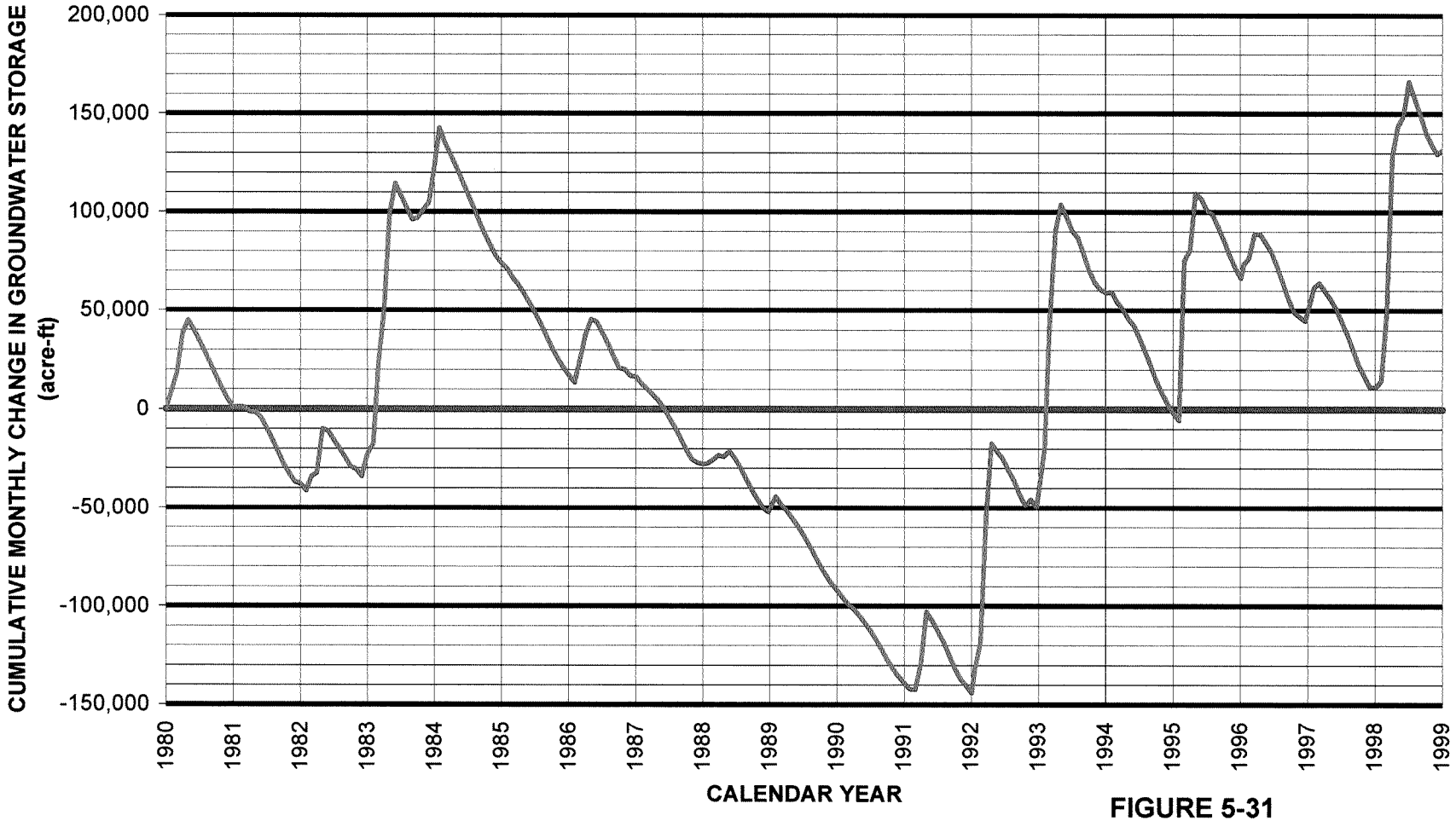

FIGURE 5-31
CUMULATIVE CHANGE IN GROUNDWATER STORAGE
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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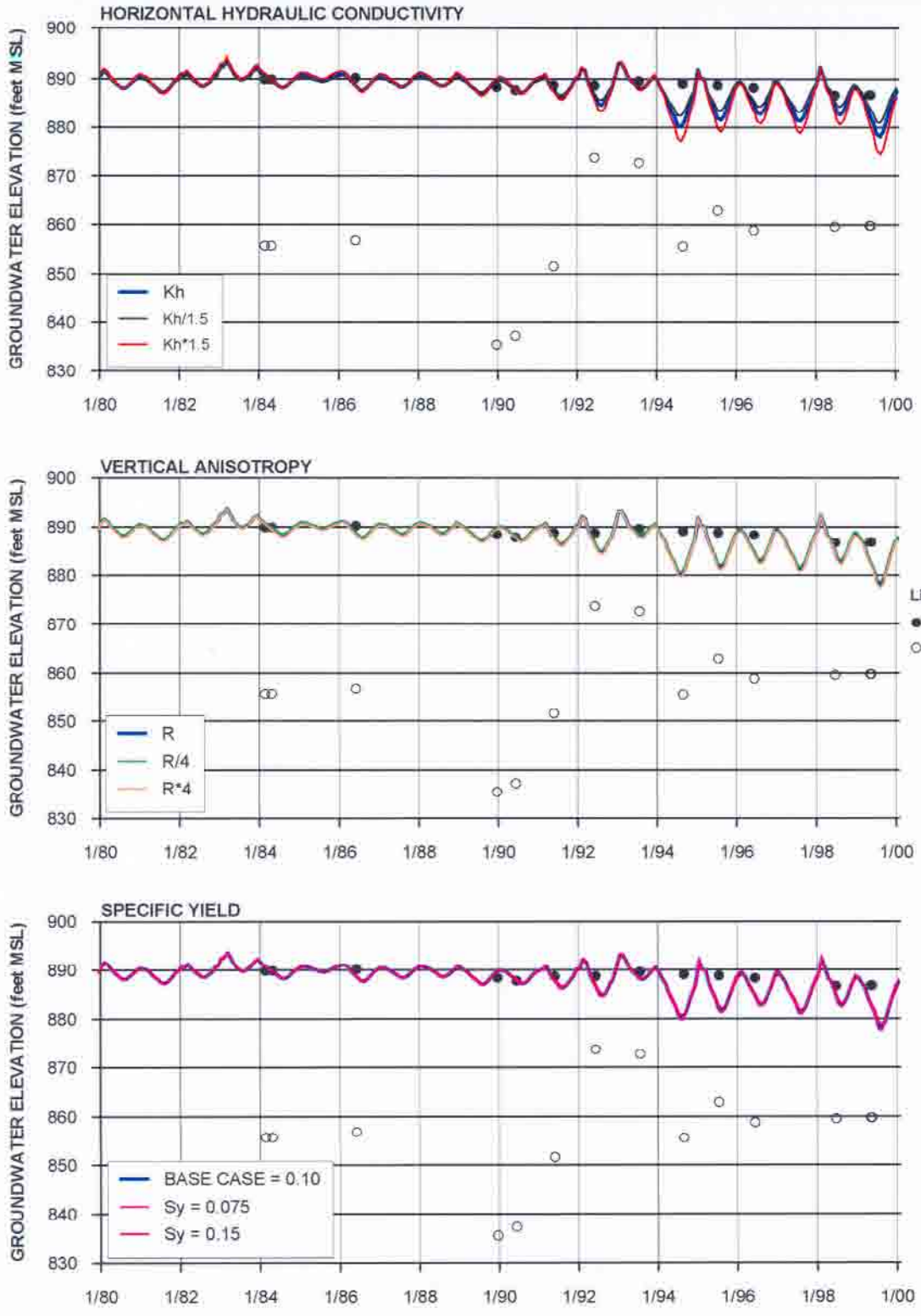
04/04/2004
178973-410.xls/Fig 5-31



NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-32
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT NLF-B7 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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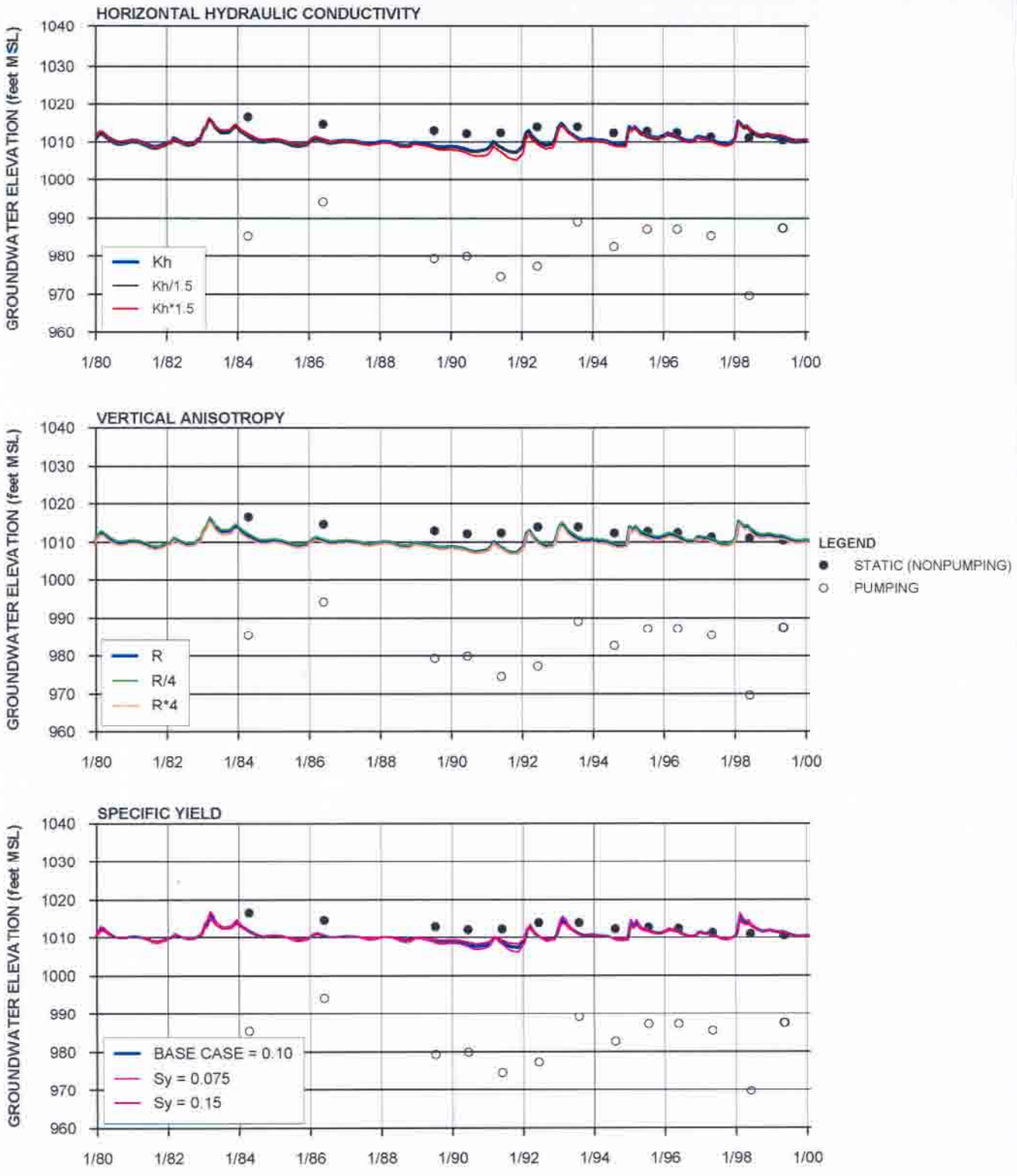

NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-33
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT NLF-G45 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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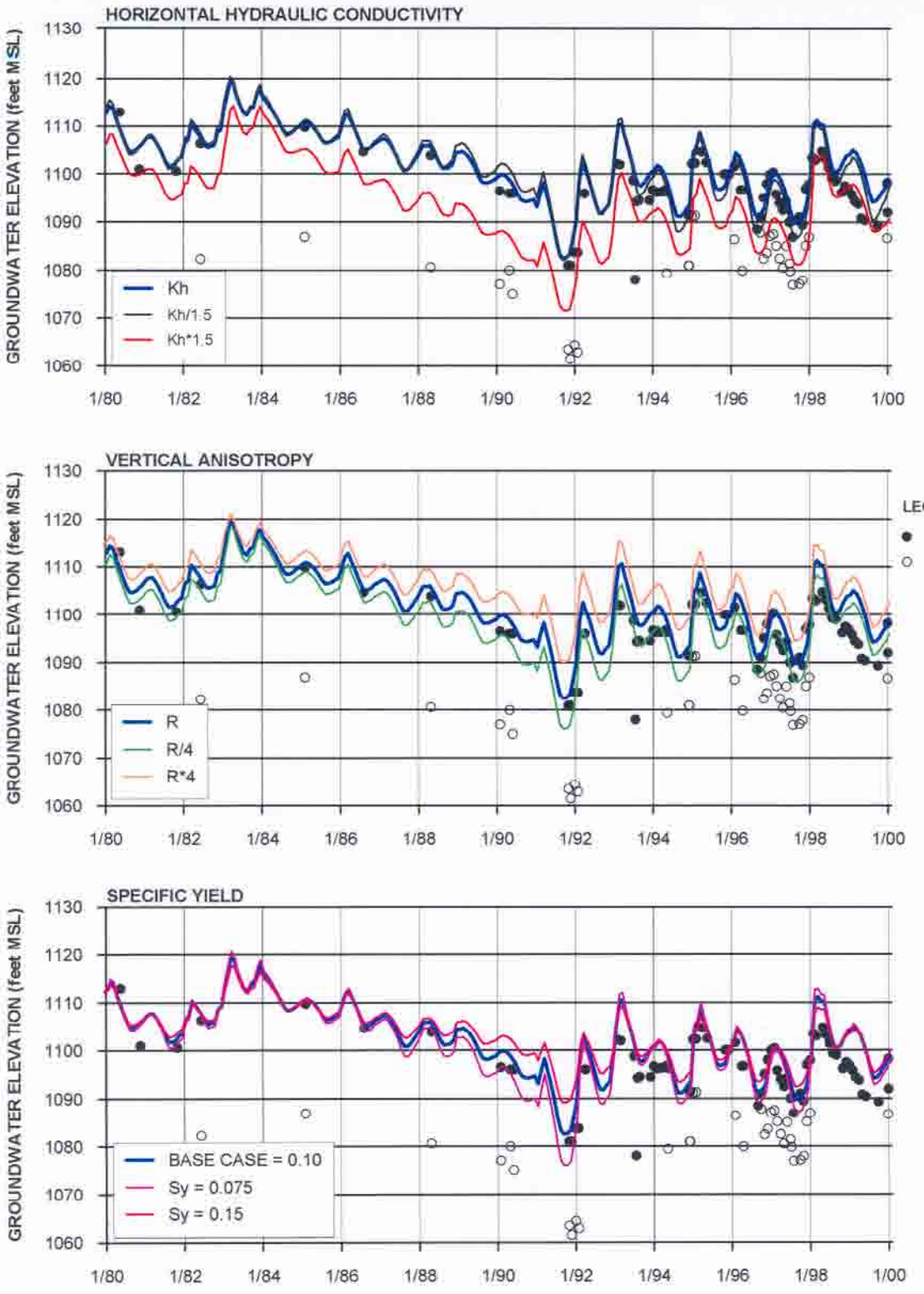

NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-34
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT VWC-N TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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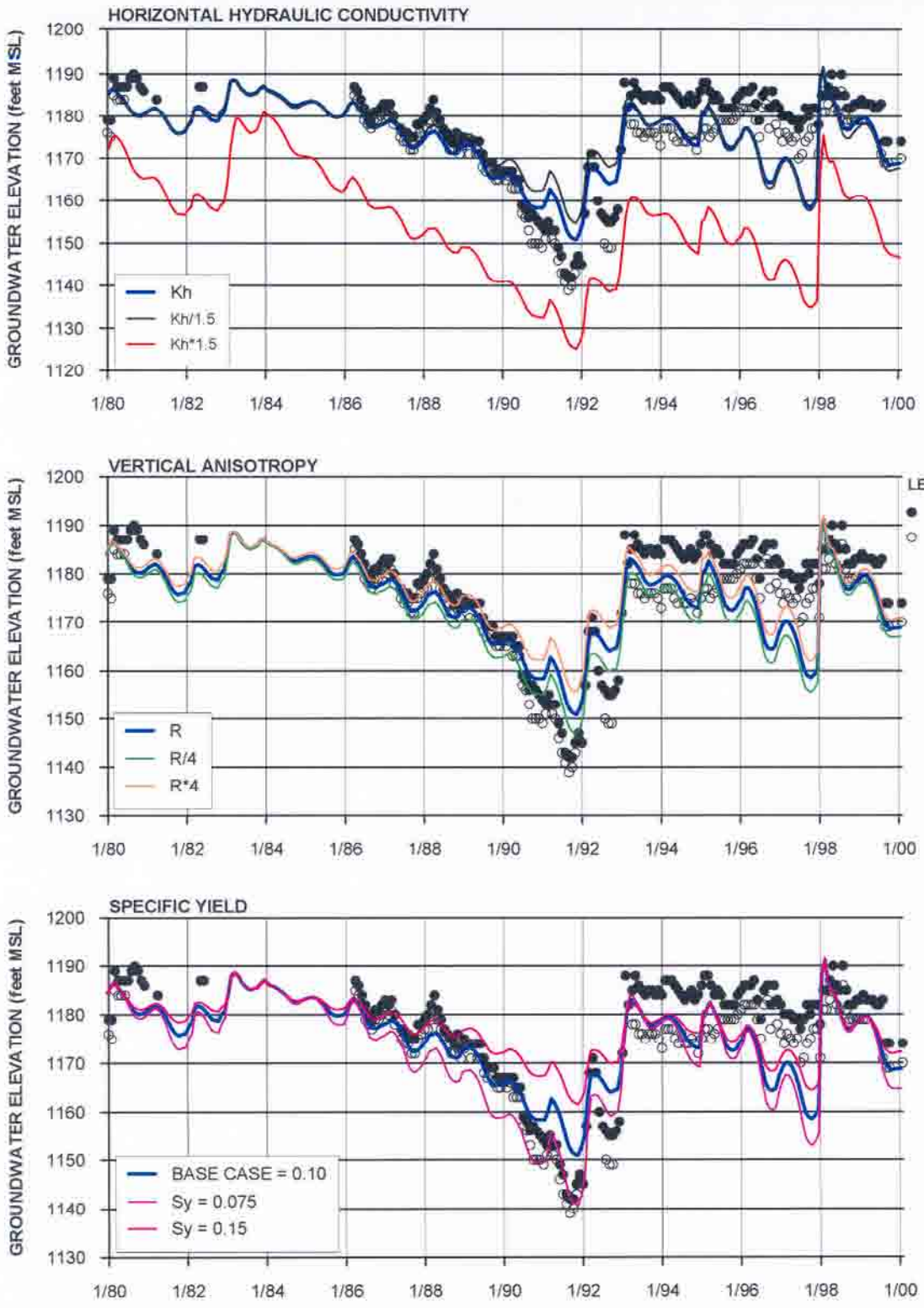
178973-321.GRF



NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-35
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT SCWC-STADIUM TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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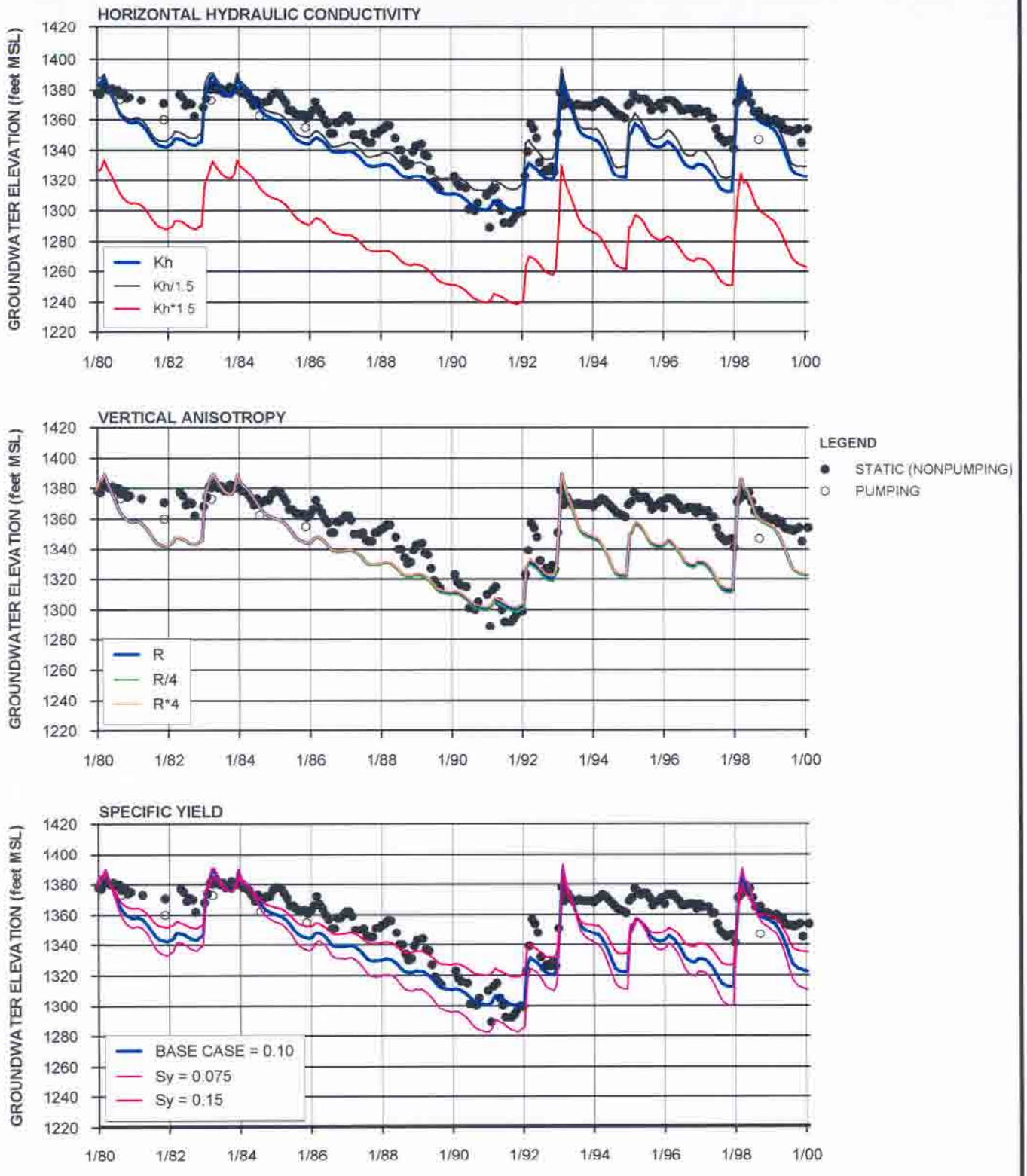
178973-322.GRF



NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-36
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT SCWC-NORTH OAKS EAST TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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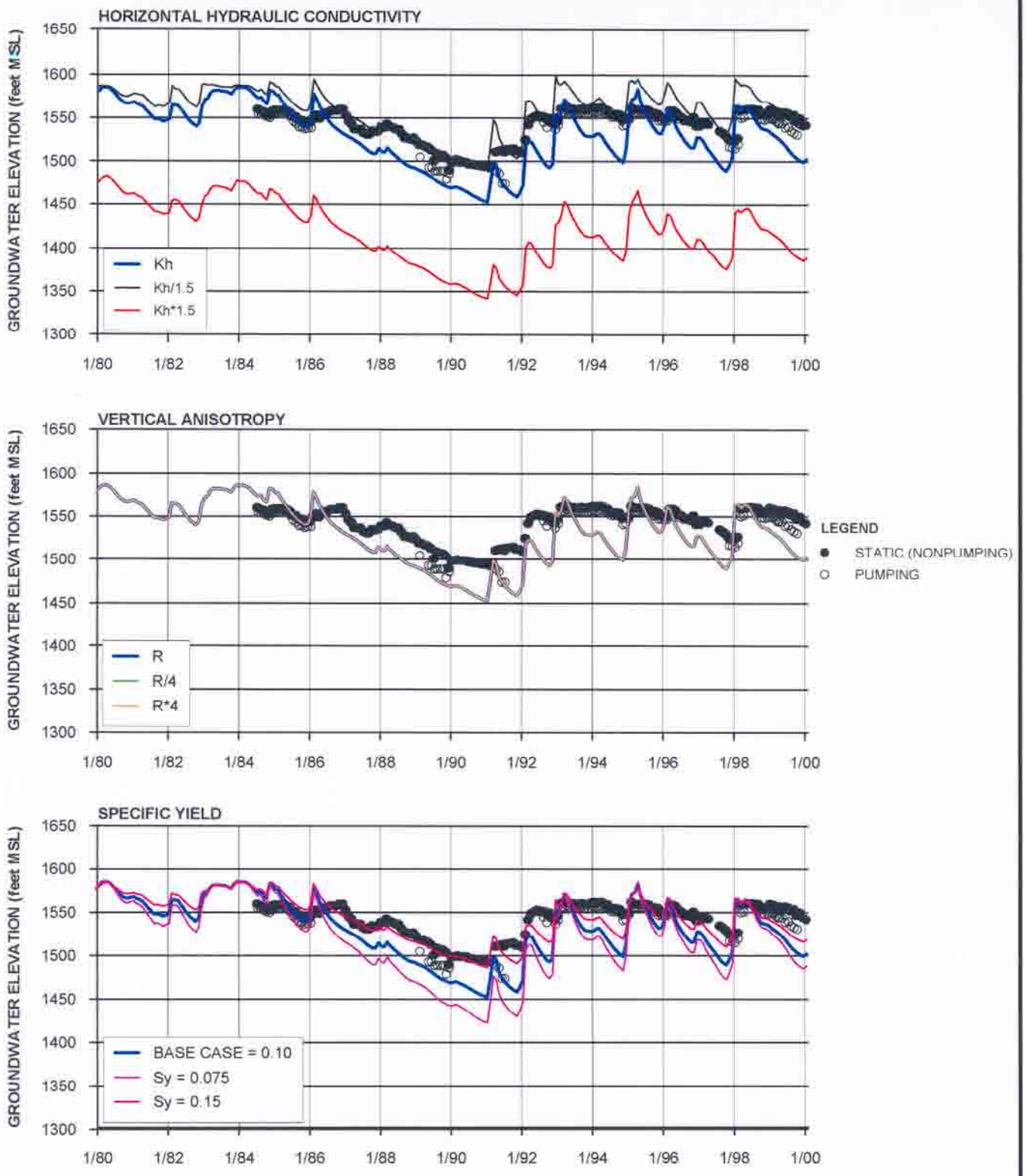

NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-37
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT NCWD-PINETREE1 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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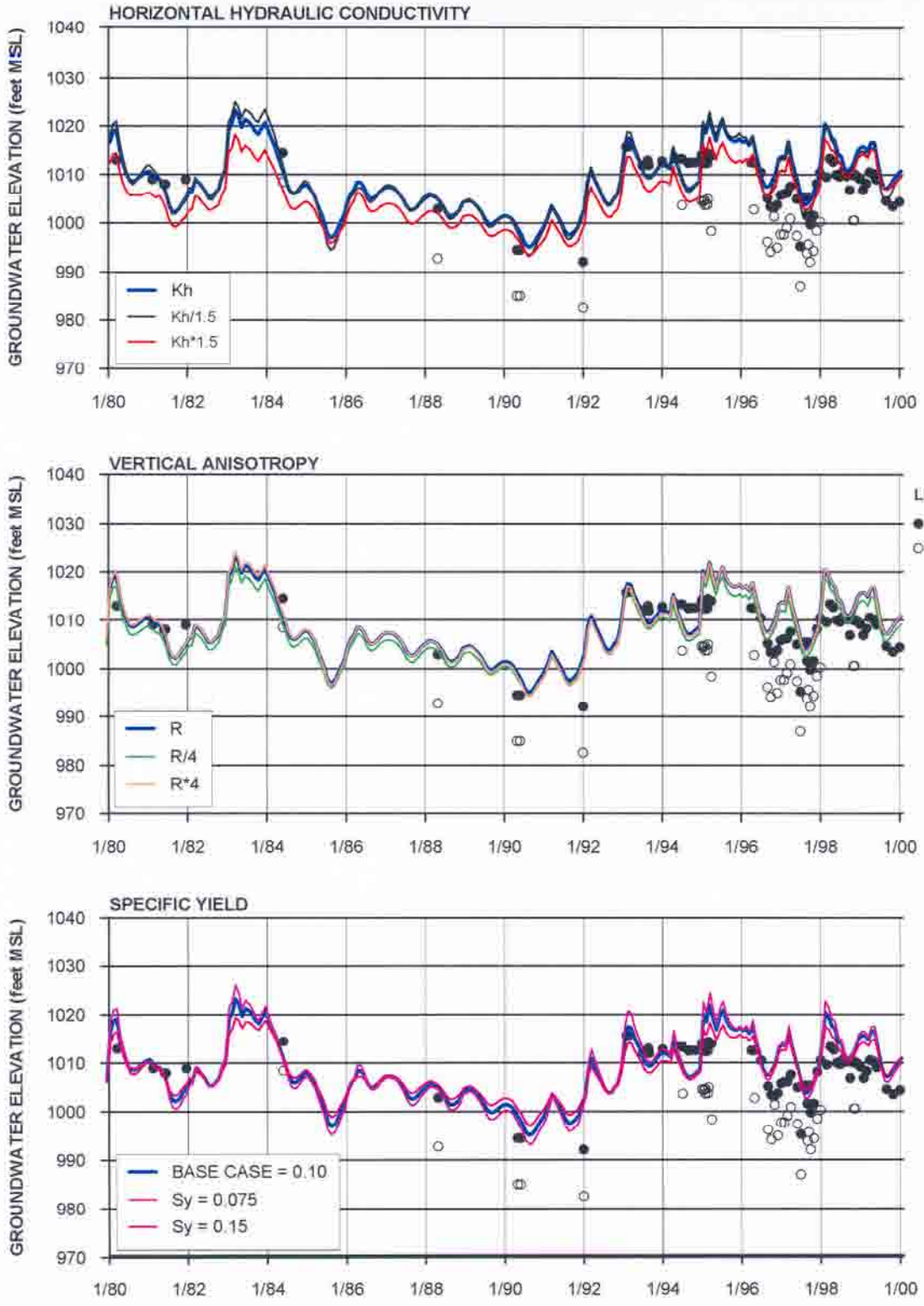
178973-323.GRF



NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. Sy= SPECIFIC YIELD
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-38
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT VWC-D TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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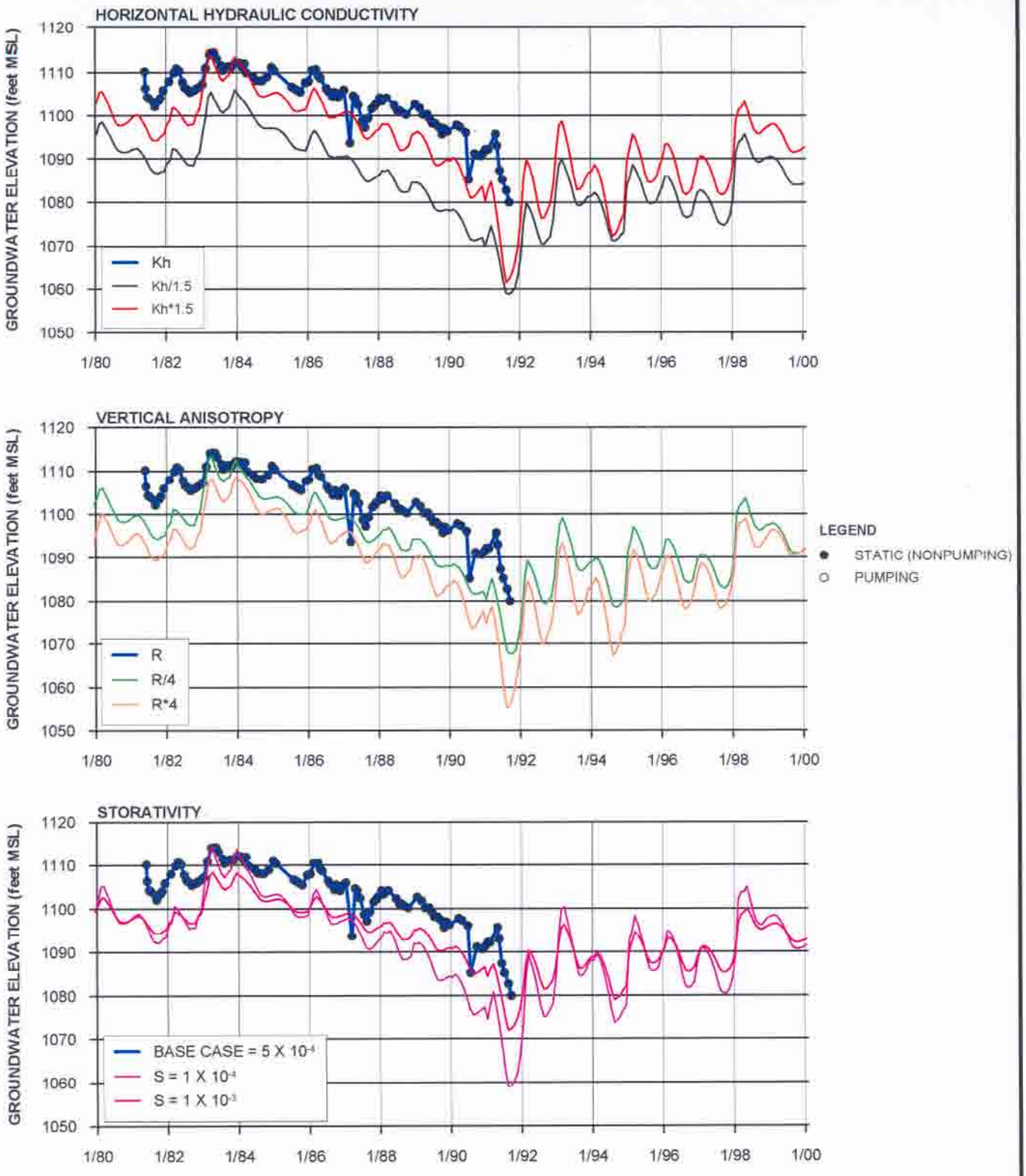
178973-324.GRF



NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. S = STORATIVITY
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-39
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT 7048C TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

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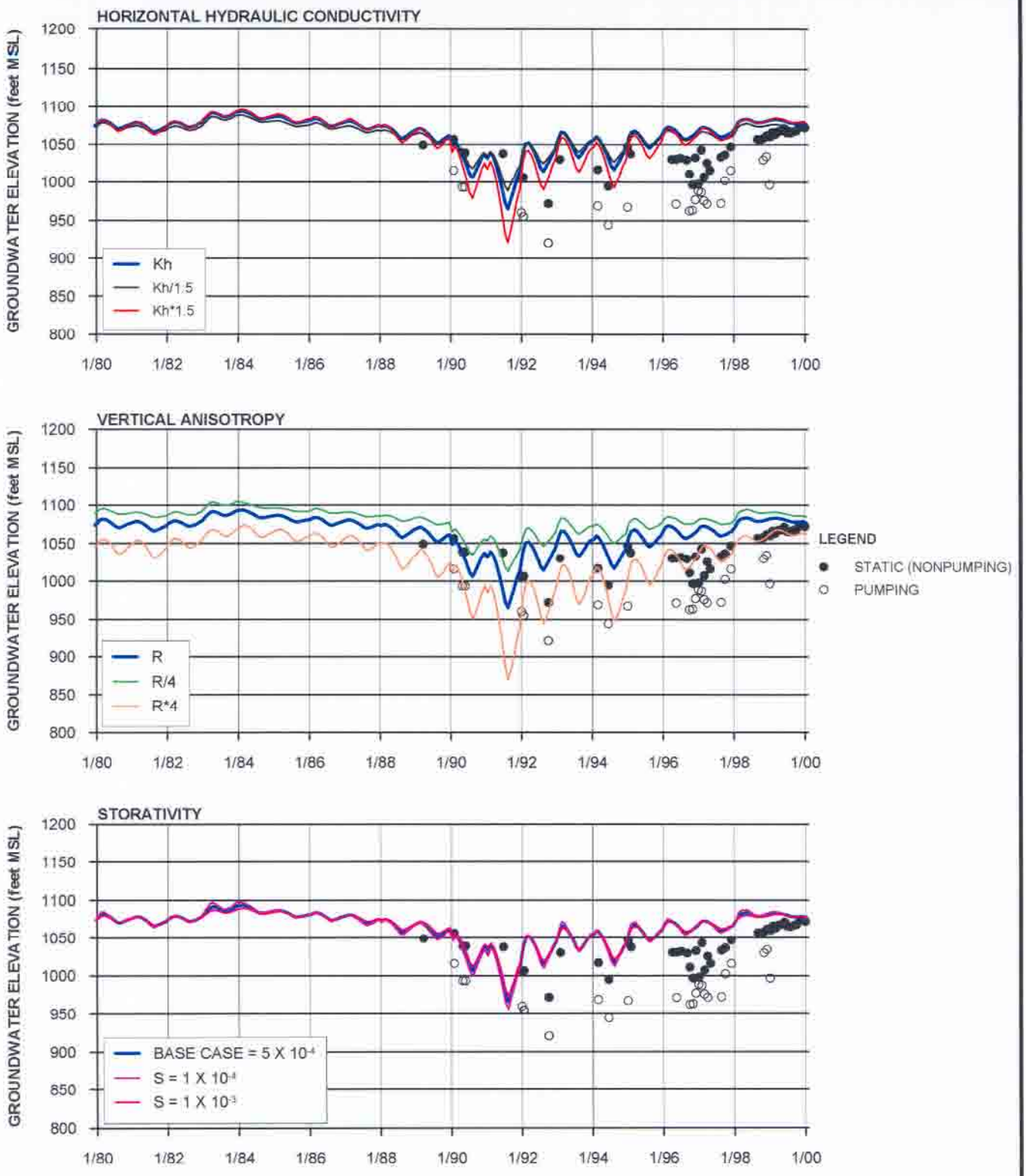

NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. S = STORATIVITY
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-40
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT VWC-201 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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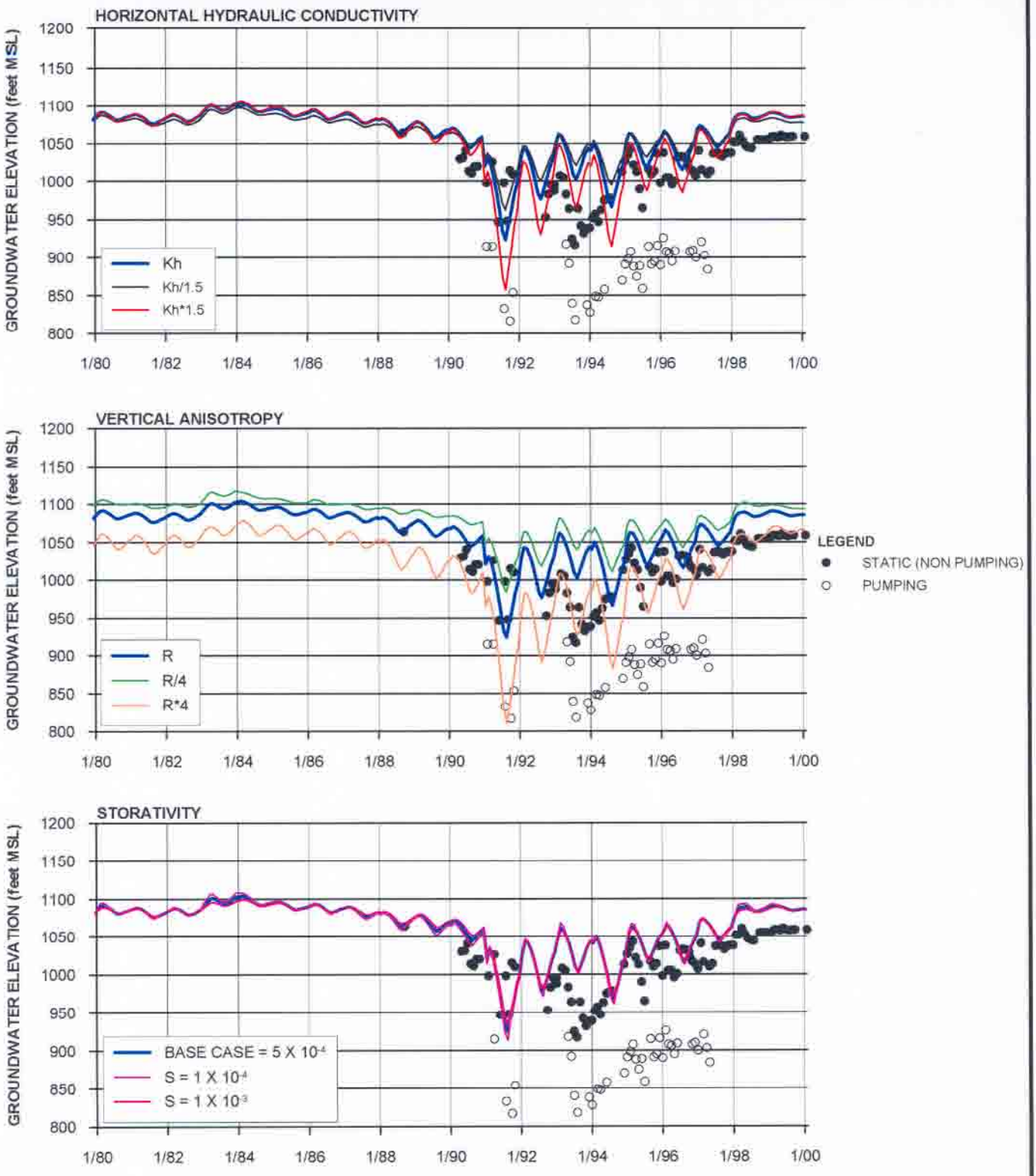

FIGURE 5-41
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT SCWC-SAUGUS 2 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. S = STORATIVITY
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

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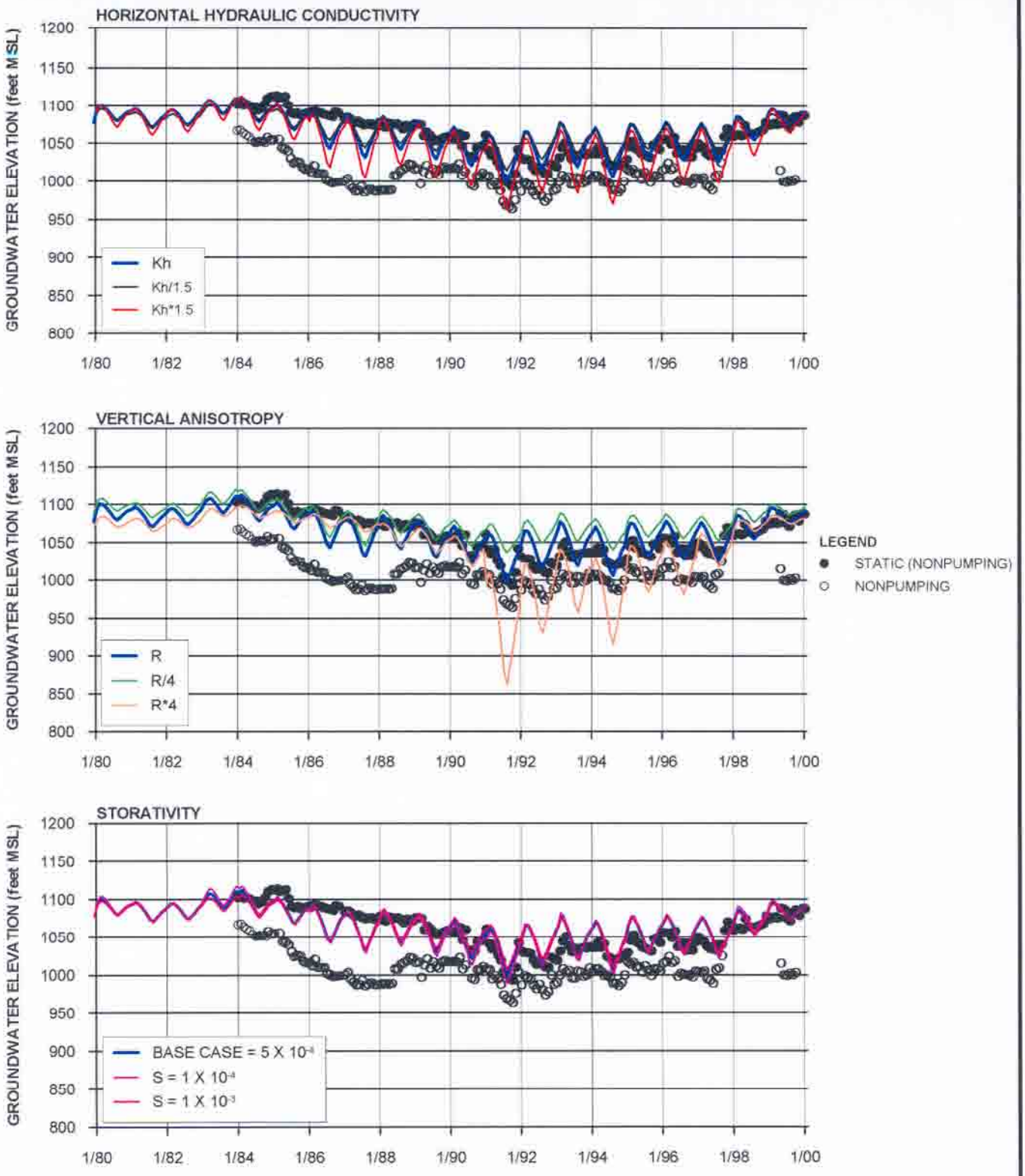

NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. S = STORATIVITY
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-42
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT NCWD-11 TO AQUIFER PARAMETER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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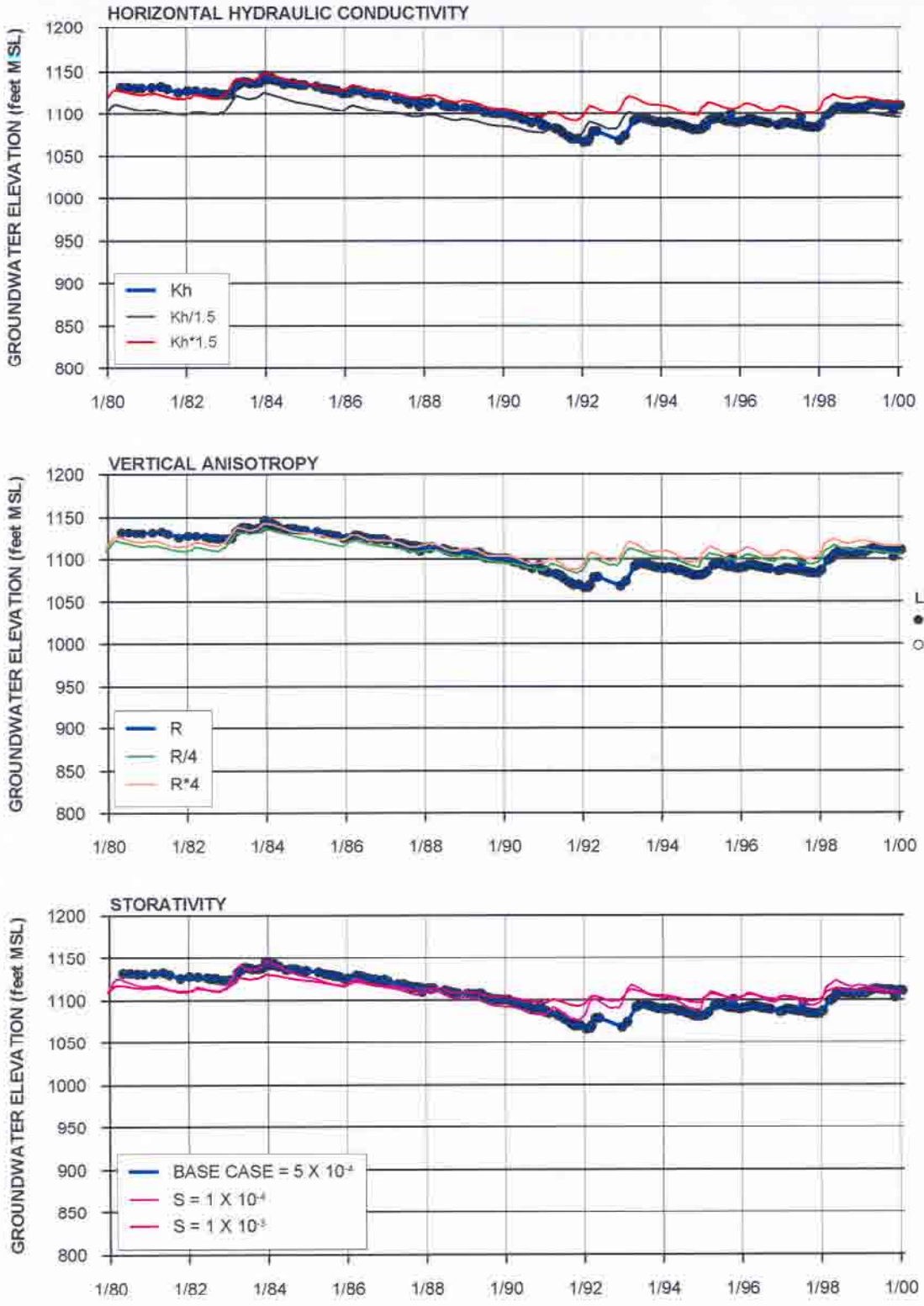

NOTES:
1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. S = STORATIVITY
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-43
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT 5851 TO AQUIFER PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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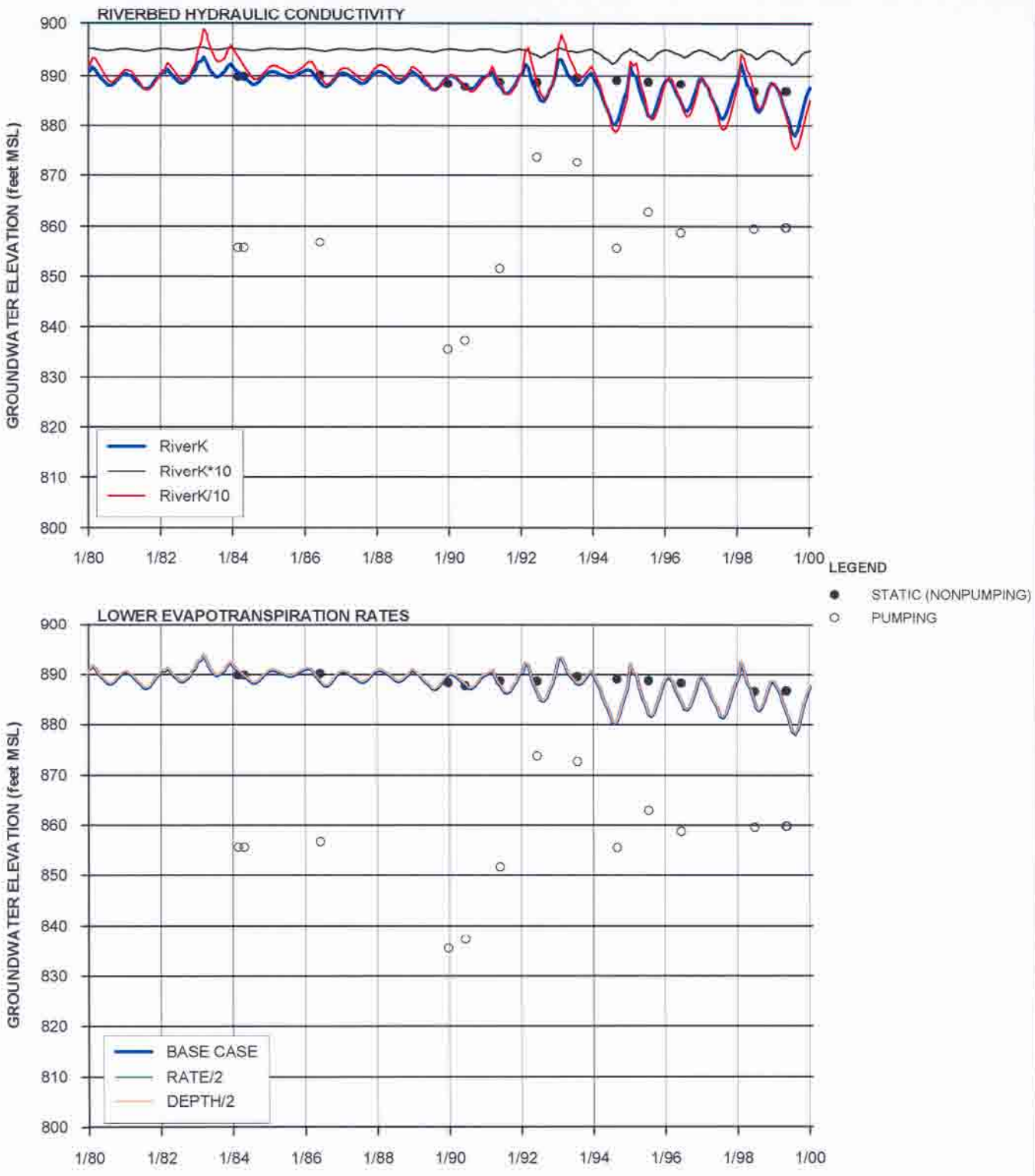

NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-44
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT NLF-B7 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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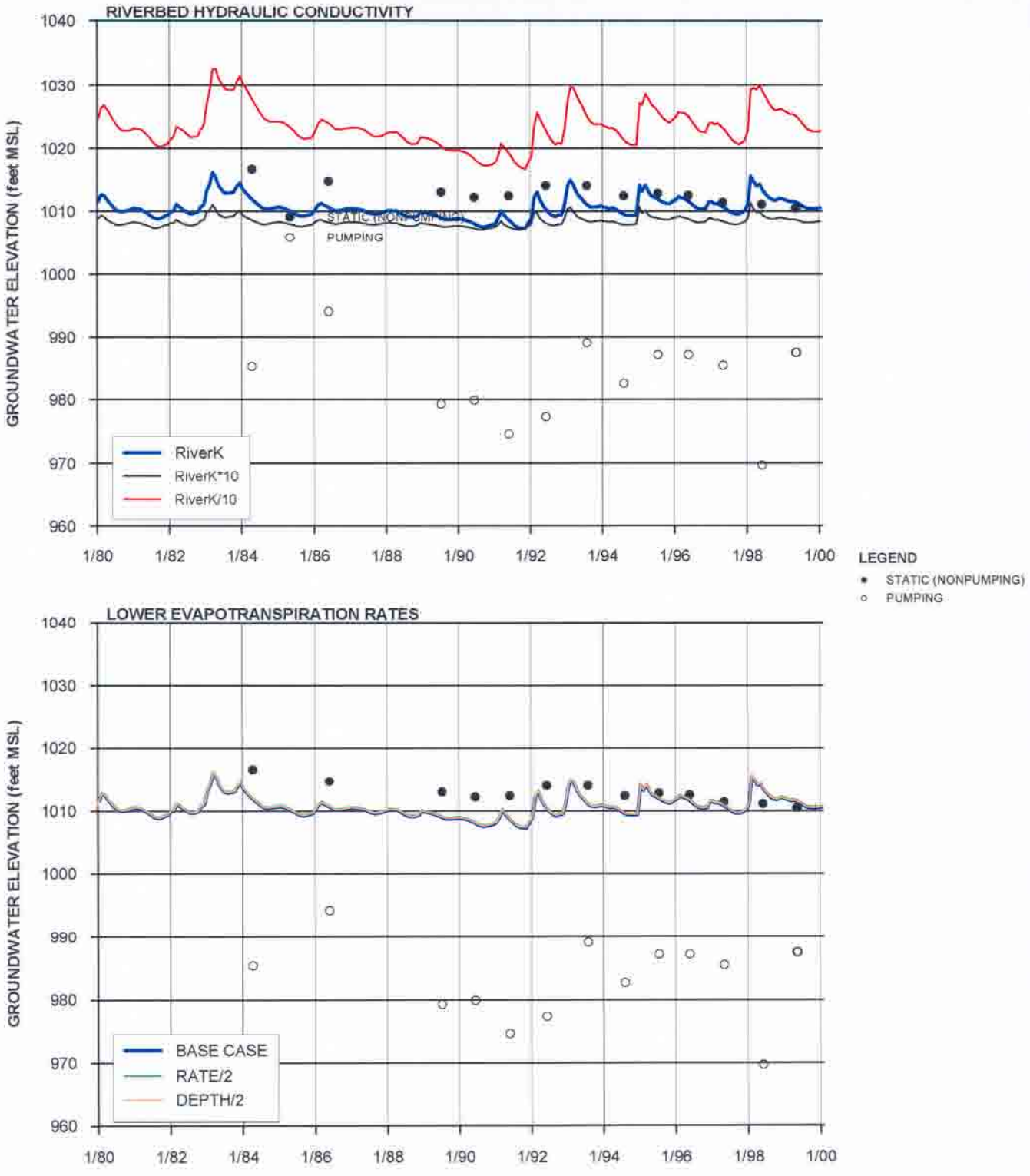

NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-45
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT NLF-G45 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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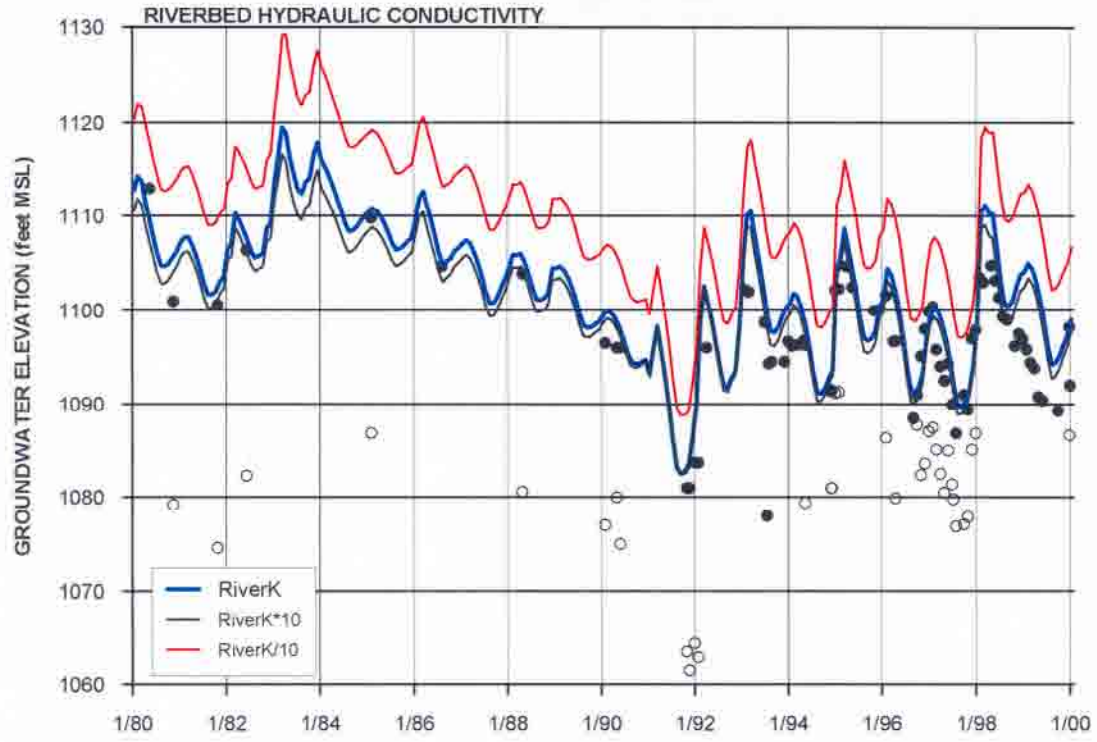

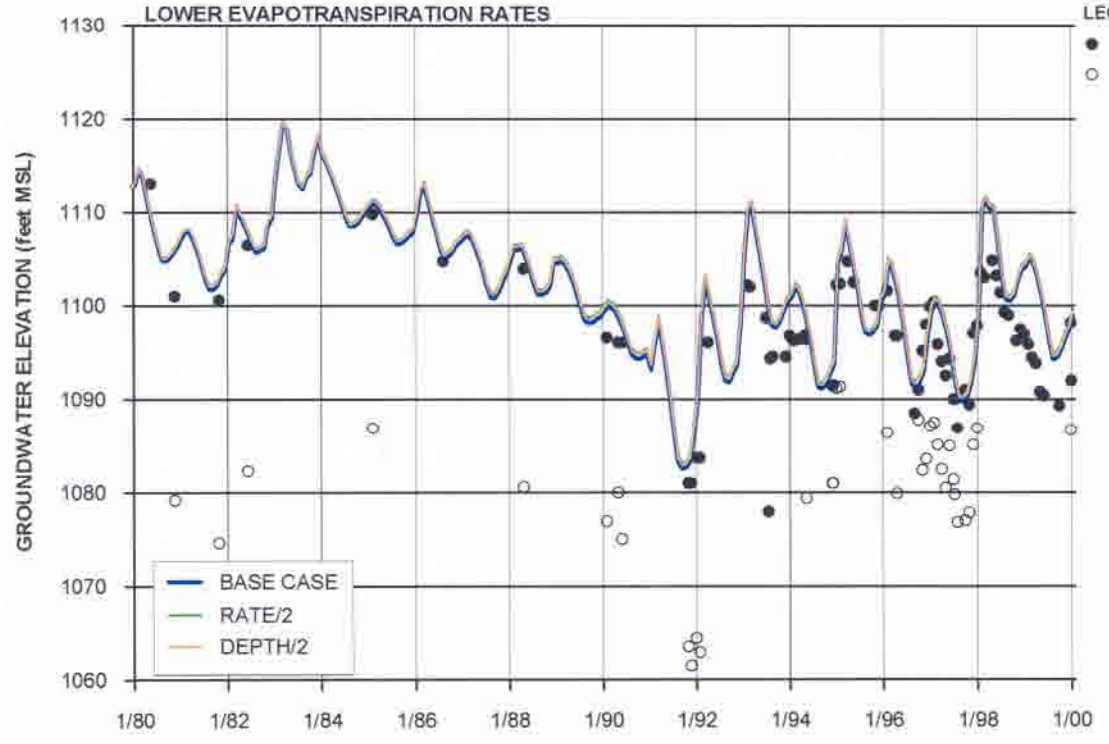

NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-46
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT VWC-N TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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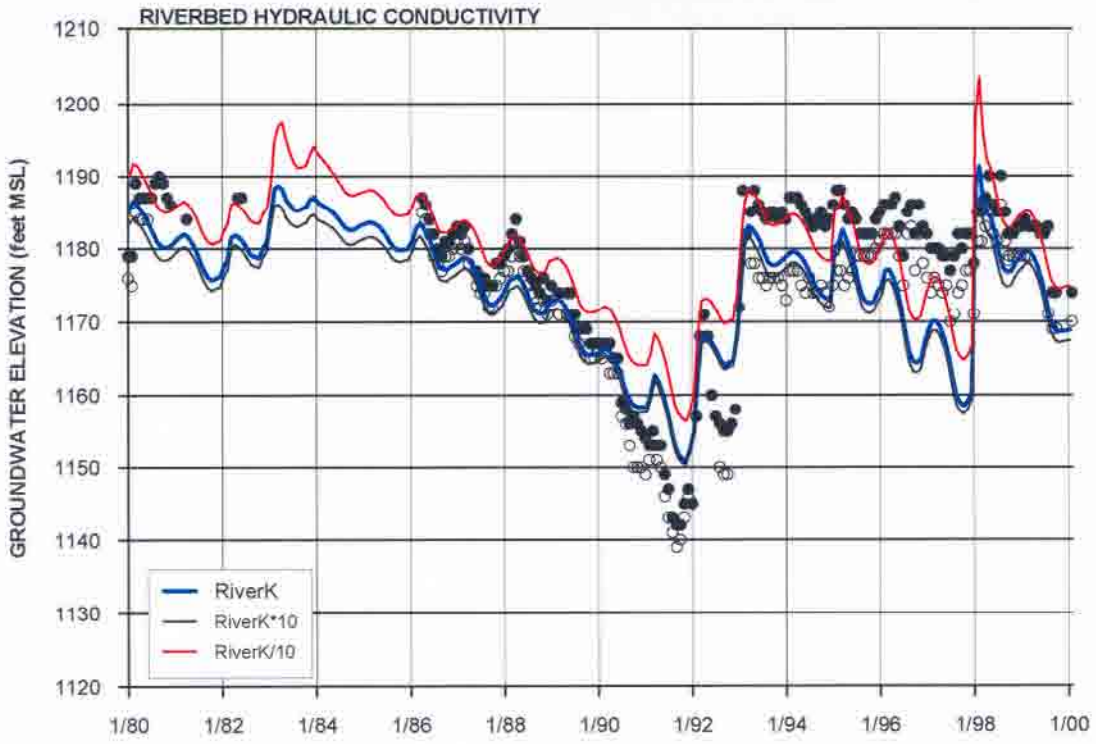
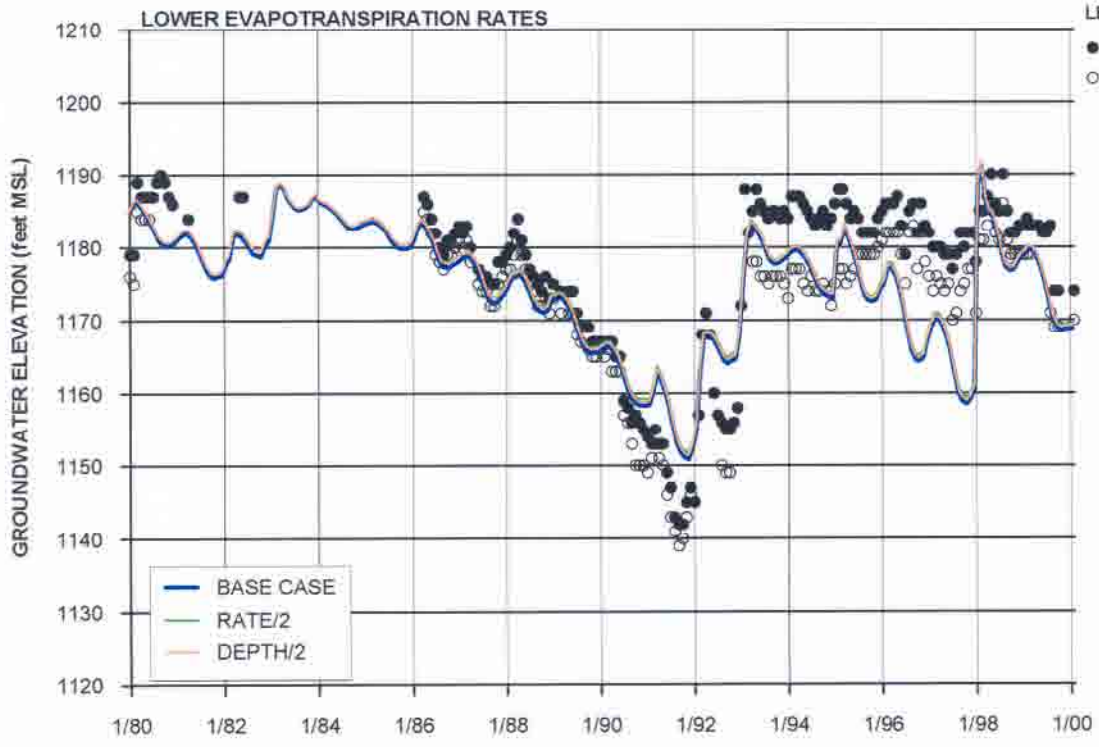
178973-334.GRF





NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-47
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT SCWC-STADIUM TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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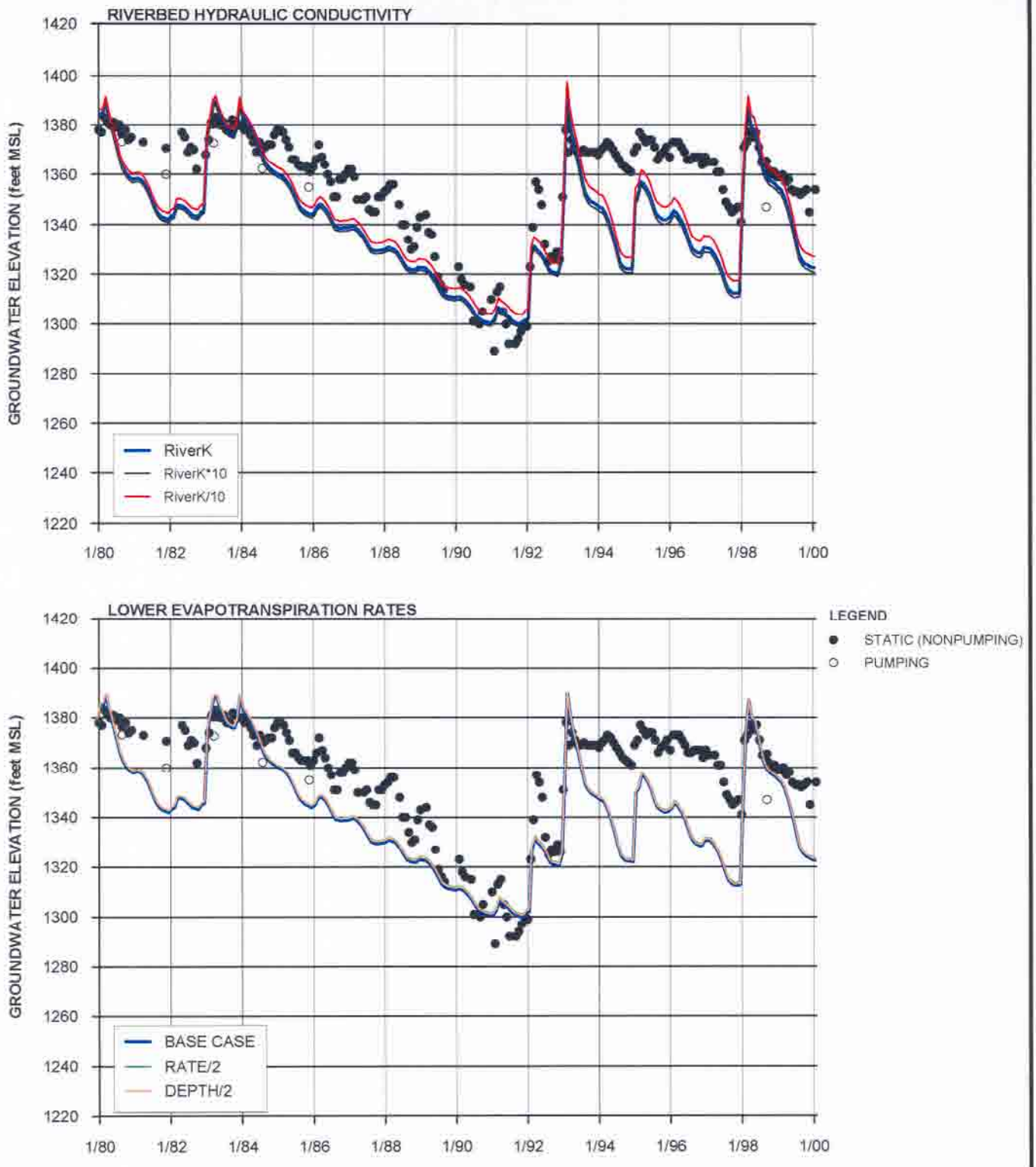

NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-48
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT SCWC-NORTH OAKS EAST TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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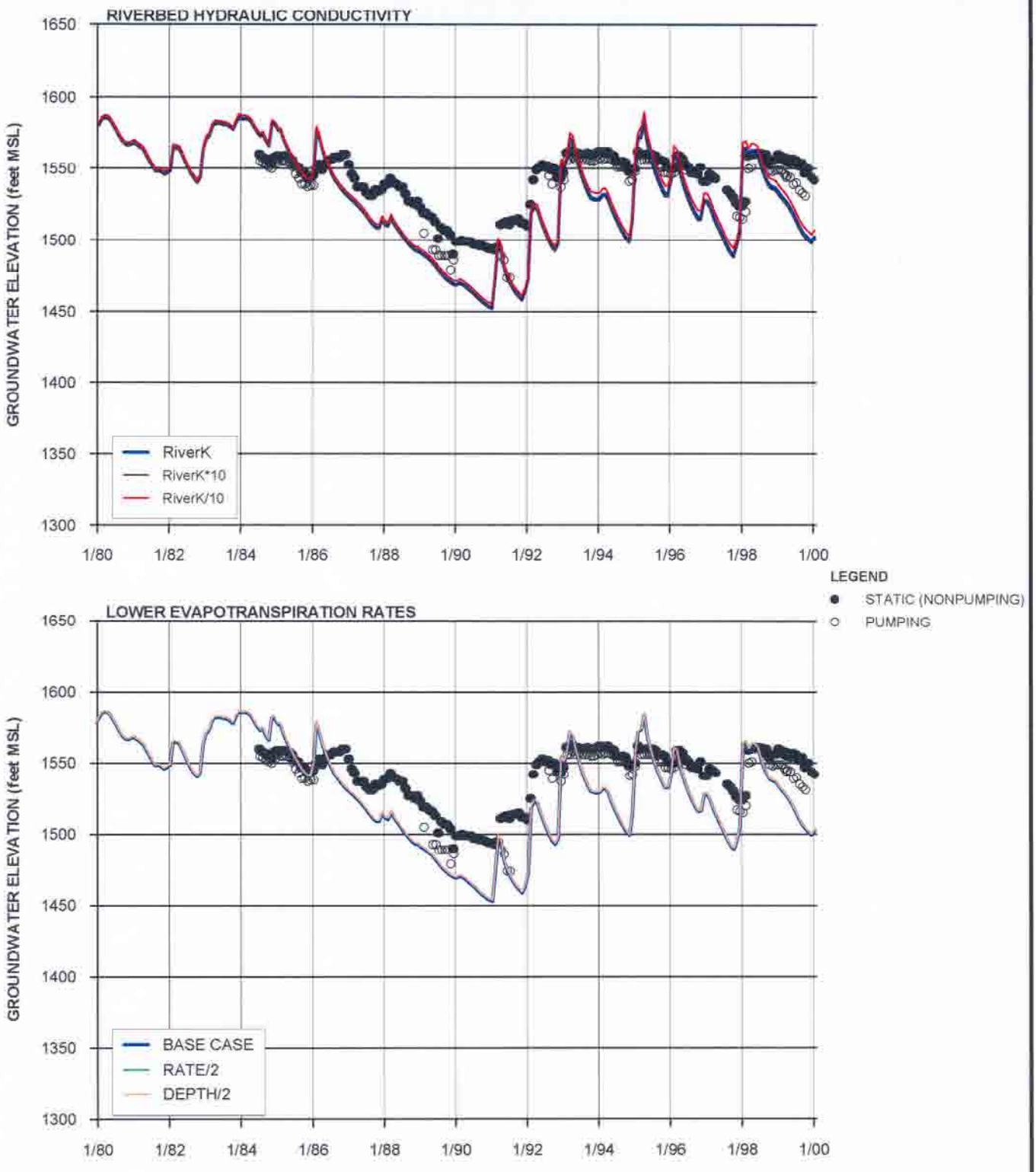

NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-49
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT SCWC-PINETREE1 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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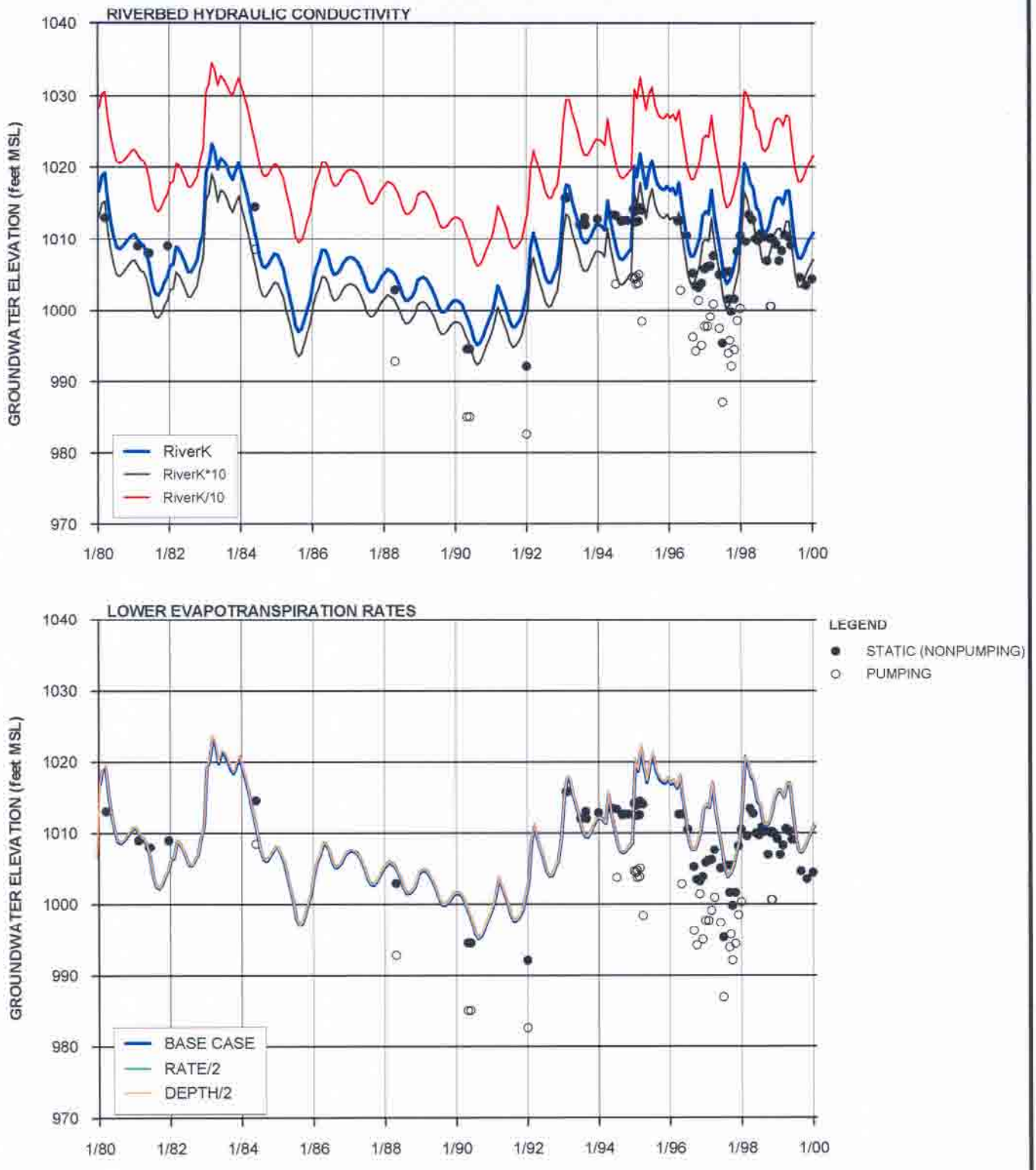

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2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-50
SENSITIVITY OF ALLUVIAL GROUNDWATER ELEVATIONS AT VWC-D TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

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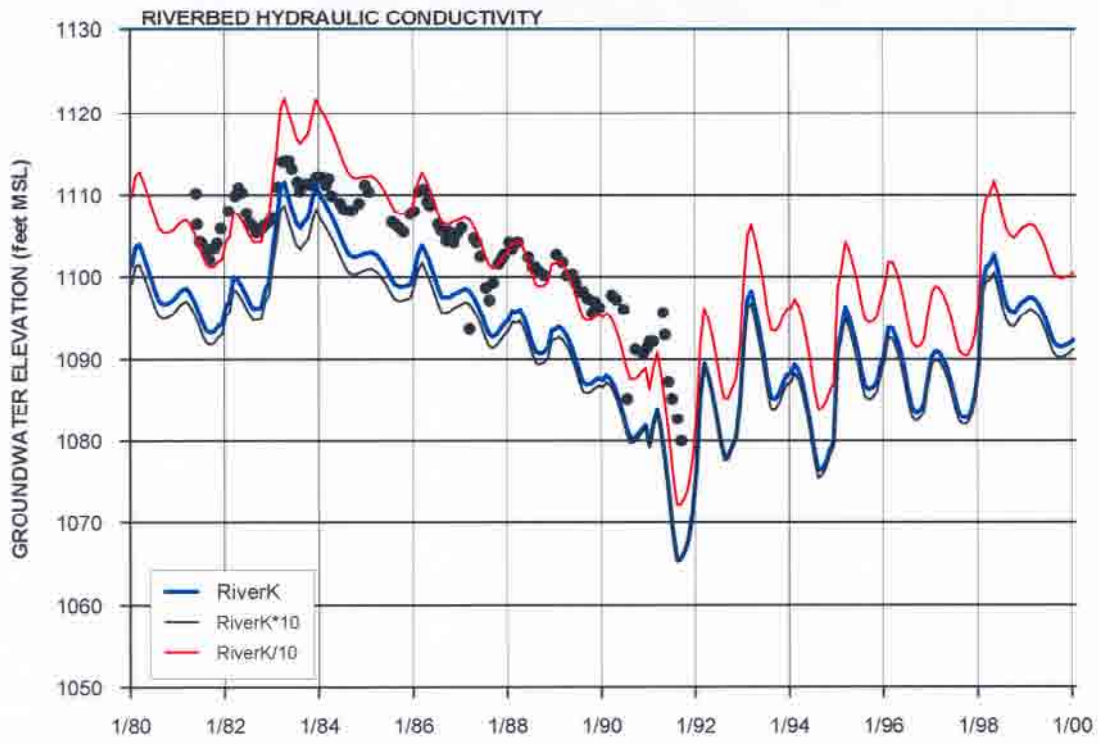

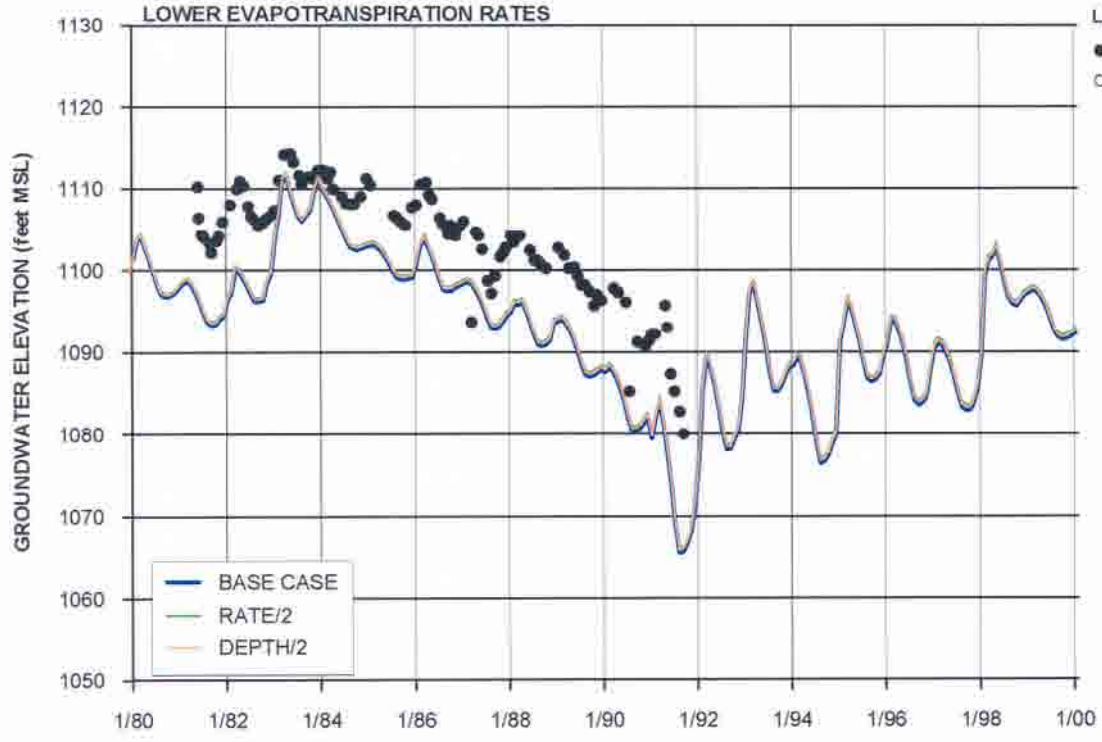

NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-51
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT 7048C TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

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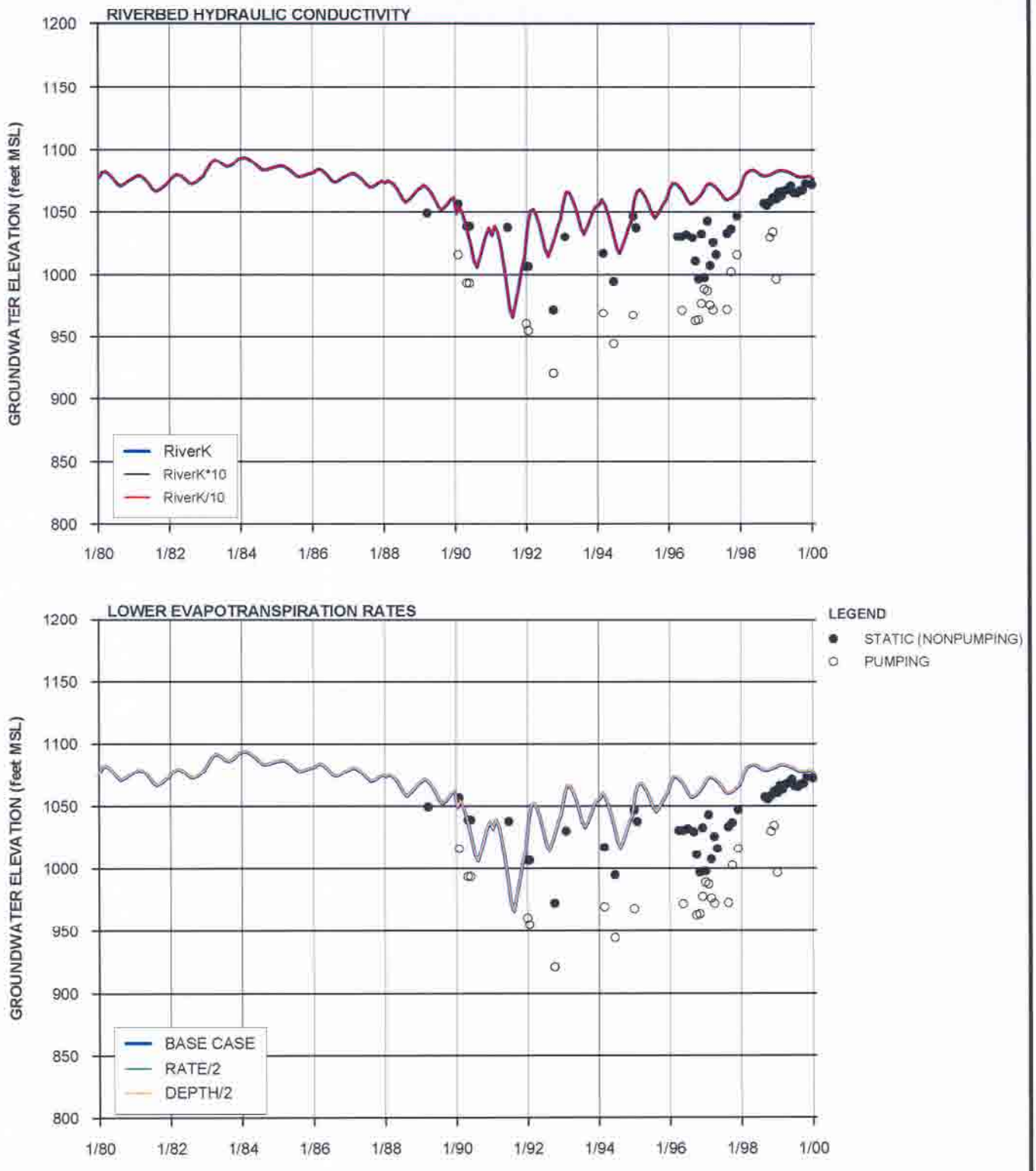

NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-52
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT VWC-201 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

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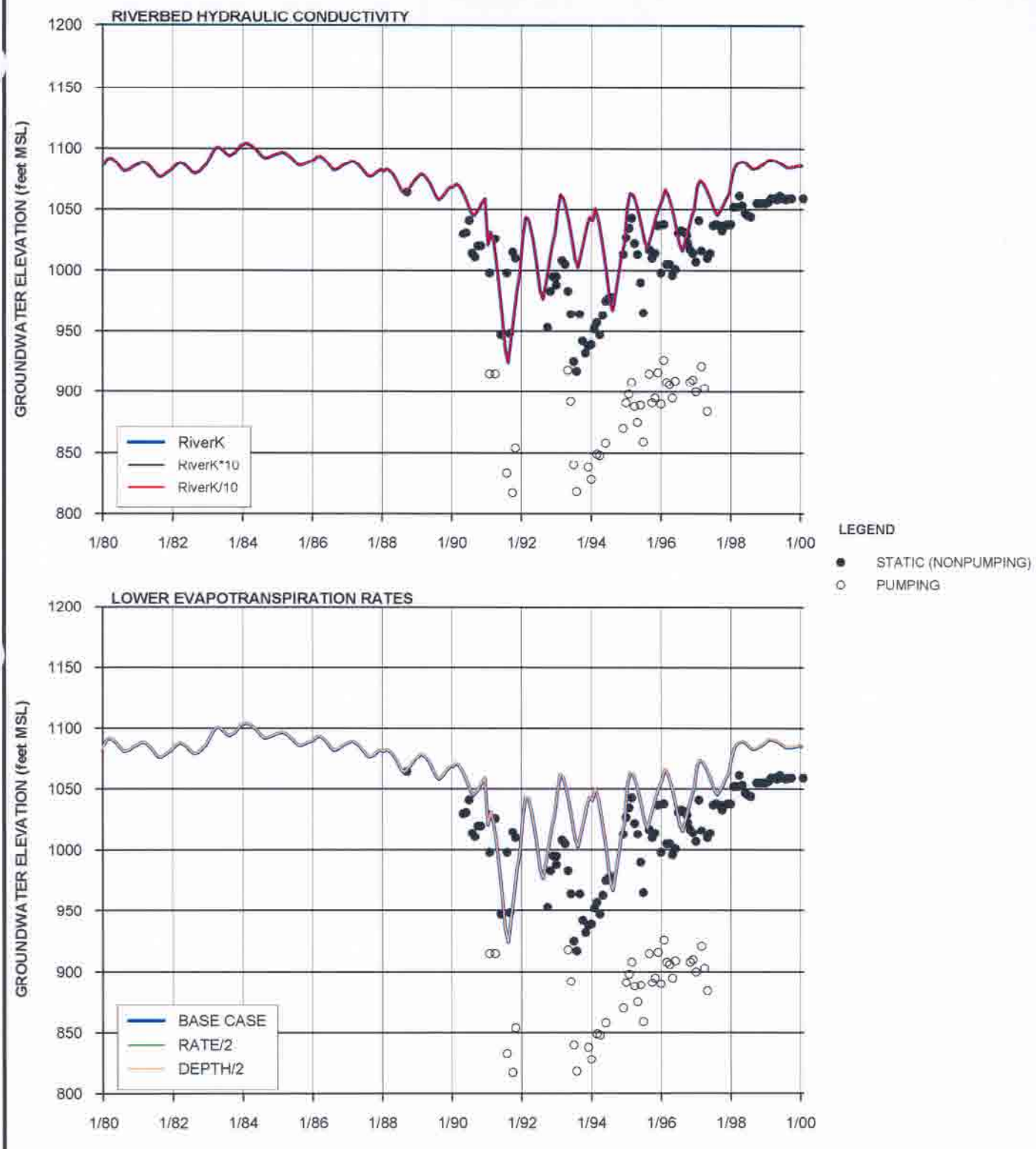

NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-53
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT SCWC-SAUGUS 2 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

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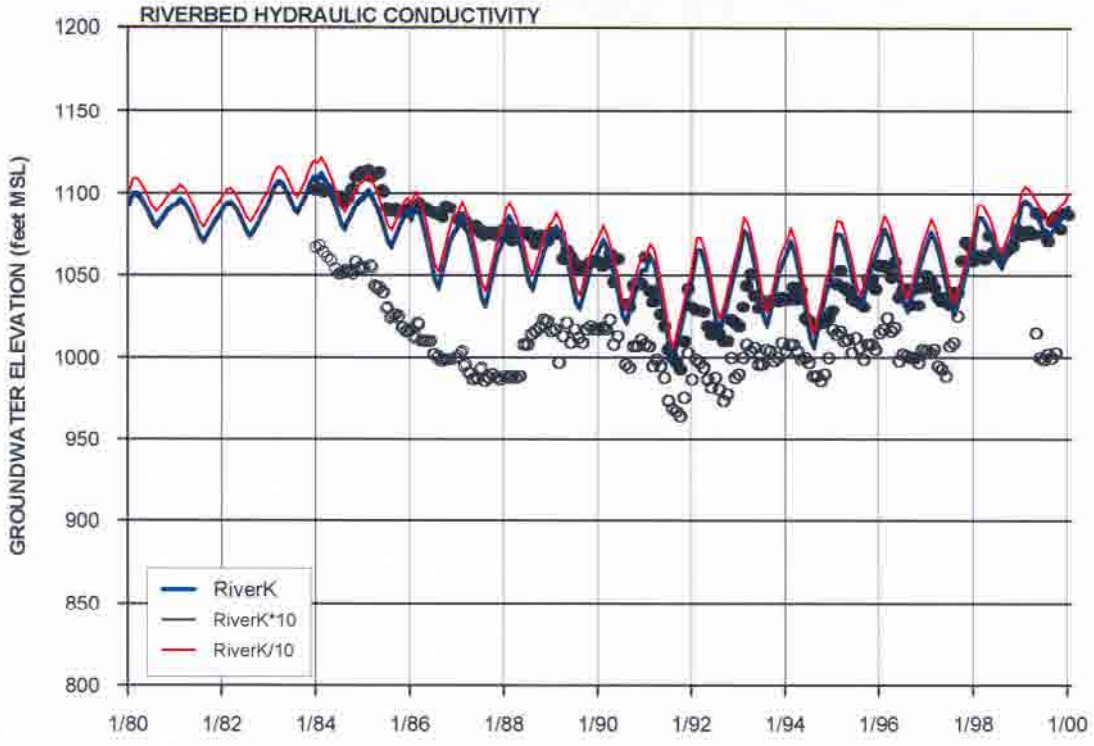

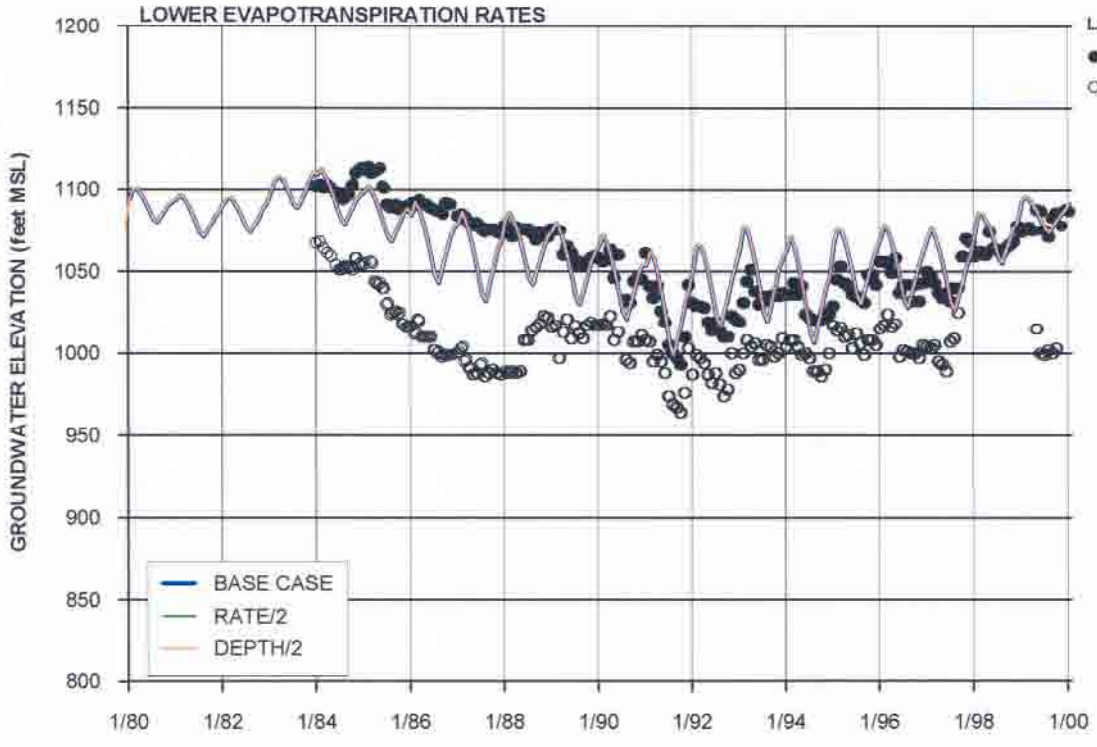

NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-54
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT NCWD-11 TO RIVER AND EVAPORTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

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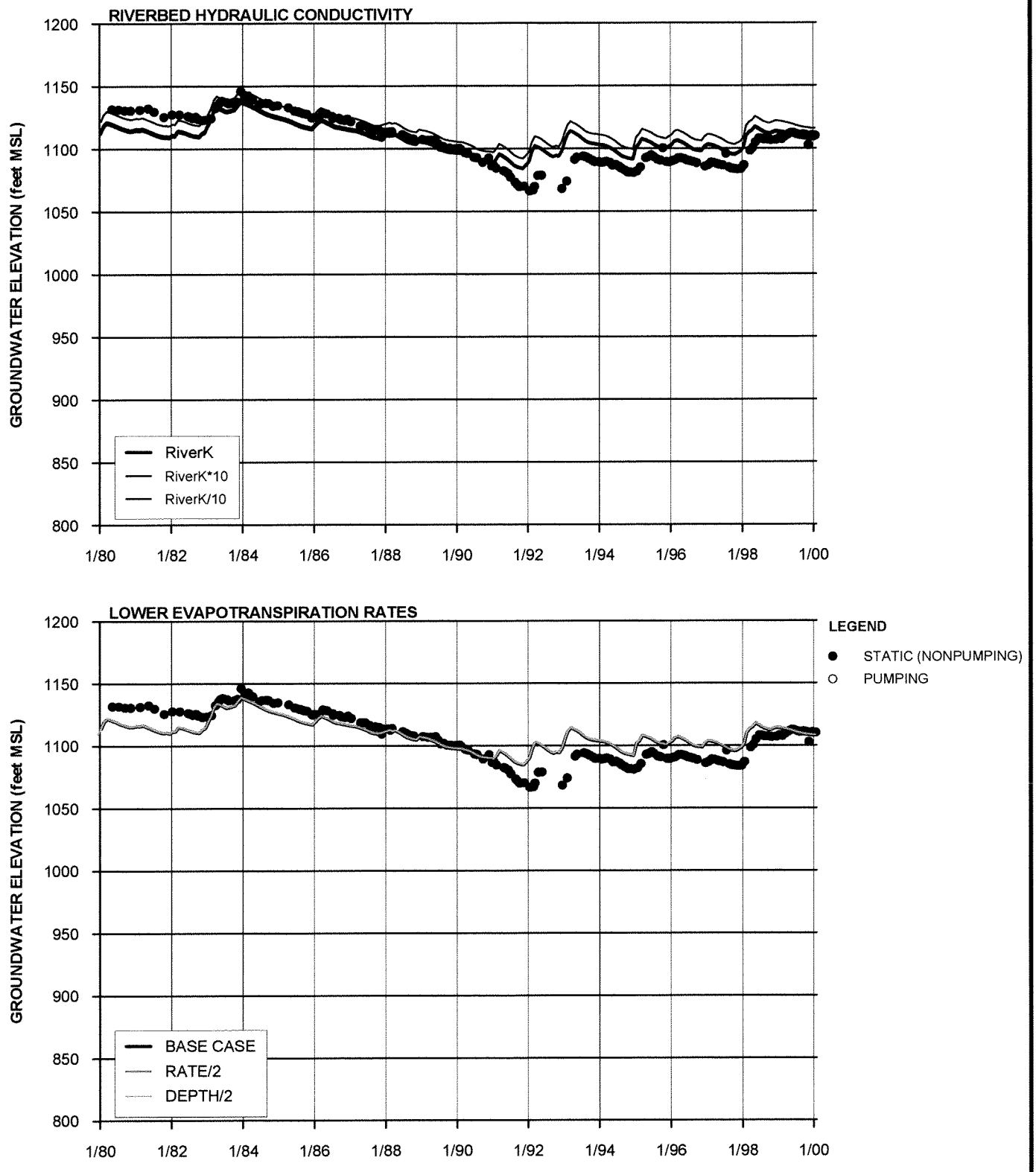

NOTES:
1. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
2. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
3. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)
4. SEE FIGURE 2-3 FOR LOCATIONS OF WELLS

FIGURE 5-55
SENSITIVITY OF SAUGUS GROUNDWATER ELEVATIONS AT 5851 TO RIVER AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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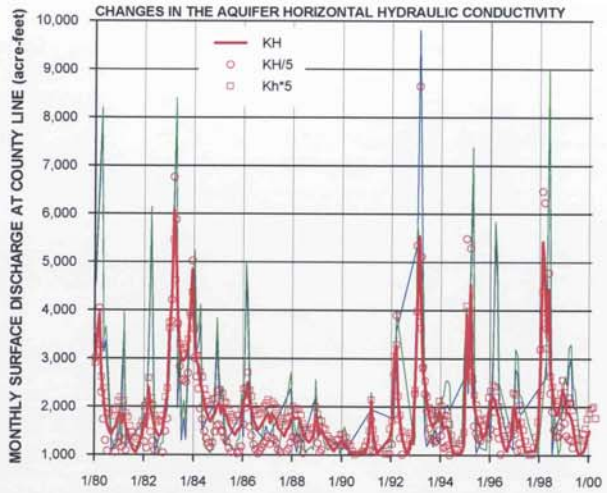

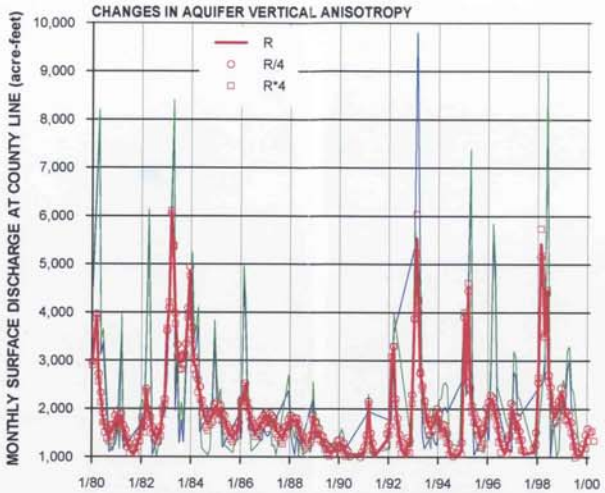

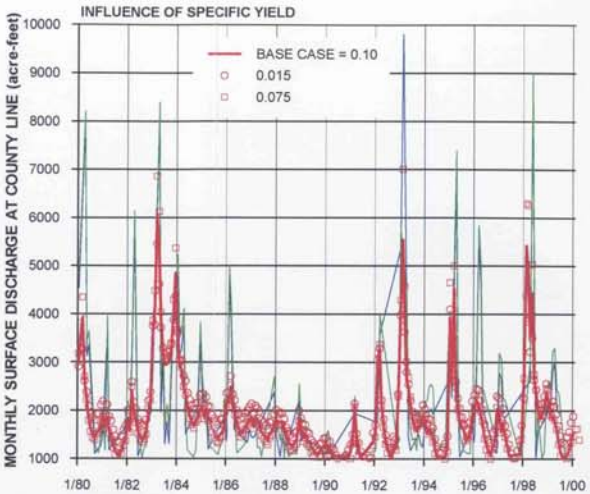

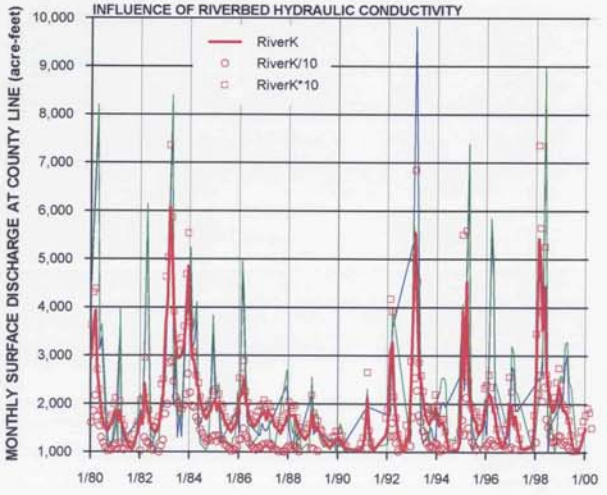

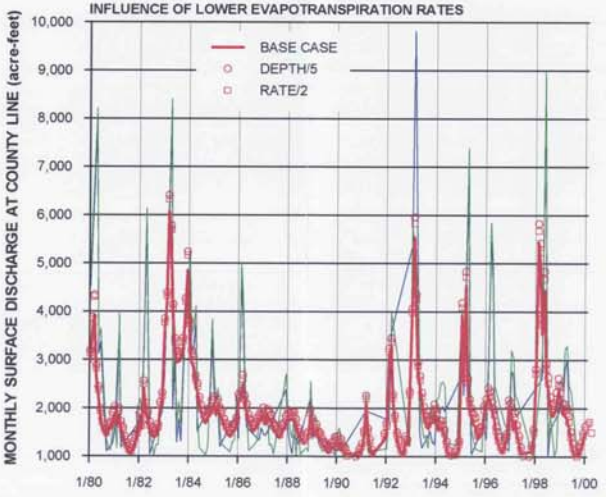

LEGEND

MEASURED (NO INFILTRATION OF SAUGUS WRP FLOWS)
MEASURED (75% INFILTRATION OF SAUGUS WRP FLOWS)

NOTES:

1. Kh = HORIZONTAL HYDRAULIC CONDUCTIVITY
2. R = VERTICAL ANISOTROPY RATIO (RATIO OF HORIZONTAL TO VERTICAL HYDRAULIC CONDUCTIVITY)
3. RiverK = RIVERBED VERTICAL HYDRAULIC CONDUCTIVITY
4. RATE = MAXIMUM RATE OF EVAPOTRANSPIRATION
5. DEPTH = ROOTING DEPTH (EXTINCTION DEPTH FOR EVAPOTRANSPIRATION)

FIGURE 5-56
SENSITIVITY OF GROUNDWATER DISCHARGES TO THE SANTA CLARA RIVER TO AQUIFER, RIVER, AND EVAPOTRANSPIRATION PARAMETERS
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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SECTION 6

Model Applicability to Local Water Resource Management

The Purveyors have developed the Regional Model as the main computer tool for their use in ongoing management of the groundwater resources in the Santa Clarita Valley. Among the objectives in developing the model were (1) to be able to evaluate the long-term sustainability (yield) of the Alluvial and Saugus aquifer systems under a range of existing and potential future water resource management conditions, and (2) to facilitate general management of water quantity and water quality issues.

The Regional Model simulates groundwater flow in the two aquifers that are present in the Santa Clara River Valley East Groundwater Subbasin. It has been developed using the database and GIS that were developed by, and are being used by, the Purveyors to manage the valley's water resources. The modeling effort built upon previous and ongoing hydrogeologic studies in the valley (RCS, 1986, 1988, 2001, 2002; CH2M HILL, 2003), as well as previous modeling efforts (CH2M HILL, 1996, 2001, 2002). Key aspects of the Regional Model's construction and calibration include the following:

a. The Regional Model covers the entire Santa Clara River Valley East Groundwater Subbasin, from the Lang stream gage, at the eastern end of the valley, to Blue Cut, just west of the county line.

b. The Regional Model includes the SWRM, which determines the monthly volume of rainfall that is available to streams that are tributaries to the Santa Clara River. The SWRM also computes how much of the runoff can recharge the Alluvial Aquifer, the locations of the recharge, and the amount of flow that remains in each stream. Further, the SWRM calculates how much flow occurs in the Santa Clara River due to tributary inflows and to WRP discharges. Together, the SWRM and the Regional Model allow for estimation of the time-varying magnitudes of total river flow and groundwater discharges to the river. In summary, the Regional Model is actually a groundwater flow model coupled with an empirical tool that estimates stormwater generation from each watershed lying upstream of, and extending into, the Regional Model's boundaries.

c. The Regional Model has been calibrated on a monthly basis to time-varying hydrologic conditions that were observed from 1980 through 1999. Calibration data consisted of groundwater elevations in both aquifers at production and monitoring wells; estimated fluctuations in groundwater discharges to the Santa Clara River; and gaged flows in the Santa Clara River. Consequently, the Regional Model is calibrated not only to groundwater elevation trends, but also to the flows of water into and out of the valley.

The Regional Model has been specifically designed for use in managing groundwater resources on a local and regional scale. Its design and calibration make it a useful tool for:

a. Evaluating groundwater management strategies, including analyzing basin operations over multi-year wet/dry cycles

b. Evaluating ASR projects or other aquifer recharge projects

c. Evaluating options for locating new or proposed water supply wells, with consideration of the avoidance and management of any contamination in the aquifer system

d. Evaluating the restoration of pumping capacity that has been impacted by perchlorate contamination in the vicinity of the Whittaker-Bermite property in the central part of the valley

Nonetheless, because no model is perfect, it should be used with care, and all model results should be examined by qualified and experienced hydrogeologists and water resource managers. Specific recommendations for the continued use and maintenance of this tool, including hydrogeologic data needs, are as follows:

a. Future predictive modeling activities should include sensitivity analyses on key model variables, particularly the Kh and Kv of both aquifer systems. This recommendation is based on the sensitivity analysis results, which show that groundwater elevations and groundwater discharge to the Santa Clara River are both sensitive to these parameters.

b. Streamflow monitoring should resume at the Lang gage, to better understand the magnitudes and timing of Santa Clara River flows into the valley. Stream gaging was discontinued at this location after October 1989. Because inflow in the Santa Clara River is one of the principal sources of water, the absence of data at this location is likely the primary reason that the Regional Model has difficulties simulating historical water level trends during certain periods at wells in the eastern-most portion of the valley. Without data from the Lang gage, simulations of future water level trends in this area will be uncertain, due to the Regional Model's tendency to under-predict groundwater elevations during drought periods.

c. The Regional Model and the SWRM should both be updated as water use conditions change in the future. Specific activities that merit updates to these tools include the planned implementation of recycled water use in the valley, continued urbanization in currently undeveloped and agricultural lands, and the increasing import of SWP water in response to increasing urban water demands.

d. Transient calibration runs should eventually be performed to test the transient model's ability to simulate conditions after 1999. The success of this activity will be more likely if streamflow data are collected at the Lang gage.

e. The Regional Model's calibration in the Saugus Formation should be tested whenever new wells are completed in this aquifer. Specifically, long-term water level monitoring should commence in these wells, and controlled pumping tests should be conducted to provide quantitative estimates of aquifer properties at new well locations, particularly in areas where wells have not been previously constructed.

f. Other activities described in the MOU between Ventura County and the Purveyors should continue, in order to provide data that can be used to improve the Regional Model and management of the local water resources. These data include pumping, rainfall, WRP discharge, streamflow, and groundwater elevation information. In particular, the groundwater elevation monitoring program that has been conducted for the past several years at production and monitoring wells should continue. Data from this program, collected by the Purveyors and LACFCD, provide valuable information for identifying and understanding the changes that occur in the hydrologic system, including the relationships between groundwater and surface water.

SECTION 7

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Memorandum of Understanding
Between the
Santa Clara River Valley
Upper Basin Water Purveyors and
United Water Conservation District

August 2001

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding ("MOU") is entered into effective August 20, 2001, by and among Castaic Lake Water Agency ("CLWA"), CLWA's Santa Clarita Water Division ("SCWC"), Newhall County Water District ("NCWD"), Valencia Water Company ("VWC") and Los Angeles County Waterworks District No. 36 ("LACWD"), which are collectively referred to as the "Upper Basin Water Purveyors" and United Water Conservation District "UWCD", hereinafter referred together as the "parties."

RECITALS

WHEREAS, UWCD is a public agency that encompasses approximately 214,000 acres of land located in central Ventura County. UWCD's service area covers the downstream portion of the Santa Clara River Valley in Ventura County, as well as the Oxnard Plain (sometimes referred to as the "Lower Santa Clara River Area"). UWCD manages surface and groundwater resources within seven groundwater basins in the Lower Santa Clara River Valley Area. UWCD's Boundary is shown on Figure 1-1; and,

WHEREAS, the Upper Basin Water Purveyors meet regularly as a technical group to coordinate conjunctive use of imported, recycled and groundwater resources of the water basins east of the Los Angeles/ Ventura County line (sometimes referred to as the "Upper Santa Clara River Area"), which is located almost entirely within northwestern Los Angeles County. The respective services areas of the Upper Basin Water Purveyors members (CLWA, SCWC, NCWD, VWC and LACWD) are shown on Figure 1-2; and,

WHEREAS, UWCD has been involved in the review of water resources in both the Lower Santa Clara River Area and also the Upper Santa Clara River Area as part of UWCD's review of the Newhall Ranch Specific Plan and EIR (NRSP); and,

WHEREAS, litigation of the Newhall Ranch Specific Plan and EIR resulted in preparation of an additional analysis to the previously certified EIR for the NRSP, including the section addressing water resource issues; and,

WHEREAS, the Additional Analysis includes a water flow model and impact analyses of the future water usage projections for the Upper Santa Clara River Area; and,

WHEREAS, UWCD, Newhall Land and Farming Company (NLF) and others have had several technical meetings to further study the Additional Analysis as it relates to the water issues, and, based on this information, and further discussions between UWCD and the Upper Basin Water Purveyors, UWCD believes that it is in the best interests of the parties and the future beneficial water resources management in the upper and lower basins to enter into a cooperative working relationship among the parties; and,

WHEREAS, the parties have determined that this MOU is the best format for establishing a program that would be implemented over time for purposes of agreeing upon overall water resources management techniques and an information database that would benefit the upper and lower basins; and,

WHEREAS, this MOU is prepared by UWCD and the Upper Basin Water Purveyors because the parties believe that a cooperative water resource monitoring program in the Upper and Lower Santa Clara River Areas is desirable to protect and enhance the conjunctive use of imported water, groundwater and surface water resources within the region; and,

WHEREAS, the parties support regional water planning efforts that rely on the provision of accurate and timely information about available water resources; and,

WHEREAS, the parties to this MOU desire to create and maintain a cooperative relationship for purposes of gathering information for UWCD and the Upper Basin Water Purveyors to be used in further assessing imported water, surface water and groundwater conditions in both the Upper and Lower Santa Clara River Areas; and,

WHEREAS, the parties to this MOU intend to form a reciprocal relationship. In order to do this, UWCD will designate an individual or individuals with technical knowledge and experience appointed by the General Manager of UWCD who will be included in discussions and efforts that take place with the Upper Basin Water Purveyors and others regarding the Upper Santa Clara River Area. Likewise, the Upper Basin Water Purveyors will designate an individual or individuals with technical knowledge and experience appointed by the General Managers of the Upper Basin Purveyors who will be included in discussions and efforts with UWCD and others regarding the Lower Santa Clara River Area, and,

WHEREAS, the goal of the MOU is to establish a joint monitoring program, which includes: (a) data collection (monitoring and testing); (b) database management; (c) groundwater flow modeling; (d) assessment of groundwater basin conditions (operational yield); and (e) report preparation and presentation.

NOW, THEREFORE, in consideration of the mutual promises and covenants herein contained, the parties to this MOU agree as follows:

1.1 **Program Monitoring.** The parties will participate in a joint monitoring program.

1.2 **Program Content.** The technical aspects of this joint monitoring program are set forth in a technical memorandum entitled, "Water Resource Monitoring Program Upper Santa Clara River Area," (Program) which is attached as Exhibit 1 and incorporated by this reference.

1.3 **Program Meetings.** The General Manager or President of each party to this MOU (or their designee) shall meet as the "Program Committee" within 30 days of the execution of this MOU. The "Program Committee" will establish appropriate subcommittees to initiate the Program and determine the meeting times and locations for the committees. The Program Committee and subcommittees will discuss and coordinate technical aspects of the Program, including the gathering, interpretation and reporting of information as outlined in the technical memorandum (Exhibit 1). Other attendees may be permitted by agreement of the parties to this MOU.

1.4 **Monitoring Costs.** The costs incurred in administrating the Monitoring Program will be determined as implementation of the Program takes place. However, it is understood that, unless the parties to this MOU agree otherwise, the Upper River monitoring costs of the program will be borne by the Upper Basin Water Purveyors because such monitoring will take place within their service areas and the Lower River monitoring costs of the program will be borne by UWCD because such monitoring will take place within its service area.

1.5 **Program Implementation.** The parties to this MOU have prepared a schedule, attached as Exhibit 2, that describes the tasks and estimated time to implement the Program. The Parties acknowledge that Program Implementation will be an on-going and evolving process and may change due to future amendments to the Program, challenging technical issues or other unforeseen circumstances.

1.6 **Water Rights.** Notwithstanding the provisions of this MOU, nothing in either this MOU or the technical memorandum (Exhibit 1) shall be construed as affecting the water rights or operations of any party, person or entity.

1.7 **Term.** This MOU shall remain in effect for an initial period of seven (7) years and shall be automatically renewed for additional one year increments unless otherwise unanimously terminated by the members of the Program Committee as that committee exists at the time action is taken to terminate this MOU.

1.8 **Counterparts.** This MOU may be executed in any number of counterparts, each of which, when so executed, will be deemed to be an original and all of which taken together will constitute one and the same agreement.

IN WITNESS WHEREOF, the parties have executed this MOU as of the date first set forth above.

United Water Conservation District

By _____
General Manager

Castaic Lake Water Agency

By _____
General Manager

Newhall County Water District

By _____
General Manager

Valencia Water Company

By _____
President

Santa Clarita Water Company

By _____
President

Los Angeles County Waterworks District No. 36

By _____
County of Los Angeles

United Water Conservation District Boundary

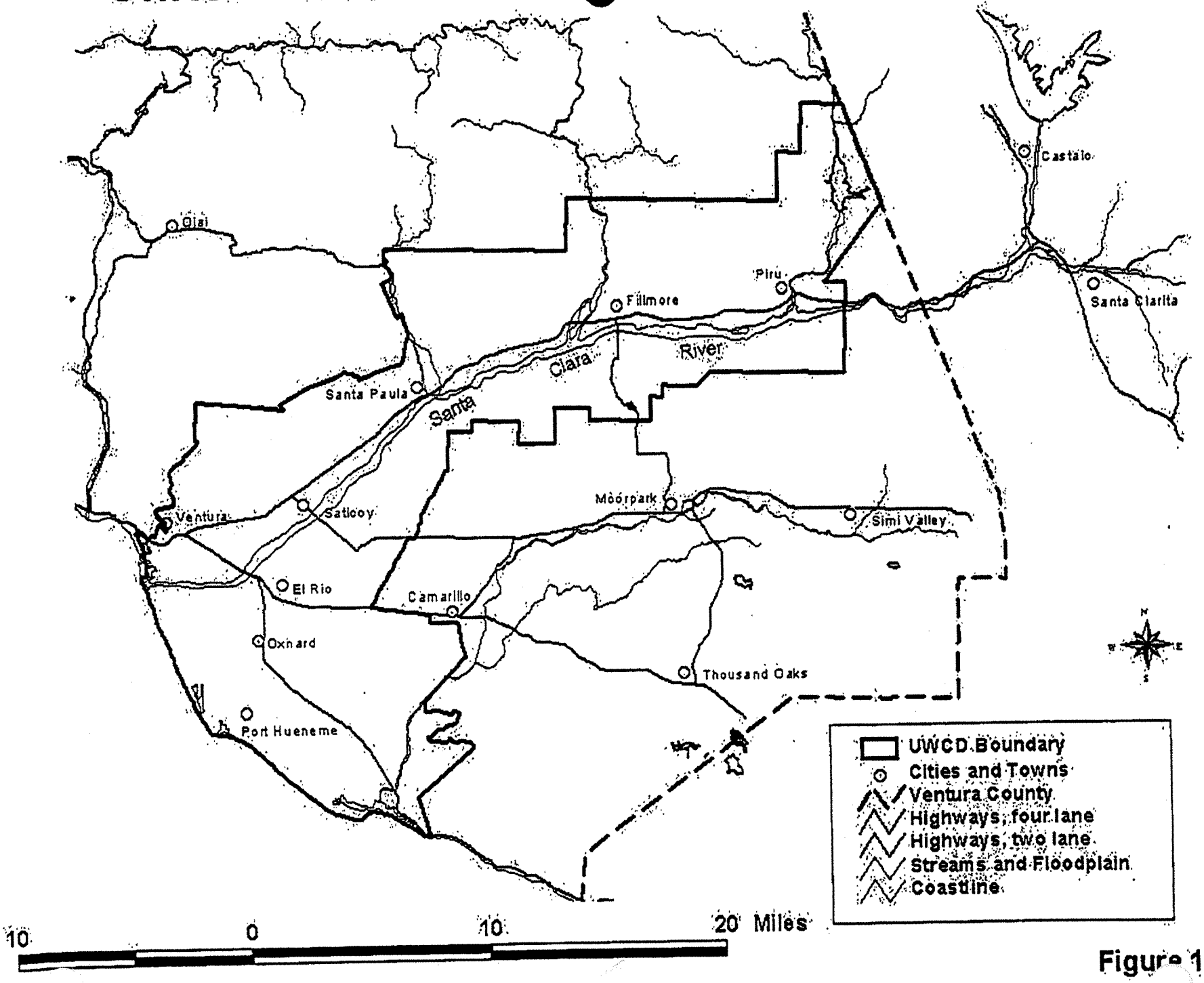


Figure 1-1

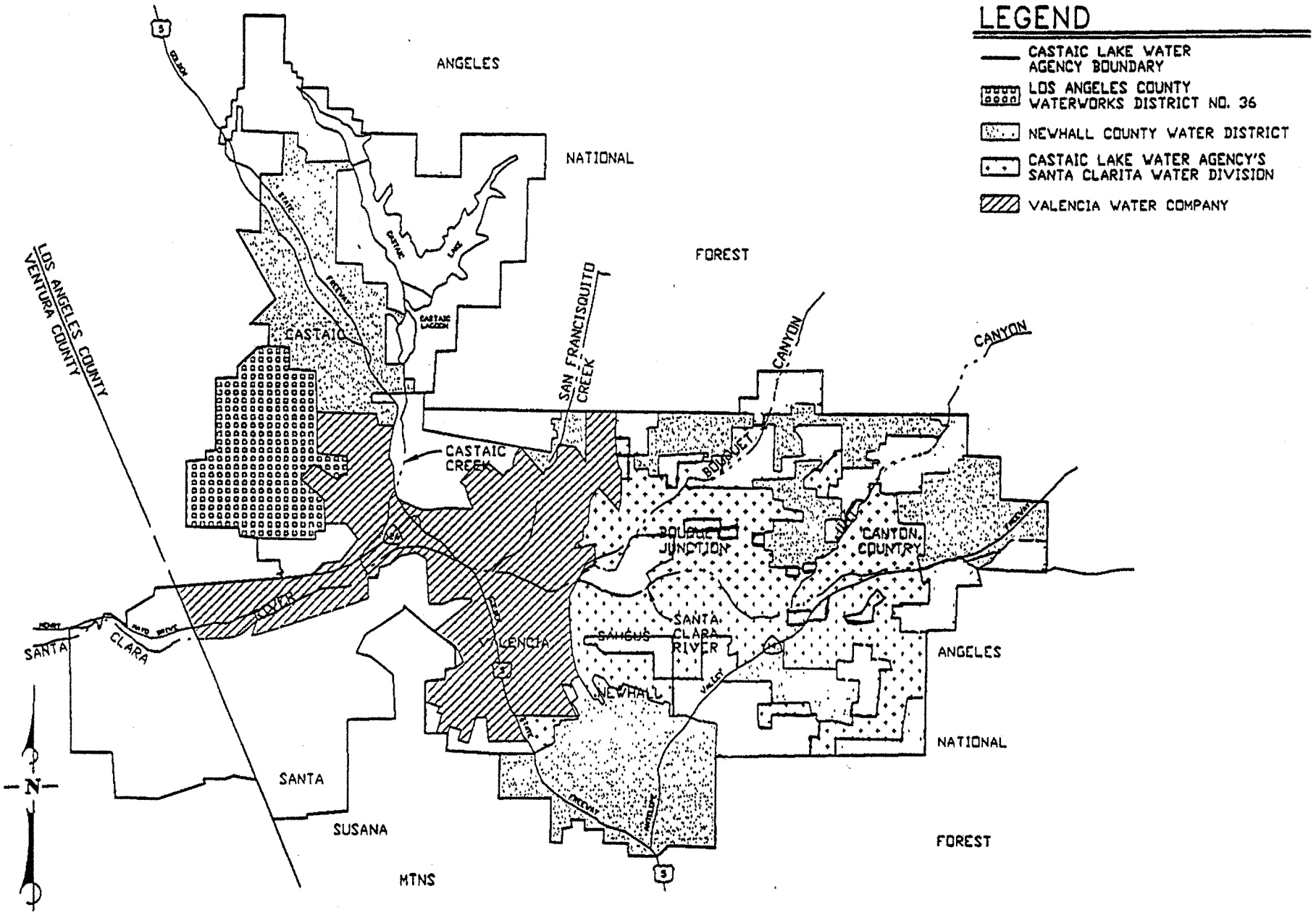


FIGURE 1-2

CLWA AND WATER PURVEYOR SERVICE AREAS

Exhibit 1
WATER RESOURCE MONITORING PROGRAM
UPPER SANTA CLARA RIVER AREA

INTRODUCTION

As part of its ongoing monitoring, interpretation, and reporting on imported water supplies and groundwater conditions in the aquifer systems underlying the Upper Santa Clara River Area, generally east of the Los Angeles County - Ventura County line and extending east to about the vicinity of Lang Station, the principal water purveyors in the area (primarily the municipal water purveyors - Castaic Lake Water Agency, Los Angeles County Waterworks District No. 36, Newhall County Water District, and Valencia Water Company) have committed to formalizing the data base on which water supply conditions are analyzed, and expanding the analysis of groundwater conditions such that the adequacy of water supply is well understood, and that both local and regional questions or issues about surface and groundwater can be addressed.

This water monitoring program outline has been prepared as a cooperative effort by the Upper Basin Water Purveyors operating in the Santa Clarita Valley and by the United Water Conservation District in Ventura County, the latter as the primary groundwater resource management entity in the Lower Santa Clara River Area (west of the Los Angeles - Ventura County line). The intent of the program outline is to delineate a series of elements that will be undertaken primarily by the Upper River Area entities, but in cooperation with United such that there is ultimately an integrated and coordinated data base, as well as agreed-upon technical tools such as a numerical groundwater flow model, to allow a continued regional understanding of water resources along the Santa Clara River. In that light, the following program includes elements which address data collection (monitoring and testing), database management, groundwater modeling, operational yield analyses, and report preparation and presentation.

DATA COLLECTION (MONITORING AND TESTING)

Historically, data on groundwater and related hydrologic conditions have been collected on varying frequencies and in varying formats throughout the Upper River Area. Fortunately, more than sufficient data have historically been collected on groundwater levels, quality, and production (pumpage) to permit general assessment of groundwater conditions, in some detail in the widely developed Alluvial aquifer and to a lesser extent the Saugus Formation aquifer. In order to expand on the general assessment of groundwater conditions, historical data collection efforts will be updated and formalized in the following areas.

Groundwater Levels and Quality - Wells in which historical and current water level data are available will be "qualified" (to confirm locations, depths, well completion details, annular seals, etc.) to confirm their utility for ongoing monitoring of water level and/or water quality in a particular aquifer. Based on a combination of qualified well details and available historical and current data, a network of existing and future wells will be developed for ongoing monitoring of groundwater levels (initially on a semi-annual frequency) and groundwater quality (initially on an annual to triennial frequency, depending on the use of the well) in both the Alluvium and the Saugus Formation aquifers. The water level and water quality monitoring networks may not be identical (as with most basins, the number of water level monitoring points will likely be greater than the number of water quality monitoring points). Also, in light of the relative differences in development of the two aquifer systems, there will be more monitoring points in the Alluvium than in the Saugus. However, as future development of the Saugus increases, particularly as the spatial extent of the Saugus "well field" expands, the Saugus monitoring network will evolve and expand accordingly. Water quality details are expected to begin with what historical analyses have been made; monitored details are expected to increase as the use of local Groundwater continues to change from irrigation supply to municipal supply, with the addition of organic and other hazardous chemical analyses of drinking water supplies in recent years. Finally, such as any dedicated monitoring wells are installed in the

area, for specific site investigation or other purposes, they will be added to the qualified well network as appropriate.

Groundwater Pumpage - Essentially all pumpage in the Upper Area (except small capacity individual domestic and similar wells) is metered or directly estimated from electrical power records, and the results are maintained in a decentralized data base. Metered measurement of all substantial capacity wells (all municipal and agricultural, as well as other private wells, e.g. golf course irrigation wells) will be continued on at least an annual basis, with progression to monthly data collection as appropriate for particular analyses that may be undertaken.

Surface Water Flows and Quality - Historical stream gage sites will be preserved as possible to allow ongoing surface water gaging of stream inflows to the Upper River area, stream outflows from the Upper River area into Ventura County, and return flows to the River system from in-area wastewater treatment plant discharges. Surface water quality at the same points will also be sampled on some frequency to continue historical records as appropriate or to document episodic or other (e.g. treated wastewater discharges) surface water flows into or out of the Upper River area.

Well and Aquifer Characteristics - Recently constructed wells, in both the Alluvium and Saugus Formation, have been tested, in some cases with the benefit of nearby monitoring wells, to determine well yields and aquifer hydraulic properties (e.g. transmissivity and storage coefficient). In limited cases, production logging and depth-specific water quality sampling has been undertaken to examine variations in aquifer productivity and quality with depth. Such as there is a need for additional spatial or vertical distribution of well yield or aquifer characteristic data, selected qualified wells will be tested in the Alluvium and Saugus aquifers. In general, all new production wells will be tested to determine the yields of the wells and the hydraulic characteristics of the aquifer materials in which they are completed at various locations in the Upper River area.

Precipitation - The locations of historical precipitation gaging will be verified and the quality of the

gaging stations will be assessed. Continuation of historical gaging will be a primary goal, with additions as appropriate to assess inflow of water within the Upper River area as well as distribution of precipitation throughout the area.

DATABASE MANAGEMENT

Geographic Information System - There is a good start on a regional GIS from the US Geological Survey's Regional Aquifer Study. For instance, roads, streams and other basic geographic features are in the USGS GIS that has been maintained and expanded by United Water Conservation District. United has commercial digital air photo coverage of Ventura County that includes a small portion of western Los Angeles County; additional digital imagery will be sought from agencies in Los Angeles County.

Most of the wells in the Valencia/Santa Clarita area are also in a USGS GIS coverage that includes well construction information. The wells are identified by owners designations as well as state well number. By using the state well number in identifying all monitoring data, information from the databases can be linked directly to the GIS well coverage.

Water Level Database - Monitoring data will be collected together in common databases, using an easily accessible program such as Microsoft Access. Groundwater level information is presently in a variety of forms, including paper copy, spreadsheet files, and agency databases. The digital information will be incorporated into a master database, but the data on paper copies will have to be entered into a computer. This will be accomplished by prioritizing the order in which this information is entered. Historic groundwater level data will be obtained from as many wells as possible, public and private, to ensure meaningful area coverage.

Water Quality Database - Water quality information may be a larger chore to organize in a database than water levels because each water sample collected is commonly analyzed for a large number of constituents. For water quality data collected in the future, analytical labs can provide results in digital form for ease of integration into a database. Historical water quality information is available digitally from the California Department of Health Services for public water supply wells (data is available for about the past ten years). For the rest of the historical water quality data, prioritizing the order of manual data entry would be necessary. Constituents of concern are obviously the first to be entered. Whether to enter all historical data will need to be addressed; this information is valuable in identifying long-term trends, but data entry takes time. United Water now has all historic water quality data for seven basins in Ventura County in a database, but it took several years to do this.

Water quality data from surface sources such as streams will also be included in the main water quality database. A location identifier can be used to tie the sample to the monitoring location in a GIS coverage. The approximate flow of the surface water source at the time of measurement should accompany each water quality data entry.

Pumpage Database - Pumpage data from individual wells is key to assessing both water level and water quality trends. This information is also required to construct a groundwater model. Some of this information has already been entered in computer files and can be readily imported into a database. Other information will likely have to be obtained on a cooperative basis. If pumpers do not have their own metered pumping records, pumpage will be estimated from other sources such as utility bills. For wells where no records have been kept, probable pumping quantities can be estimated through land use records and, in the case of irrigated agriculture, from irrigation methods and practices. This calculated information should not be entered directly in the pumpage database.

Streamflow Database - There should be a database of streamflow measured at various monitoring points. For USGS gauges, much of this information is already in digital form. Other agencies, such as County Flood Control, may also have digital data.

GROUNDWATER FLOW MODELING

As part of the technical analysis of water supply alternatives to meet projected water demands of the proposed Newhall Ranch project in the Upper River area, a numerical groundwater flow model was prepared for that project's proponent. That model was developed to focus on the feasibility and impacts of a potential storage and recovery project in the Saugus Formation, including the impacts of injection and recovery pumping in the Saugus on the overlying Alluvium, and the resultant impacts on Santa Clara River flows out of the Upper River area. The current model is calibrated for a steady state condition, including the addition of some focused injection and pumping. As a result, it represents a useful initial modeling effort of the overall aquifer system in the Upper River area. Depending on its availability for other uses in the Upper River area, that initial model will be subjected to transient calibration efforts and additional calibration of the Alluvial aquifer. The model will then become an evolving tool for analysis of ongoing groundwater development and recharge, in conjunction with imported surface water, and the resultant impacts on groundwater conditions in the Upper River area, as well as on surface outflows to the downstream basins on the Santa Clara River.

OPERATIONAL YIELD OF THE BASIN

A primary objective of the monitoring efforts, database management efforts, and modeling efforts described above is to assess groundwater basin conditions in the Upper River area in the context of the long term sustainability of the Alluvium aquifer and the generally underlying Saugus Formation, and to operate the basin such that the operating yield is not exceeded over a multi-year wet/dry cycle. This operational yield includes flexibility of groundwater use by allowing increased groundwater use during dry periods and increased recharge (direct or in-lieu) with supplemental water when it is

available. The operational yield protects the aquifer by assuring that groundwater supplies are adequately replenished from one wet/dry cycle to the next. Historical groundwater data demonstrates that the Alluvium has been, and continues to be developed within its long-term sustainability (i.e. no chronic lowering of water levels, no notable trend toward degradation of groundwater quality, etc.). Limited historical data in the Saugus Formation shows no lowering of water levels or degradation of water quality where it has been developed.

While current planning places future pumping of the Alluvium in the same range as has historically occurred for several decades, with anticipated similar results in terms of Alluvial water levels, storage, and quality, the model described above will be a useful tool to quantify the impacts in water budget terms and to analyze a range of scenarios as appropriate to optimize the use of the high-yielding Alluvium. The Saugus Formation is alternately being considered for short-term dry-period water supply at capacities higher than have historically been pumped from that formation, and for injection, storage and recovery of water as part of the overall water supply of the Upper Santa Clara River area. The model will also be used to determine the operational yield of the Saugus under a wide-ranging set of low to high pumping capacities (during wet to dry years, respectively), and with varying aquifer storage (recharge), to avoid undesirable impacts and assure that the operating yield is not exceeded over a multi-year wet/dry cycle.

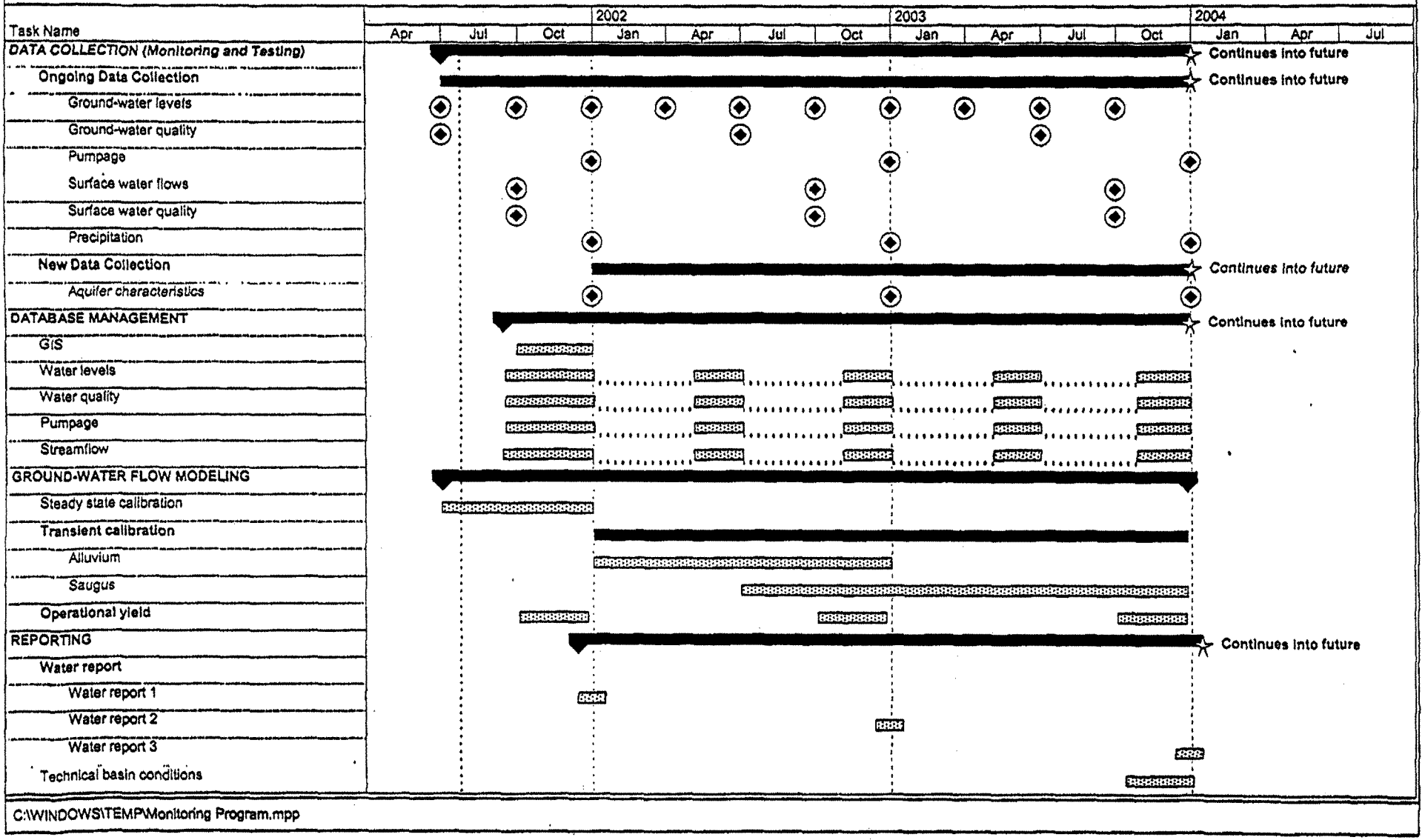
REPORTING

Beginning in 1998, an annual report on water supply conditions in the Upper Santa Clara River area has been prepared by the water purveyors in the Upper River area. Those reports have focused on a planning-level discussion of current and immediate future water demands, and the availability of local Groundwater and imported surface water to meet those demands. The overall primary objectives of the reports have been to provide some documentation, to local and County planners as

well as County Supervisors, on the water supply conditions in the Santa Clarita Valley and to present a general assessment of the status of groundwater conditions in both the Alluvial and Saugus aquifer systems, with a focus of that assessment on historical and recent groundwater development within operating yield parameters.

As the water resource monitoring program described above is implemented and evolves, it is planned that reporting on groundwater basin conditions will evolve in two generally parallel ways: 1) a continuation of the annual reporting on current water supply conditions, as a basis for current planning and consideration of development proposals; and 2) the addition of less frequent, more technically oriented reports on the geologic and hydrologic aspects of the groundwater resources of the Upper River area, including documentation of: a) groundwater basin conditions, b) development and application of modeling efforts to assess operational yield and the impacts of long-term planned utilization of local groundwater as part of the overall water supply, and c) assessment of actual versus predicted impacts on groundwater and surface water, including basin outflows, combined with ongoing updated assessments of the adequacy of local groundwater management actions and identification of any needed changes which are identified over time. As needed, the resource monitoring program and technical reports will be coordinated with interested regulatory agencies such as the Regional Water Quality Control Board, the California Department of Health Services and the California Department of Toxics and Substance Control.

Exhibit 2
WATER RESOURCE MONITORING PROGRAM
UPPER SANTA CLARA RIVER AREA



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APPENDIX B

Analyses of Specific Capacity Test Data for the Alluvial Aquifer

Specific capacity data are available for production wells in the Alluvial Aquifer through 2000. Tables B-1 through B-6 present these data and the calculations of estimated transmissivity (T) and horizontal hydraulic conductivity (Kh) values, along with how these values compare with the values used in the calibrated groundwater flow model at each well location. Rows in bold font identify specific capacity tests that were considered to provide the best indications of aquifer properties.

The tables show the testing data for different geographic areas in the Alluvial Aquifer[1], as well as the estimated drawdown in the aquifer formation for different values of well efficiency. Because of the unconfined nature of the Alluvial Aquifer system, the following equations were used to calculate T and Kh (Driscoll, 1986):

$$s = s_{well} * E$$

$$T = 1500 * Q / s \quad (1)$$

$$Kh = T / (7.48 * b_{typical})$$

where:

s = the estimated drawdown in the aquifer formation

s_{well} = the measured drawdown in the well during the efficiency test

E = the well estimated efficiency

T = the transmissivity (gallons per day per foot [gpd/ft])

Q = the pumping rate (gallons per minute [gpm])

Q/s = specific capacity of the well

Kh = the horizontal hydraulic conductivity of the alluvial aquifer (feet per day [ft/day])

$b_{typical}$ = the typical long-term average saturated thickness (feet [ft]) of the alluvial aquifer at the location of the specific well

For each test, Tables B-1 through B-6 show the data and the calculations for drawdown, T, and Kh at different estimated well efficiencies (70 percent is the typical efficiency of a well that is in good condition; 50 percent reflects a well that is less efficient).[2] As shown in the table, the T and Kh values vary widely with location, as well as over time at individual wells. The table uses bold font to identify those tests that are believed to be the least affected

[1] See Figure 2-3 for well locations. See also Figure 4-1 for the locations of the target wells and zones that were used during calibration of the Alluvial Aquifer in the Santa Clarita Valley Groundwater Model (Regional Model).

[2] Well efficiency is a function of the design, construction, and condition of the well.

by well efficiency issues (i.e., show the highest specific capacity values) and therefore provide the best estimate of aquifer parameter values at each well location. Specific conclusions from this analysis are:

a. In the western alluvium along the main Santa Clara River valley (west of I-5), it appears that few wells have high enough efficiencies to provide estimates of Alluvial Aquifer Kh values. The highest specific capacities for the Alluvial Aquifer are indicated by only about 19 of the 335 tests performed in this area. For these 19 tests and a well efficiency of 70 percent, the Kh ranges from approximately 300 to 1,000 ft/day and is typically approximately 500 to 600 ft/day. The Regional Model uses a Kh of 550 ft/day throughout this area.

b. In the central valley, between I-5 and Soledad Canyon, 8 of the 11 tested wells appear to provide usable estimates of Alluvial Aquifer Kh values. These wells indicate a Kh range typically between 250 and 600 feet/day, though one well (NLF-R2) indicates Kh values potentially as high as 800 ft/day or greater. The Regional Model uses values between 245 and 375 ft/day in most of this area, and 550 ft/day at the very eastern edge of this area, at the mouth of Soledad Canyon.

c. In the lower reach of Soledad Canyon, most wells indicate Kh values ranging from 600 ft/day to more than 1,000 ft/day. Only the SCWC-Honby well suggests lower Kh values of approximately 300 to 550 ft/day. The Regional Model uses a Kh of 550 ft/day throughout this area.

d. In the upper reach of Soledad Canyon, the Kh values show more variability from well to well than lower Soledad Canyon. Kh values in upper Soledad Canyon range from approximately 300 to 700 ft/day at some wells, and 900 to 1,500 ft/day at the other wells. The Regional Model uses Kh values ranging from 350 ft/day at the eastern end of the canyon to 550 ft/day farther west.

e. In the tributary canyons north of the Santa Clara River, Alluvial Aquifer Kh values tend to be slightly lower than along the Santa Clara River main valley.

    1. Along Castaic Creek, Kh values are commonly between 350 and 600 ft/day, though a few tests suggest values as high as 800 to 1,000 ft/day. The Regional Model uses a value of 315 ft/day below Castaic Dam and at the NCWD Castaic wellfield, and 350 ft/day between this wellfield and the alluvial valley containing the Santa Clara River.

    2. In San Francisquito Canyon, the W series wells owned by VWC and NLF suggest Kh values of approximately 200 to 400 ft/day. The Regional Model uses a value of 105 ft/day.

    3. In Bouquet Canyon, the two SCWC wells suggest Kh values of approximately 500 to 900 ft/day. The Regional Model uses a value of 140 ft/day at SCWC-Guida in the central portion of the canyon, and 245 ft/day at SCWC-Clark well in the lower reaches of the canyon.

The estimation of K values from specific capacity test data is a method that provides only an approximation of aquifer properties. This method is valuable for constraining the Regional Model's calibration because specific capacity tests provide the only source of data that allow

estimation and comparison of Alluvial Aquifer properties across the valley. Nonetheless, the method is affected by the following factors and uncertainties:

a. The measured drawdown in a well is affected by the radius of the well and the borehole, and the efficiency of the well at the time it is tested.

b. Yield and drawdown are affected by the length of the well screen and the fraction of the aquifer's thickness that is screened.

c. Fluctuations in water levels that occur seasonally and over multi-year periods affect the yield and drawdown of the well, and also the estimates of saturated thickness that are necessary for performing the calculations.

Reference

Driscoll, Fletcher G. 1986. *Groundwater and Wells*. Second Edition.

Tables

TABLE B-1

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Western Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
NLF	B5	**04/24/1984**	**1988**	**6.9**	**288.1**	**6.9**	**4.83**	**3.45**	**82,534**	**115,548**	**60,500**	**110**	**750**	**1,050**	**550**
		06/09/1986	1816	5.6	324.3	5.6	3.92	2.8	92,905	130,067		110	845	1,182	
		10/15/1987	1878	6.6	284.5	6.6	4.62	3.3	81,503	114,104		110	741	1,037	
		10/04/1988	1342	6.7	200.3	6.7	4.69	3.35	57,382	80,334		110	522	730	
		07/20/1989	1659	8.6	192.9	8.6	6.02	4.3	55,262	77,366		110	502	703	
		06/13/1990	1699	8	212.4	8	5.6	4	60,848	85,187		110	553	774	
		05/28/1991	**2013**	**7.6**	**264.9**	**7.6**	**5.32**	**3.8**	**75,888**	**106,243**	**60,500**	**110**	**690**	**966**	**550**
		07/26/1993	1895	7.2	263.2	7.2	5.04	3.6	75,401	105,561		110	685	960	
		08/15/1994	1870	6.3	296.8	6.3	4.41	3.15	85,027	119,037		110	773	1,082	
		07/18/1995	2081	6.5	320.2	6.5	4.55	3.25	91,730	128,422		110	834	1,167	
		06/10/1996	**2045**	**6.5**	**314.6**	**6.5**	**4.55**	**3.25**	**90,126**	**126,176**	**60,500**	**110**	**819**	**1,147**	**550**
		05/08/1997	1898	6.6	287.6	6.6	4.62	3.3	82,391	115,348		110	749	1,049	
		03/28/2000	**2357**	**6**	**392.8**	**6**	**4.2**	**3**	**112,529**	**157,540**	**60,500**	**110**	**1,023**	**1,432**	**550**
NLF	B6	05/21/1984	1473	12.1	121.7	12.1	8.47	6.05	34,864	48,810		110	317	444	
		06/09/1986	1886	15	125.7	15	10.5	7.5	36,010	50,414		110	327	458	
		10/15/1987	1190	10.4	114.4	10.4	7.28	5.2	32,773	45,882		110	298	417	
		07/20/1989	1043	8.4	124.2	8.4	5.88	4.2	35,581	49,813		110	323	453	
		06/13/1990	1083	10.4	104.1	10.4	7.28	5.2	29,822	41,751		110	271	380	
		05/30/1991	1603	11.9	134.7	11.9	8.33	5.95	38,589	54,024		110	351	491	
		06/10/1992	**1746**	**11.6**	**150.5**	**11.6**	**8.12**	**5.8**	**43,115**	**60,361**	**60,500**	**110**	**392**	**549**	**550**
		07/26/1993	1473	6.7	219.9	6.7	4.69	3.35	62,997	88,195		110	573	802	
		08/15/1994	1460	15.5	94.2	15.5	10.85	7.75	26,986	37,781		110	245	343	
		07/19/1995	**1600**	**9.2**	**173.9**	**9.2**	**6.44**	**4.6**	**49,819**	**69,746**	**60,500**	**110**	**453**	**634**	**550**
		06/10/1996	1274	18.6	68.5	18.6	13.02	9.3	19,624	27,473		110	178	250	
		05/08/1997	1394	15.6	89.4	15.6	10.92	7.8	25,611	35,856		110	233	326	
		06/26/1998	1554	15	103.6	15	10.5	7.5	29,679	41,551		110	270	378	
		05/06/1999	1504	13.3	113.1	13.3	9.31	6.65	32,401	45,361		110	295	412	
		05/21/1999	1504	13.3	113.1	13.3	9.31	6.65	32,401	45,361		110	295	412	
		04/21/2000	1086	22.4	48.5	22.4	15.68	11.2	13,894	19,452		110	126	177	
NLF	B7	02/24/1984	832	34.2	24.3	34.2	23.94	17.1	6,961	9,746	60,500	110	63	89	550
		04/24/1984	832	34.2	24.3	34.2	23.94	17.1	6,961	9,746		110	63	89	
		06/03/1986	766	33.4	22.9	33.4	23.38	16.7	6,560	9,184		110	60	83	
		12/21/1989	700	52.9	13.2	52.9	37.03	26.45	3,782	5,294		110	34	48	
		06/12/1990	766	50.5	15.2	50.5	35.35	25.25	4,354	6,096		110	40	55	
		05/29/1991	878	37.1	23.7	37.1	25.97	18.55	6,790	9,505		110	62	86	
		06/10/1992	837	14.9	56.2	14.9	10.43	7.45	16,100	22,540		110	146	205	
		07/23/1993	911	16.9	53.9	16.9	11.83	8.45	15,441	21,618		110	140	197	
		08/30/1994	730	33.5	21.8	33.5	23.45	16.75	6,245	8,743		110	57	79	
		07/17/1995	720	25.9	27.8	25.9	18.13	12.95	7,964	11,150		110	72	101	
		06/11/1996	725	29.5	24.6	29.5	20.65	14.75	7,047	9,866		110	64	90	
		06/26/1998	689	27.1	25.4	27.1	18.97	13.55	7,277	10,187		110	66	93	
		05/10/1999	915	27	33.9	27	18.9	13.5	9,712	13,596		110	88	124	
		05/21/1999	915	27	33.9	27	18.9	13.5	9,712	13,596		110	88	124	
		04/21/2000	945	49.6	19.1	49.6	34.72	24.8	5,472	7,660		110	50	70	
NLF	B10	07/13/1982	1325	33.2	39.9	33.2	23.24	16.6	11,430	16,003	60,500	110	104	145	550
		05/29/1991	1556	38.7	40.2	38.7	27.09	19.35	11,516	16,123		110	105	147	
		07/26/1993	1637	41	39.9	41	28.7	20.5	11,430	16,003		110	104	145	
		08/10/1994	1328	31.9	41.6	31.9	22.33	15.95	11,917	16,684		110	108	152	
		07/18/1995	1409	37.2	37.9	37.2	26.04	18.6	10,858	15,201		110	99	138	
		06/10/1996	1339	40	33.5	40	28	20	9,597	13,436		110	87	122	
		05/08/1997	1316	45.7	28.8	45.7	31.99	22.85	8,251	11,551		110	75	105	
		06/04/1998	1263	36.5	34.6	36.5	25.55	18.25	9,912	13,877		110	90	126	

TABLE B-1

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Western Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		05/06/1999	1259	43.4	29	43.4	30.38	21.7	8,308	11,631		110	76	106	
		05/21/1999	1259	43.4	29	43.4	30.38	21.7	8,308	11,631		110	76	106	
		04/21/2000	1259	39.4	32	39.4	27.58	19.7	9,167	12,834		110	83	117	
NLF	B11	07/27/1993	219	14.9	14.7	14.9	10.43	7.45	4,211	5,896	60,500	110	38	54	550
		08/17/1994	226	15.5	14.6	15.5	10.85	7.75	4,183	5,856		110	38	53	
		07/17/1995	429	12.4	34.6	12.4	8.68	6.2	9,912	13,877		110	90	126	
		05/14/1997	950	28	33.9	28	19.6	14	9,712	13,596		110	88	124	
		06/26/1998	817	22.9	35.7	22.9	16.03	11.45	10,227	14,318		110	93	130	
		05/10/1999	714	19.5	36.6	19.5	13.65	9.75	10,485	14,679		110	95	133	
		05/21/1999	714	19.5	36.6	19.5	13.65	9.75	10,485	14,679		110	95	133	
		04/21/2000	860	26.2	32.8	26.2	18.34	13.1	9,396	13,155		110	85	120	
NLF	C	04/09/1984	1351	49.4	27.3	49.4	34.58	24.7	7,821	10,949	60,500	110	71	100	550
		05/21/1986	1325	54.2	24.4	54.2	37.94	27.1	6,990	9,786		110	64	89	
		10/19/1987	1342	46	29.2	46	32.2	23	8,365	11,711		110	76	106	
		10/04/1988	1336	45	29.7	45	31.5	22.5	8,508	11,912		110	77	108	
		07/10/1989	1360	35.2	38.6	35.2	24.64	17.6	11,058	15,481		110	101	141	
		06/11/1990	1331	36.6	36.4	36.6	25.62	18.3	10,428	14,599		110	95	133	
		05/06/1991	1342	48.3	27.8	48.3	33.81	24.15	7,964	11,150		110	72	101	
		06/08/1992	1257	48	26.2	48	33.6	24	7,506	10,508		110	68	96	
		07/30/1993	1178	26.6	44.3	26.6	18.62	13.3	12,691	17,767		110	115	162	
		08/02/1994	1318	24.6	53.6	24.6	17.22	12.3	15,355	21,497		110	140	195	
		06/28/1995	1290	29	44.5	29	20.3	14.5	12,748	17,848		110	116	162	
		05/30/1996	1238	35.6	34.8	35.6	24.92	17.8	9,969	13,957		110	91	127	
		04/24/1997	1247	34	36.7	34	23.8	17	10,514	14,719		110	96	134	
		05/27/1998	1282	36.3	35.3	36.3	25.41	18.15	10,113	14,158		110	92	129	
		04/27/1999	1152	37.6	30.6	37.6	26.32	18.8	8,766	12,273		110	80	112	
		05/21/1999	1152	37.6	30.6	37.6	26.32	18.8	8,766	12,273		110	80	112	
		04/21/2000	1195	34	35.1	34	23.8	17	10,055	14,078		110	91	128	
NLF	C3	04/17/1984	935	42.4	22.1	42.4	29.68	21.2	6,331	8,864	60,500	110	58	81	550
		05/14/1986	870	54.7	15.9	54.7	38.29	27.35	4,555	6,377		110	41	58	
		07/12/1989	908	37.3	24.3	37.3	26.11	18.65	6,961	9,746		110	63	89	
		06/11/1990	549	25.1	21.9	25.1	17.57	12.55	6,274	8,783		110	57	80	
		05/07/1991	573	24.3	23.6	24.3	17.01	12.15	6,761	9,465		110	61	86	
		06/09/1992	814	45.5	17.9	45.5	31.85	22.75	5,128	7,179		110	47	65	
		07/31/1993	633	31.4	20.2	31.4	21.98	15.7	5,787	8,102		110	53	74	
		08/05/1994	739	19.2	38.5	19.2	13.44	9.6	11,029	15,441		110	100	140	
		07/11/1995	638	23.3	27.4	23.3	16.31	11.65	7,850	10,989		110	71	100	
		06/04/1996	553	30.9	17.9	30.9	21.63	15.45	5,128	7,179		110	47	65	
		05/07/1997	894	62.4	14.3	62.4	43.68	31.2	4,097	5,735		110	37	52	
		06/03/1998	754	64.1	11.8	64.1	44.87	32.05	3,380	4,733		110	31	43	
		05/03/1999	653	74.7	8.7	74.7	52.29	37.35	2,492	3,489		110	23	32	
		05/21/1999	653	74.7	8.7	74.7	52.29	37.35	2,492	3,489		110	23	32	
		04/21/2000	573	53.2	10.8	53.2	37.24	26.6	3,094	4,332		110	28	39	
NLF	C4	04/17/1984	1280	43.2	29.6	43.2	30.24	21.6	8,480	11,872		110	77	108	
		05/14/1986	1056	41	25.8	41	28.7	20.5	7,391	10,348		110	67	94	
		06/11/1990	1130	30	37.7	30	21	15	10,800	15,120		110	98	137	
		05/07/1991	1348	35.9	37.5	35.9	25.13	17.95	10,743	15,040		110	98	137	
		06/09/1992	1225	36.7	33.4	36.7	25.69	18.35	9,568	13,396		110	87	122	
		07/29/1993	834	21.3	39.2	21.3	14.91	10.65	11,230	15,722		110	102	143	
		08/05/1994	**1038**	**12.6**	**82.4**	**12.6**	**8.82**	**6.3**	**23,606**	**33,048**	**60,500**	**110**	**215**	**300**	**550**
		07/11/1995	1248	24.9	50.1	24.9	17.43	12.45	14,353	20,094		110	130	183	
		06/04/1996	1279	25.1	51	25.1	17.57	12.55	14,610	20,455		110	133	186	

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Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		05/07/1997	1310	27.8	47.1	27.8	19.46	13.9	13,493	18,890		110	123	172	
		06/03/1998	1279	29.4	43.5	29.4	20.58	14.7	12,462	17,447		110	113	159	
		05/03/1999	1072	32	33.5	32	22.4	16	9,597	13,436		110	87	122	
		05/21/1999	1072	32	33.5	32	22.4	16	9,597	13,436		110	87	122	
		04/21/2000	1156	30	38.5	30	21	15	11,029	15,441		110	100	140	
NLF	C5	04/09/1984	674	56.9	11.8	56.9	39.83	28.45	3,380	4,733	60,500	110	31	43	550
		05/15/1986	592	88.2	6.7	88.2	61.74	44.1	1,919	2,687		110	17	24	
		10/19/1987	587	84.3	7	84.3	59.01	42.15	2,005	2,807		110	18	26	
		07/18/1989	697	49.9	14	49.9	34.93	24.95	4,011	5,615		110	36	51	
		06/12/1990	638	68.3	9.3	68.3	47.81	34.15	2,664	3,730		110	24	34	
		05/08/1991	715	63.5	11.3	63.5	44.45	31.75	3,237	4,532		110	29	41	
		06/09/1992	722	63.9	11.3	63.9	44.73	31.95	3,237	4,532		110	29	41	
		07/30/1993	715	41.9	17.1	41.9	29.33	20.95	4,899	6,858		110	45	62	
		08/08/1994	796	13.6	58.5	13.6	9.52	6.8	16,759	23,463		110	152	213	
		07/07/1995	802	14.9	53.8	14.9	10.43	7.45	15,413	21,578		110	140	196	
		05/30/1996	945	21.6	43.8	21.6	15.12	10.8	12,548	17,567		110	114	160	
		05/06/1997	880	18.2	48.4	18.2	12.74	9.1	13,866	19,412		110	126	176	
		06/01/1998	885	21.5	41.2	21.5	15.05	10.75	11,803	16,524		110	107	150	
		04/27/1999	895	21.2	42.2	21.2	14.84	10.6	12,089	16,925		110	110	154	
		05/21/1999	895	21.2	42.2	21.2	14.84	10.6	12,089	16,925		110	110	154	
		04/21/2000	804	17.2	46.7	17.2	12.04	8.6	13,379	18,730		110	122	170	
NLF	C6	04/09/1984	153	29.9	5.1	29.9	20.93	14.95	1,461	2,045	60,500	110	13	19	550
		05/15/1986	137	34.2	4	34.2	23.94	17.1	1,146	1,604		110	10	15	
		10/19/1987	147	33.7	4.4	33.7	23.59	16.85	1,261	1,765		110	11	16	
		07/12/1989	124	31.4	3.9	31.4	21.98	15.7	1,117	1,564		110	10	14	
		06/06/1990	141	36.4	3.9	36.4	25.48	18.2	1,117	1,564		110	10	14	
		05/08/1991	133	41	3.2	41	28.7	20.5	917	1,283		110	8	12	
		12/21/1994	445	33.8	13.2	33.8	23.66	16.9	3,782	5,294		110	34	48	
		07/07/1995	459	33.2	13.8	33.2	23.24	16.6	3,953	5,535		110	36	50	
		05/28/1996	405	39.7	10.2	39.7	27.79	19.85	2,922	4,091		110	27	37	
		04/24/1997	364	44.6	8.2	44.6	31.22	22.3	2,349	3,289		110	21	30	
		05/27/1998	349	49.2	7.1	49.2	34.44	24.6	2,034	2,848		110	18	26	
		04/27/1999	305	50	6.1	50	35	25	1,748	2,447		110	16	22	
		05/21/1999	305	50	6.1	50	35	25	1,748	2,447		110	16	22	
		04/21/2000	260	50.5	5.1	50.5	35.35	25.25	1,461	2,045		110	13	19	
NLF	C7	04/10/1984	1118	44.5	25.1	44.5	31.15	22.25	7,191	10,067	60,500	110	65	92	550
		05/15/1986	1050	42.4	24.8	42.4	29.68	21.2	7,105	9,947		110	65	90	
		10/14/1987	1104	38.5	28.7	38.5	26.95	19.25	8,222	11,511		110	75	105	
		07/10/1989	434	38.3	11.3	38.3	26.81	19.15	3,237	4,532		110	29	41	
		06/11/1990	1067	32.8	32.5	32.8	22.96	16.4	9,311	13,035		110	85	118	
		05/28/1991	1082	37.6	28.8	37.6	26.32	18.8	8,251	11,551		110	75	105	
		06/08/1992	1047	47.1	22.2	47.1	32.97	23.55	6,360	8,904		110	58	81	
		07/31/1993	1054	37.9	27.8	37.9	26.53	18.95	7,964	11,150		110	72	101	
		08/01/1994	1008	39.5	25.5	39.5	27.65	19.75	7,305	10,227		110	66	93	
		06/28/1995	1082	38.1	28.4	38.1	26.67	19.05	8,136	11,390		110	74	104	
		06/03/1996	1032	43.7	23.6	43.7	30.59	21.85	6,761	9,465		110	61	86	
		05/06/1997	995	44.4	22.4	44.4	31.08	22.2	6,417	8,984		110	58	82	
		06/03/1998	919	50.9	18.1	50.9	35.63	25.45	5,185	7,259		110	47	66	
		05/03/1999	944	44.6	21.2	44.6	31.22	22.3	6,073	8,503		110	55	77	
		05/21/1999	944	44.6	21.2	44.6	31.22	22.3	6,073	8,503		110	55	77	
		04/21/2000	914	42.5	21.5	42.5	29.75	21.25	6,159	8,623		110	56	78	

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Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
NLF	C8	10/19/1950	318	76.3	4.2	76.3	53.41	38.15	1,203	1,684	60,500	110	11	15	550
		09/26/1951	365	52.5	7	52.5	36.75	26.25	2,005	2,807		110	18	26	
		10/01/1952	434	39.4	11	39.4	27.58	19.7	3,151	4,412		110	29	40	
		02/08/1955	548	56.4	9.7	56.4	39.48	28.2	2,779	3,890		110	25	35	
		10/04/1956	351	76.4	4.6	76.4	53.48	38.2	1,318	1,845		110	12	17	
		07/05/1957	260	92	2.8	92	64.4	46	802	1,123		110	7	10	
		09/12/1957	522	77	6.8	77	53.9	38.5	1,948	2,727		110	18	25	
		07/30/1958	394	49	8	49	34.3	24.5	2,292	3,209		110	21	29	
		10/31/1958	493	69.3	7.1	69.3	48.51	34.65	2,034	2,848		110	18	26	
		08/05/1959	443	76	5.8	76	53.2	38	1,662	2,326		110	15	21	
		07/06/1960	443	78.4	5.7	78.4	54.88	39.2	1,633	2,286		110	15	21	
		07/20/1961	329	72.3	4.6	72.3	50.61	36.15	1,318	1,845		110	12	17	
		05/31/1962	318	97.2	3.3	97.2	68.04	48.6	945	1,324		110	9	12	
		05/09/1963	271	104.6	2.6	104.6	73.22	52.3	745	1,043		110	7	9	
		07/14/1964	365	87.2	4.2	87.2	61.04	43.6	1,203	1,684		110	11	15	
		08/04/1965	362	88.9	4.1	88.9	62.23	44.45	1,175	1,644		110	11	15	
		11/01/1966	410	85	4.8	85	59.5	42.5	1,375	1,925		110	13	18	
		08/09/1967	377	104	3.6	104	72.8	52	1,031	1,444		110	9	13	
		08/28/1968	332	96.6	3.4	96.6	67.62	48.3	974	1,364		110	9	12	
		08/19/1969	410	75.4	5.4	75.4	52.78	37.7	1,547	2,166		110	14	20	
		07/09/1970	351	71.5	4.9	71.5	50.05	35.75	1,404	1,965		110	13	18	
		08/04/1971	572	76.4	7.5	76.4	53.48	38.2	2,149	3,008		110	20	27	
		01/12/1972	373	122.8	3	122.8	85.96	61.4	859	1,203		110	8	11	
		05/18/1972	414	110.9	3.7	110.9	77.63	55.45	1,060	1,484		110	10	13	
		07/17/1973	439	90.8	4.8	90.8	63.56	45.4	1,375	1,925		110	13	18	
		07/01/1974	419	108.8	3.9	108.8	76.16	54.4	1,117	1,564		110	10	14	
		05/03/1976	363	99.8	3.6	99.8	69.86	49.9	1,031	1,444		110	9	13	
		05/21/1984	546	59	9.3	59	41.3	29.5	2,664	3,730		110	24	34	
		07/10/1989	477	52.7	9.1	52.7	36.89	26.35	2,607	3,650		110	24	33	
		06/12/1990	488	52.2	9.3	52.2	36.54	26.1	2,664	3,730		110	24	34	
		05/06/1991	525	49.4	10.6	49.4	34.58	24.7	3,037	4,251		110	28	39	
		06/08/1992	477	48.6	9.8	48.6	34.02	24.3	2,807	3,930		110	26	36	
		07/30/1993	488	51.6	9.5	51.6	36.12	25.8	2,722	3,810		110	25	35	
		08/02/1994	520	30.4	17.1	30.4	21.28	15.2	4,899	6,858		110	45	62	
		07/11/1995	503	24.6	20.4	24.6	17.22	12.3	5,844	8,182		110	53	74	
		06/03/1996	535	29.3	18.3	29.3	20.51	14.65	5,243	7,340		110	48	67	
		05/06/1997	476	36.9	12.9	36.9	25.83	18.45	3,696	5,174		110	34	47	
		06/01/1998	478	34.5	13.9	34.5	24.15	17.25	3,982	5,575		110	36	51	
		05/03/1999	475	32.7	14.5	32.7	22.89	16.35	4,154	5,816		110	38	53	
		05/21/1999	475	32.7	14.5	32.7	22.89	16.35	4,154	5,816		110	38	53	
		04/21/2000	455	30.8	14.8	30.8	21.56	15.4	4,240	5,936		110	39	54	
NLF	E4	05/24/1984	1473	39.5	37.3	39.5	27.65	19.75	10,686	14,960	71,500	130	82	115	550
		06/02/1986	1511	41	36.9	41	28.7	20.5	10,571	14,799		130	81	114	
		10/03/1988	1897	42.9	44.2	42.9	30.03	21.45	12,662	17,727		130	97	136	
		07/18/1989	1576	35.5	44.4	35.5	24.85	17.75	12,720	17,807		130	98	137	
		06/04/1991	1225	17.5	70	17.5	12.25	8.75	20,053	28,075		130	154	216	
		07/23/1993	1944	38.2	50.9	38.2	26.74	19.1	14,582	20,414		130	112	157	
		05/22/1997	1956	37.2	52.6	37.2	26.04	18.6	15,069	21,096		130	116	162	
		05/11/1999	1868	39.7	47.1	39.7	27.79	19.85	13,493	18,890		130	104	145	
		05/21/1999	1868	39.7	47.1	39.7	27.79	19.85	13,493	18,890		130	104	145	
		04/21/2000	1691	30.5	55.4	30.5	21.35	15.25	15,871	22,219		130	122	171	

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NLF	E5	06/10/1992	1320	84	15.7	84	58.8	42	4,498	6,297		130	35	48	
		08/11/1993	1274	63.3	20.1	63.3	44.31	31.65	5,758	8,061		130	44	62	
		12/21/1994	1203	24.9	48.3	24.9	17.43	12.45	13,837	19,372		130	106	149	
		07/25/1995	1191	23.8	50	23.8	16.66	11.9	14,324	20,053		130	110	154	
		05/28/1996	824	13.6	60.6	13.6	9.52	6.8	17,361	24,305		130	134	187	
		05/12/1997	1179	15.1	78.1	15.1	10.57	7.55	22,374	31,324		130	172	241	
		06/04/1998	1022	22.7	45	22.7	15.89	11.35	12,892	18,048		130	99	139	
		06/05/1998	1022	22.7	45	22.7	15.89	11.35	12,892	18,048		130	99	139	
		08/18/2000	**705**	**5.1**	**138.2**	**5.1**	**3.57**	**2.55**	**39,591**	**55,428**	**71,500**	**130**	**305**	**426**	**550**
NLF	E7	08/11/1993	263	2.5	105.2	2.5	1.75	1.25	30,138	42,193	71,500	130	232	325	550
		08/08/1994	328	2.5	131.2	2.5	1.75	1.25	37,586	52,620		130	289	405	
		07/03/1995	325	2.4	135.4	2.4	1.68	1.2	38,789	54,305		130	298	418	
		06/05/1996	334	2.7	123.7	2.7	1.89	1.35	35,437	49,612		130	273	382	
		05/12/1997	320	2.6	123.1	2.6	1.82	1.3	35,265	49,372		130	271	380	
		05/16/1997	320	2.6	123.1	2.6	1.82	1.3	35,265	49,372		130	271	380	
NLF	E9	04/11/1984	601	75.6	7.9	75.6	52.92	37.8	2,263	3,168	63,250	130	17	24	550
		05/20/1986	578	76.2	7.6	76.2	53.34	38.1	2,177	3,048		130	17	23	
		12/11/1986	1190	57.1	20.8	57.1	39.97	28.55	5,959	8,342		130	46	64	
		10/13/1987	1069	59.9	17.8	59.9	41.93	29.95	5,099	7,139		130	39	55	
		09/28/1988	894	61.2	14.6	61.2	42.84	30.6	4,183	5,856		130	32	45	
		07/11/1989	897	60	15	60	42	30	4,297	6,016		130	33	46	
		05/29/1990	876	60.3	14.5	60.3	42.21	30.15	4,154	5,816		130	32	45	
		04/18/1991	970	60.3	16.1	60.3	42.21	30.15	4,612	6,457		130	35	50	
		06/04/1992	897	62.4	14.4	62.4	43.68	31.2	4,125	5,775		130	32	44	
		07/22/1993	1021	55.6	18.4	55.6	38.92	27.8	5,271	7,380		130	41	57	
		07/19/1994	1053	52.1	20.2	52.1	36.47	26.05	5,787	8,102		130	45	62	
		07/03/1995	1058	51.5	20.5	51.5	36.05	25.75	5,873	8,222		130	45	63	
		05/23/1996	1073	49.7	21.6	49.7	34.79	24.85	6,188	8,663		130	48	67	
		04/23/1997	1050	50.1	21	50.1	35.07	25.05	6,016	8,422		130	46	65	
		06/03/1998	1021	50.8	20.1	50.8	35.56	25.4	5,758	8,061		130	44	62	
		05/04/1999	1107	39.8	27.8	39.8	27.86	19.9	7,964	11,150		130	61	86	
		04/21/2000	1117	29.6	37.7	29.6	20.72	14.8	10,800	15,120		130	83	116	
NLF	G45	04/16/1984	1590	31.2	51	31.2	21.84	15.6	14,610	20,455	63,250	115	127	178	550
		05/27/1986	1008	20.5	49.2	20.5	14.35	10.25	14,095	19,733		115	123	172	
		07/13/1989	1379	33.7	40.9	33.7	23.59	16.85	11,717	16,404		115	102	143	
		06/14/1990	1399	32.3	43.3	32.3	22.61	16.15	12,405	17,366		115	108	151	
		05/30/1991	1456	37.8	38.5	37.8	26.46	18.9	11,029	15,441		115	96	134	
		06/10/1992	1434	36.7	39.1	36.7	25.69	18.35	11,201	15,682		115	97	136	
		07/29/1993	1172	24.9	47.1	24.9	17.43	12.45	13,493	18,890		115	117	164	
		08/08/1994	1325	29.7	44.6	29.7	20.79	14.85	12,777	17,888		115	111	156	
		07/19/1995	1140	25.6	44.5	25.6	17.92	12.8	12,748	17,848		115	111	155	
		05/23/1996	1130	25.3	44.7	25.3	17.71	12.65	12,806	17,928		115	111	156	
		05/07/1997	1162	25.9	44.9	25.9	18.13	12.95	12,863	18,008		115	112	157	
		06/04/1998	1396	41.4	33.7	41.4	28.98	20.7	9,654	13,516		115	84	118	
		05/10/1999	1030	23	44.8	23	16.1	11.5	12,834	17,968		115	112	156	
		05/21/1999	1030	23	44.8	23	16.1	11.5	12,834	17,968		115	112	156	
		04/21/2000	1257	26.9	46.7	26.9	18.83	13.45	13,379	18,730		115	116	163	
NLF	X3	04/11/1984	802	41	19.6	41	28.7	20.5	5,615	7,861	63,250	115	49	68	550
		05/20/1986	505	53.4	9.5	53.4	37.38	26.7	2,722	3,810		115	24	33	
		10/13/1987	740	40.6	18.2	40.6	28.42	20.3	5,214	7,299		115	45	63	
		09/28/1988	477	45.5	10.5	45.5	31.85	22.75	3,008	4,211		115	26	37	
		07/11/1989	572	61.4	9.3	61.4	42.98	30.7	2,664	3,730		115	23	32	

TABLE B-1

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Western Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		05/29/1990	444	47.5	9.3	47.5	33.25	23.75	2,664	3,730		115	23	32	
		04/18/1991	475	48.6	9.8	48.6	34.02	24.3	2,807	3,930		115	24	34	
		06/04/1992	587	46.1	12.7	46.1	32.27	23.05	3,638	5,094		115	32	44	
		07/22/1993	496	54	9.2	54	37.8	27	2,636	3,690		115	23	32	
		07/18/1994	465	52.2	8.9	52.2	36.54	26.1	2,550	3,570		115	22	31	
		07/03/1995	490	49.4	9.9	49.4	34.58	24.7	2,836	3,971		115	25	35	
		05/14/1996	449	53.9	8.3	53.9	37.73	26.95	2,378	3,329		115	21	29	
		04/23/1997	485	53.8	9	53.8	37.66	26.9	2,578	3,610		115	22	31	
		05/06/1998	531	47.9	11.1	47.9	33.53	23.95	3,180	4,452		115	28	39	
		05/04/1999	493	43.2	11.4	43.2	30.24	21.6	3,266	4,572		115	28	40	
		05/21/1999	493	43.2	11.4	43.2	30.24	21.6	3,266	4,572		115	28	40	
		04/21/2000	513	43.2	11.9	43.2	30.24	21.6	3,409	4,773		115	30	42	

Notes:

E = well efficiency

Kh = horizontal hydraulic conductivity

T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

TABLE B-2

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Central Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
VWC	I	**05/23/1984**	**993**	**8.7**	**114.1**	**8.7**	**6.09**	**4.35**	**32,687**	**45,762**	**22,500**	**130**	**251**	**352**	**375**
		06/09/1986	**1058**	**9.6**	**110.2**	**9.6**	**6.72**	**4.8**	**31,570**	**44,198**	**22,500**	**130**	**243**	**340**	**375**
		02/03/1992	140	73	1.9	73	51.1	36.5	544	762		130	4	6	
		07/06/1994	129	86.2	1.5	86.2	60.34	43.1	430	602		130	3	5	
		08/01/1994	129	86.2	1.5	86.2	60.34	43.1	430	602		130	3	5	
VWC	K2	**01/29/1992**	**1563**	**7.1**	**220.1**	**7.1**	**4.97**	**3.55**	**63,054**	**88,275**	**54,375**	**145**	**435**	**609**	**375**
		05/13/1994	1365	7.1	192.3	7.1	4.97	3.55	55,090	77,126		145	380	532	
		04/17/1996	1650	8.6	191.9	8.6	6.02	4.3	54,975	76,965		145	379	531	
		07/11/1997	**1333**	**6.3**	**211.6**	**6.3**	**4.41**	**3.15**	**60,619**	**84,866**	**54,375**	**145**	**418**	**585**	**375**
		12/30/1998	1409	6.7	210.3	6.7	4.69	3.35	60,246	84,345		145	415	582	
VWC	L2	04/26/1984	2197	28.3	77.6	28.3	19.81	14.15	22,231	31,123	54,375	145	153	215	375
		11/21/1991	1400	19	73.7	19	13.3	9.5	21,113	29,559		145	146	204	
		01/29/1992	1466	26.1	56.2	26.1	18.27	13.05	16,100	22,540		145	111	155	
		05/13/1994	1256	32.8	38.3	32.8	22.96	16.4	10,972	15,361		145	76	106	
		04/17/1996	1210	29.6	40.9	29.6	20.72	14.8	11,717	16,404		145	81	113	
		07/14/1997	851	17.6	48.4	17.6	12.32	8.8	13,866	19,412		145	96	134	
		12/11/1998	931	24.5	38	24.5	17.15	12.25	10,886	15,241		145	75	105	
VWC	N	08/05/1969	1891	31.6	59.8	31.6	22.12	15.8	17,131	23,984	54,375	145	118	165	375
		08/27/1970	1787	27	66.2	27	18.9	13.5	18,965	26,551		145	131	183	
		07/21/1977	1427	15.2	93.9	15.2	10.64	7.6	26,900	37,660		145	186	260	
		05/23/1978	1448	14.6	99.2	14.6	10.22	7.3	28,419	39,786		145	196	274	
		11/05/1979	1427	15.4	92.7	15.4	10.78	7.7	26,557	37,179		145	183	256	
		11/17/1980	1450	21.8	66.5	21.8	15.26	10.9	19,051	26,671		145	131	184	
		10/26/1981	1427	26	54.9	26	18.2	13	15,728	22,019		145	108	152	
		06/10/1982	1427	24.1	59.2	24.1	16.87	12.05	16,960	23,743		145	117	164	
		02/04/1985	1562	22.9	68.2	22.9	16.03	11.45	19,538	27,353		145	135	189	
		08/07/1986	1450	23	63	23	16.1	11.5	18,048	25,267		145	124	174	
		04/25/1988	1404	23.3	60.3	23.3	16.31	11.65	17,275	24,184		145	119	167	
		02/01/1990	1380	22.5	61.3	22.5	15.75	11.25	17,561	24,586		145	121	170	
		05/30/1990	1350	21	64.3	21	14.7	10.5	18,421	25,789		145	127	178	
		11/21/1991	1320	19.5	67.7	19.5	13.65	9.75	19,395	27,152		145	134	187	
		01/30/1992	1378	20.8	66.3	20.8	14.56	10.4	18,994	26,591		145	131	183	
		05/13/1994	1328	16.9	78.6	16.9	11.83	8.45	22,517	31,524		145	155	217	
		04/18/1996	1320	16.8	78.6	16.8	11.76	8.4	22,517	31,524		145	155	217	
		07/11/1997	927	10.2	90.9	10.2	7.14	5.1	26,041	36,457		145	180	251	
		12/01/1998	1086	11.5	94.4	11.5	8.05	5.75	27,044	37,861		145	187	261	
VWC	N3	**11/21/1991**	**1550**	**8**	**193.8**	**8**	**5.6**	**4**	**55,519**	**77,727**	**79,750**	**145**	**383**	**536**	**550**
		05/12/1994	1520	11.3	134.5	11.3	7.91	5.65	38,531	53,944		145	266	372	
		04/18/1996	1294	7	184.9	7	4.9	3.5	52,970	74,158		145	365	511	
		07/14/1997	1121	6.5	172.5	6.5	4.55	3.25	49,417	69,184		145	341	477	
		12/11/1998	1319	8.5	155.2	8.5	5.95	4.25	44,461	62,246		145	307	429	
VWC	N4	**11/21/1991**	**1510**	**5.5**	**274.5**	**5.5**	**3.85**	**2.75**	**78,638**	**110,094**	**54,375**	**145**	**542**	**759**	**375**
		01/28/1992	1474	6.5	226.8	6.5	4.55	3.25	64,973	90,963		145	448	627	
		05/12/1994	1303	6.3	206.8	6.3	4.41	3.15	59,244	82,941		145	409	572	
		04/17/1996	1384	5.3	261.1	5.3	3.71	2.65	74,799	104,719		145	516	722	
		07/14/1997	1171	5	234.2	5	3.5	2.5	67,093	93,930		145	463	648	
		12/11/1998	1249	4.6	271.5	4.6	3.22	2.3	77,779	108,890		145	536	751	

TABLE B-2

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Central Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
VWC	Q2	02/17/1955	2343	24.2	96.8	24.2	16.94	12.1	27,731	38,824		145	191	268	
		03/09/1955	2310	23.5	98.3	23.5	16.45	11.75	28,161	39,425		145	194	272	
		10/21/1955	2103	21.5	97.8	21.5	15.05	10.75	28,018	39,225		145	193	271	
		08/01/1957	1589	28.9	55	28.9	20.23	14.45	15,756	22,059		145	109	152	
		11/18/1958	1696	26.3	64.5	26.3	18.41	13.15	18,478	25,869		145	127	178	
		07/26/1960	1073	17.9	59.9	17.9	12.53	8.95	17,160	24,024		145	118	166	
		06/27/1962	1349	34.6	39	34.6	24.22	17.3	11,173	15,642		145	77	108	
		06/19/1963	1920	25.5	75.3	25.5	17.85	12.75	21,572	30,201		145	149	208	
		09/21/1964	1611	24.3	66.3	24.3	17.01	12.15	18,994	26,591		145	131	183	
		09/17/1965	1414	17.7	79.9	17.7	12.39	8.85	22,890	32,045		145	158	221	
		07/26/1967	1806	16	112.9	16	11.2	8	32,343	45,281		145	223	312	
		10/05/1970	1711	15.6	109.7	15.6	10.92	7.8	31,427	43,997		145	217	303	
		08/16/1971	1880	17.2	109.3	17.2	12.04	8.6	31,312	43,837		145	216	302	
		07/03/1974	2022	25.9	78.1	25.9	18.13	12.95	22,374	31,324		145	154	216	
		10/21/1975	1552	37.9	40.9	37.9	26.53	18.95	11,717	16,404		145	81	113	
		08/03/1976	1688	19.7	85.7	19.7	13.79	9.85	24,551	34,372		145	169	237	
		06/14/1977	1688	19.7	85.7	19.7	13.79	9.85	24,551	34,372		145	169	237	
		05/24/1978	1626	20.5	79.3	20.5	14.35	10.25	22,718	31,805		145	157	219	
		12/03/1979	1542	29.4	52.4	29.4	20.58	14.7	15,011	21,016		145	104	145	
		11/13/1980	1752	33.2	52.8	33.2	23.24	16.6	15,126	21,176		145	104	146	
		06/09/1982	1898	43.5	43.6	43.5	30.45	21.75	12,490	17,487		145	86	121	
		02/25/1985	1960	54.8	35.8	54.8	38.36	27.4	10,256	14,358		145	71	99	
		08/07/1986	1804	72.4	24.9	72.4	50.68	36.2	7,133	9,987		145	49	69	
		04/28/1988	**2297**	**18.4**	**124.8**	**18.4**	**12.88**	**9.2**	**35,752**	**50,053**	**79,750**	**145**	**247**	**345**	**550**
		02/01/1990	1965	19.5	100.8	19.5	13.65	9.75	28,877	40,428		145	199	279	
		05/29/1990	1890	18	105	18	12.6	9	30,080	42,112		145	207	290	
		03/19/1992	1874	19	98.6	19	13.3	9.5	28,247	39,545		145	195	273	
		05/24/1994	1637	15.3	107	15.3	10.71	7.65	30,653	42,914		145	211	296	
		04/05/1996	1466	15.9	92.2	15.9	11.13	7.95	26,413	36,979		145	182	255	
		07/23/1997	1206	14	86.1	14	9.8	7	24,666	34,532		145	170	238	
		12/17/1998	1225	19.1	64.1	19.1	13.37	9.55	18,363	25,709		145	127	177	
NLF	R2	07/23/1941	1730	29.5	58.6	29.5	20.65	14.75	16,788	23,503		90	187	261	
		06/21/1945	1520	8	190	8	5.6	4	54,431	76,203		90	605	847	
		12/18/1946	1352	6	225.3	6	4.2	3	64,544	90,361		90	717	1,004	
		10/29/1947	**1680**	**6.4**	**262.5**	**6.4**	**4.48**	**3.2**	**75,201**	**105,281**	**22,050**	**90**	**836**	**1,170**	**245**
		06/20/1949	**1672**	**9**	**185.8**	**9**	**6.3**	**4.5**	**53,228**	**74,519**	**22,050**	**90**	**591**	**828**	**245**
		05/23/1950	1152	45.5	25.3	45.5	31.85	22.75	7,248	10,147		90	81	113	
		10/16/1950	672	8.1	83	8.1	5.67	4.05	23,778	33,289		90	264	370	
		01/19/1951	1310	6	218.3	6	4.2	3	62,538	87,553		90	695	973	
		09/28/1951	328	4	82	4	2.8	2	23,491	32,888		90	261	365	
		06/06/1952	1200	11	109.1	11	7.7	5.5	31,255	43,757		90	347	486	
		01/15/1955	1010	19.5	51.8	19.5	13.65	9.75	14,840	20,775		90	165	231	
		03/03/1955	1119	19.1	58.6	19.1	13.37	9.55	16,788	23,503		90	187	261	
		10/18/1955	620	38.7	16	38.7	27.09	19.35	4,584	6,417		90	51	71	
		09/19/1956	588	22.4	26.3	22.4	15.68	11.2	7,534	10,548		90	84	117	
		08/01/1957	429	8.3	51.7	8.3	5.81	4.15	14,811	20,735		90	165	230	
		09/24/1957	600	28	21.4	28	19.6	14	6,131	8,583		90	68	95	
		08/18/1959	660	34.7	19	34.7	24.29	17.35	5,443	7,620		90	60	85	
		08/18/1960	538	32.4	16.6	32.4	22.68	16.2	4,756	6,658		90	53	74	
		09/11/1961	362	7.6	47.6	7.6	5.32	3.8	13,636	19,091		90	152	212	

TABLE B-2

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Central Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		06/13/1962	660	11.6	56.9	11.6	8.12	5.8	16,301	22,821		90	181	254	
		05/06/1963	880	14.6	60.3	14.6	10.22	7.3	17,275	24,184		90	192	269	
		09/21/1964	725	16.4	44.2	16.4	11.48	8.2	12,662	17,727		90	141	197	
		08/05/1965	491	12.1	40.6	12.1	8.47	6.05	11,631	16,283		90	129	181	
		10/12/1967	523	10.2	51.3	10.2	7.14	5.1	14,696	20,575		90	163	229	
		08/07/1968	588	8.5	69.2	8.5	5.95	4.25	19,824	27,754		90	220	308	
		08/16/1971	545	2.1	259.5	2.1	1.47	1.05	74,341	104,078		90	826	1,156	
		06/21/1972	548	1.9	288.4	1.9	1.33	0.95	82,620	115,668		90	918	1,285	
		10/20/1975	460	1.8	255.6	1.8	1.26	0.9	73,224	102,513		90	814	1,139	
		04/07/1977	714	3.4	210	3.4	2.38	1.7	60,160	84,225		90	668	936	
		09/30/1980	708	2.7	262.2	2.7	1.89	1.35	75,115	105,160		90	835	1,168	
NLF	S	08/25/1937	1220	15	81.3	15	10.5	7.5	23,291	32,607		145	161	225	
		08/01/1938	1113	10.9	102.1	10.9	7.63	5.45	29,249	40,949		145	202	282	
		08/03/1938	1195	12	99.6	12	8.4	6	28,533	39,947		145	197	275	
		07/17/1940	1052	11.3	93.1	11.3	7.91	5.65	26,671	37,340		145	184	258	
		09/25/1940	1173	13	90.2	13	9.1	6.5	25,840	36,176		145	178	249	
		07/23/1941	1278	12	106.5	12	8.4	6	30,510	42,714		145	210	295	
		06/28/1945	1183	14.5	81.6	14.5	10.15	7.25	23,377	32,727		145	161	226	
		07/01/1946	1135	23.5	48.3	23.5	16.45	11.75	13,837	19,372		145	95	134	
		12/18/1946	**1028**	**5**	**205.6**	**5**	**3.5**	**2.5**	**58,900**	**82,460**	**54,375**	**145**	**406**	**569**	**375**
		10/17/1947	1400	22.5	62.2	22.5	15.75	11.25	17,819	24,947		145	123	172	
		09/15/1948	1350	26	51.9	26	18.2	13	14,868	20,816		145	103	144	
		06/17/1949	1415	24	59	24	16.8	12	16,902	23,663		145	117	163	
		05/24/1950	1385	25	55.4	25	17.5	12.5	15,871	22,219		145	109	153	
		10/03/1950	1120	29.5	38	29.5	20.65	14.75	10,886	15,241		145	75	105	
		07/17/1952	1146	24.5	46.8	24.5	17.15	12.25	13,407	18,770		145	92	129	
		07/07/1953	913	13.5	67.6	13.5	9.45	6.75	19,366	27,112		145	134	187	
		05/14/1954	1320	24	55	24	16.8	12	15,756	22,059		145	109	152	
		02/23/1955	1101	20.8	52.9	20.8	14.56	10.4	15,155	21,217		145	105	146	
		03/07/1955	1293	21	61.6	21	14.7	10.5	17,647	24,706		145	122	170	
		11/14/1955	457	7.6	60.1	7.6	5.32	3.8	17,217	24,104		145	119	166	
		07/03/1958	1330	12	110.8	12	8.4	6	31,742	44,439		145	219	306	
		10/15/1958	726	7.5	96.8	7.5	5.25	3.75	27,731	38,824		145	191	268	
		07/23/1959	731	8.1	90.2	8.1	5.67	4.05	25,840	36,176		145	178	249	
		07/26/1960	695	7.8	89.1	7.8	5.46	3.9	25,525	35,735		145	176	246	
		08/17/1961	669	6.8	98.4	6.8	4.76	3.4	28,189	39,465		145	194	272	
		05/29/1962	721	6.2	116.3	6.2	4.34	3.1	33,317	46,644		145	230	322	
		04/22/1963	726	6.4	113.4	6.4	4.48	3.2	32,487	45,481		145	224	314	
		08/19/1964	658	6.4	102.8	6.4	4.48	3.2	29,450	41,230		145	203	284	
		08/18/1965	674	6.2	108.7	6.2	4.34	3.1	31,140	43,596		145	215	301	
		10/12/1967	638	5.6	113.9	5.6	3.92	2.8	32,630	45,682		145	225	315	
		08/06/1968	716	6.2	115.5	6.2	4.34	3.1	33,088	46,324		145	228	319	
		09/10/1968	721	6.4	112.7	6.4	4.48	3.2	32,286	45,201		145	223	312	
		08/06/1969	783	6.8	115.1	6.8	4.76	3.4	32,974	46,163		145	227	318	
		08/24/1970	1047	8.8	119	8.8	6.16	4.4	34,091	47,727		145	235	329	
		08/19/1971	1021	8.6	118.7	8.6	6.02	4.3	34,005	47,607		145	235	328	
		06/21/1972	1139	10.8	105.5	10.8	7.56	5.4	30,223	42,313		145	208	292	
		08/14/1973	**1169**	**9**	**129.9**	**9**	**6.3**	**4.5**	**37,214**	**52,099**	**54,375**	**145**	**257**	**359**	**375**
		01/14/1975	1082	9	120.2	9	6.3	4.5	34,435	48,209		145	237	332	
		05/13/1976	1115	44.2	25.2	44.2	30.94	22.1	7,219	10,107		145	50	70	

TABLE B-2

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Central Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		04/07/1977	1011	9.4	107.6	9.4	6.58	4.7	30,825	43,155		145	213	298	
		08/15/1978	1035	45.5	22.7	45.5	31.85	22.75	6,503	9,104		145	45	63	
		09/24/1981	937	11.4	82.2	11.4	7.98	5.7	23,549	32,968		145	162	227	
		08/19/1982	1078	9.5	113.5	9.5	6.65	4.75	32,515	45,521		145	224	314	
NLF	S2	09/20/1940	2630	26	101.2	26	18.2	13	28,992	40,588	54,375	145	200	280	375
		07/24/1941	3055	32.2	94.9	32.2	22.54	16.1	27,187	38,061		145	187	262	
		06/12/1945	2775	50.4	55.1	50.4	35.28	25.2	15,785	22,099		145	109	152	
		07/24/1946	2630	28	93.9	28	19.6	14	26,900	37,660		145	186	260	
		12/17/1946	2380	49.8	47.8	49.8	34.86	24.9	13,694	19,171		145	94	132	
		03/31/1947	2940	40	73.5	40	28	20	21,056	29,479		145	145	203	
		10/18/1947	2630	48	54.8	48	33.6	24	15,699	21,979		145	108	152	
		09/15/1948	2130	54	39.4	54	37.8	27	11,287	15,802		145	78	109	
		06/17/1949	2090	46	45.4	46	32.2	23	13,006	18,209		145	90	126	
		05/24/1950	1970	41	48	41	28.7	20.5	13,751	19,251		145	95	133	
		10/03/1950	1420	45.3	31.3	45.3	31.71	22.65	8,967	12,553		145	62	87	
		01/19/1951	2130	50	42.6	50	35	25	12,204	17,086		145	84	118	
		05/15/1954	2040	32.5	62.8	32.5	22.75	16.25	17,991	25,187		145	124	174	
		02/16/1955	1466	28.3	51.8	28.3	19.81	14.15	14,840	20,775		145	102	143	
		03/07/1955	1692	27.3	62	27.3	19.11	13.65	17,762	24,866		145	122	171	
		11/04/1955	1201	31	38.7	31	21.7	15.5	11,087	15,521		145	76	107	
		12/30/1955	1950	20	97.5	20	14	10	27,932	39,104		145	193	270	
		09/27/1956	1448	43.5	33.3	43.5	30.45	21.75	9,540	13,356		145	66	92	
		08/02/1957	1337	35.9	37.2	35.9	25.13	17.95	10,657	14,920		145	73	103	
		10/09/1957	1605	43	37.3	43	30.1	21.5	10,686	14,960		145	74	103	
		07/03/1958	1800	44	40.9	44	30.8	22	11,717	16,404		145	81	113	
		10/10/1958	1485	39.4	37.7	39.4	27.58	19.7	10,800	15,120		145	74	104	
		07/23/1959	1305	39.6	33	39.6	27.72	19.8	9,454	13,235		145	65	91	
		07/19/1960	1120	31	36.1	31	21.7	15.5	10,342	14,479		145	71	100	
		08/17/1961	1178	27	43.6	27	18.9	13.5	12,490	17,487		145	86	121	
		06/14/1962	1225	30.9	39.6	30.9	21.63	15.45	11,345	15,882		145	78	110	
		04/22/1963	1406	30	46.9	30	21	15	13,436	18,810		145	93	130	
		07/28/1964	1016	29	35	29	20.3	14.5	10,027	14,037		145	69	97	
		08/18/1965	1142	24.8	46	24.8	17.36	12.4	13,178	18,449		145	91	127	
		01/09/1967	1748	26	67.2	26	18.2	13	19,251	26,952		145	133	186	
		10/12/1967	1634	26	62.8	26	18.2	13	17,991	25,187		145	124	174	
		08/05/1968	1455	24.8	58.7	24.8	17.36	12.4	16,816	23,543		145	116	162	
		08/06/1969	1490	30.6	48.7	30.6	21.42	15.3	13,951	19,532		145	96	135	
		08/24/1970	2194	29.8	73.6	29.8	20.86	14.9	21,085	29,519		145	145	204	
		08/19/1971	2308	32.2	71.7	32.2	22.54	16.1	20,540	28,757		145	142	198	
		07/26/1972	2206	30.6	72.1	30.6	21.42	15.3	20,655	28,917		145	142	199	
		08/14/1973	1783	18	99.1	18	12.6	9	28,390	39,746		145	196	274	
		01/15/1975	2251	52.2	43.1	52.2	36.54	26.1	12,347	17,286		145	85	119	
		05/13/1976	1554	47.6	32.6	47.6	33.32	23.8	9,339	13,075		145	64	90	
		04/06/1977	2001	22	91	22	15.4	11	26,070	36,497		145	180	252	
		06/21/1978	2613	48	54.4	48	33.6	24	15,584	21,818		145	107	150	
		09/24/1981	1824	21.8	83.7	21.8	15.26	10.9	23,978	33,570		145	165	232	
		07/27/1982	1790	21.9	81.7	21.9	15.33	10.95	23,405	32,767		145	161	226	
		05/30/1984	1813	22.2	81.7	22.2	15.54	11.1	23,405	32,767		145	161	226	

TABLE B-2

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Central Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
NLF	S3	04/11/1951	939	57	16.5	57	39.9	28.5	4,727	6,618		145	33	46	
		07/07/1953	766	72.3	10.6	72.3	50.61	36.15	3,037	4,251		145	21	29	
		07/23/1954	844	57	14.8	57	39.9	28.5	4,240	5,936		145	29	41	
		03/03/1955	928	45.5	20.4	45.5	31.85	22.75	5,844	8,182		145	40	56	
		03/07/1955	871	45	19.4	45	31.5	22.5	5,558	7,781		145	38	54	
		11/04/1955	736	53.5	13.8	53.5	37.45	26.75	3,953	5,535		145	27	38	
		08/03/1956	700	60.5	11.6	60.5	42.35	30.25	3,323	4,652		145	23	32	
		07/24/1957	674	57.5	11.7	57.5	40.25	28.75	3,352	4,693		145	23	32	
		10/02/1957	594	82	7.2	82	57.4	41	2,063	2,888		145	14	20	
		08/16/1961	576	58.1	9.9	58.1	40.67	29.05	2,836	3,971		145	20	27	
		06/14/1962	695	50.8	13.7	50.8	35.56	25.4	3,925	5,495		145	27	38	
		06/06/1963	786	31.2	25.2	31.2	21.84	15.6	7,219	10,107		145	50	70	
		08/19/1964	716	36.5	19.6	36.5	25.55	18.25	5,615	7,861		145	39	54	
		08/18/1965	720	35.2	20.5	35.2	24.64	17.6	5,873	8,222		145	41	57	
		09/11/1968	**945**	**7.3**	**129.5**	**7.3**	**5.11**	**3.65**	**37,099**	**51,939**	**79,750**	**145**	**256**	**358**	**550**
		08/06/1969	1033	8.4	123	8.4	5.88	4.2	35,237	49,332		145	243	340	
		08/24/1970	1047	8.8	119	8.8	6.16	4.4	34,091	47,727		145	235	329	
		08/19/1971	1040	8.4	123.8	8.4	5.88	4.2	35,466	49,652		145	245	342	
		06/12/1972	1042	8.8	118.4	8.8	6.16	4.4	33,919	47,487		145	234	327	
		08/14/1973	1045	8.8	118.8	8.8	6.16	4.4	34,034	47,647		145	235	329	
		01/14/1975	**1016**	**7.9**	**128.6**	**7.9**	**5.53**	**3.95**	**36,841**	**51,578**	**79,750**	**145**	**254**	**356**	**550**
		04/14/1977	1007	8.6	117.1	8.6	6.02	4.3	33,547	46,965		145	231	324	
		06/21/1978	587	6.1	96.2	6.1	4.27	3.05	27,559	38,583		145	190	266	
		09/24/1981	632	6.8	92.9	6.8	4.76	3.4	26,614	37,259		145	184	257	
		07/26/1982	649	6	108.2	6	4.2	3	30,997	43,396		145	214	299	
		05/29/1984	649	6.9	94.1	6.9	4.83	3.45	26,958	37,741		145	186	260	
		05/22/1986	639	8	79.9	8	5.6	4	22,890	32,045		145	158	221	
		06/14/1990	433	5	86.6	5	3.5	2.5	24,809	34,733		145	171	240	
		06/04/1991	520	6.1	85.2	6.1	4.27	3.05	24,408	34,171		145	168	236	

Notes:

Kh = horizontal hydraulic conductivity

T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

TABLE B-3

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Lower Soledad Canyon, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
SCWC	Stadium	07/20/1965	812	8.3	97.8	8.3	5.81	4.15	28,018	39,225		90	311	436	
		06/06/1972	531	1.6	331.9	1.6	1.12	0.8	95,082	133,115		90	1,056	1,479	
		03/19/1974	**1046**	**2.8**	**373.6**	**2.8**	**1.96**	**1.4**	**107,028**	**149,840**	**63,250**	**90**	**1,189**	**1,665**	**550**
		04/10/1975	**965**	**2.8**	**344.6**	**2.8**	**1.96**	**1.4**	**98,720**	**138,209**	**63,250**	**90**	**1,097**	**1,536**	**550**
		04/12/1976	901	3.4	265	3.4	2.38	1.7	75,917	106,283		90	844	1,181	
		07/11/1977	836	4	209	4	2.8	2	59,874	83,824		90	665	931	
		05/10/1978	942	3.9	241.5	3.9	2.73	1.95	69,184	96,858		90	769	1,076	
		04/01/1979	930	3.1	300	3.1	2.17	1.55	85,943	120,321		90	955	1,337	
		09/01/1979	**937**	**3.1**	**302.3**	**3.1**	**2.17**	**1.55**	**86,602**	**121,243**	**63,250**	**90**	**962**	**1,347**	**550**
		09/22/1998	945	3.6	262.5	3.6	2.52	1.8	75,201	105,281		90	836	1,170	
VWC	U4	07/27/1967	1383	13.1	105.6	13.1	9.17	6.55	30,252	42,353		115	263	368	
		08/07/1968	1686	12.4	136	12.4	8.68	6.2	38,961	54,545		115	339	474	
		08/18/1969	**2621**	**10.2**	**257**	**10.2**	**7.14**	**5.1**	**73,625**	**103,075**	**63,250**	**115**	**640**	**896**	**550**
		08/13/1973	**2679**	**8**	**334.9**	**8**	**5.6**	**4**	**95,942**	**134,318**	**63,250**	**115**	**834**	**1,168**	**550**
		10/31/1979	1021	3.8	268.7	3.8	2.66	1.9	76,977	107,767		115	669	937	
		11/10/1980	1123	4.1	273.9	4.1	2.87	2.05	78,466	109,853		115	682	955	
		06/08/1982	1144	4.4	260	4.4	3.08	2.2	74,484	104,278		115	648	907	
		01/29/1985	962	3.8	253.2	3.8	2.66	1.9	72,536	101,551		115	631	883	
		08/18/1986	941	3.9	241.3	3.9	2.73	1.95	69,127	96,778		115	601	842	
		04/21/1988	1080	4.2	257.1	4.2	2.94	2.1	73,654	103,115		115	640	897	
		02/01/1990	1073	3.5	306.6	3.5	2.45	1.75	87,834	122,968		115	764	1,069	
		05/29/1990	1073	3.5	306.6	3.5	2.45	1.75	87,834	122,968		115	764	1,069	
		01/23/1992	978	4.5	217.3	4.5	3.15	2.25	62,252	87,152		115	541	758	
		06/14/1994	1057	4.2	251.7	4.2	2.94	2.1	72,107	100,949		115	627	878	
		04/04/1996	958	3.5	273.7	3.5	2.45	1.75	78,409	109,773		115	682	955	
		07/17/1997	919	3.3	278.5	3.3	2.31	1.65	79,784	111,698		115	694	971	
		12/29/1998	**1198**	**5.3**	**226**	**5.3**	**3.71**	**2.65**	**64,744**	**90,642**		**115**	**563**	**788**	
VWC	U3	07/27/1967	1389	9	154.3	9	6.3	4.5	44,204	61,885		115	384	538	
		08/07/1968	784	9	87.1	9	6.3	4.5	24,952	34,933		115	217	304	
		08/15/1973	**1997**	**4.7**	**424.9**	**4.7**	**3.29**	**2.35**	**121,725**	**170,414**	**63,250**	**115**	**1,058**	**1,482**	**550**
		10/21/1975	1087	3	362.3	3	2.1	1.5	103,791	145,307		115	903	1,264	
		08/02/1976	997	2.9	343.8	2.9	2.03	1.45	98,491	137,888		115	856	1,199	
		06/13/1977	907	4.1	221.2	4.1	2.87	2.05	63,369	88,717		115	551	771	
		05/31/1978	1074	4.3	249.8	4.3	3.01	2.15	71,562	100,187		115	622	871	
		10/31/1979	939	3.5	268.3	3.5	2.45	1.75	76,862	107,607		115	668	936	
		11/10/1980	898	3.4	264.1	3.4	2.38	1.7	75,659	105,922		115	658	921	
		06/08/1982	1181	4	295.3	4	2.8	2	84,597	118,436		115	736	1,030	
		01/28/1985	**1276**	**4**	**319**	**4**	**2.8**	**2**	**91,387**	**127,941**	**63,250**	**115**	**795**	**1,113**	**550**
		08/18/1986	961	3.2	300.3	3.2	2.24	1.6	86,029	120,441		115	748	1,047	
		04/21/1988	**1249**	**3.6**	**346.9**	**3.6**	**2.52**	**1.8**	**99,379**	**139,131**	**63,250**	**115**	**864**	**1,210**	**550**
		02/01/1990	**1253**	**3**	**417.7**	**3**	**2.1**	**1.5**	**119,662**	**167,527**	**63,250**	**115**	**1,041**	**1,457**	**550**
		05/29/1990	1162	3	387.3	3	2.1	1.5	110,953	155,334		115	965	1,351	
		01/24/1992	1078	5.2	207.3	5.2	3.64	2.6	59,387	83,142		115	516	723	
		07/18/1994	1217	3.9	312.1	3.9	2.73	1.95	89,410	125,174		115	777	1,088	
		04/04/1996	979	2.9	337.6	2.9	2.03	1.45	96,715	135,401		115	841	1,177	
		07/17/1997	861	2.6	331.2	2.6	1.82	1.3	94,882	132,834		115	825	1,155	
		01/18/1999	**1224**	**3.6**	**340**	**3.6**	**2.52**	**1.8**	**97,403**	**136,364**	**63,250**	**115**	**847**	**1,186**	**550**
SCWC	Honby	07/23/1965	613	26.4	23.2	26.4	18.48	13.2	6,646	9,305		90	74	103	
		06/02/1972	712	4	178	4	2.8	2	50,993	71,390		90	567	793	
		06/05/1972	781	14.4	54.2	14.4	10.08	7.2	15,527	21,738		90	173	242	
		04/02/1974	684	14.6	46.8	14.6	10.22	7.3	13,407	18,770		90	149	209	
		04/16/1975	654	14.2	46.1	14.2	9.94	7.1	13,207	18,489		90	147	205	

TABLE B-3

Specific Capacity Data from Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Lower Soledad Canyon, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		04/13/1976	623	3.5	178	3.5	2.45	1.75	50,993	71,390		90	567	793	
		05/03/1976	674	13.8	48.8	13.8	9.66	6.9	13,980	19,572		90	155	217	
		07/28/1977	801	16.5	48.5	16.5	11.55	8.25	13,894	19,452		90	154	216	
		08/25/1977	702	7.2	97.5	7.2	5.04	3.6	27,932	39,104		90	310	434	
		05/11/1978	**970**	**8.2**	**118.3**	**8.2**	**5.74**	**4.1**	**33,890**	**47,447**	**49,500**	**90**	**377**	**527**	**550**
		05/25/1978	835	18.4	45.4	18.4	12.88	9.2	13,006	18,209		90	145	202	
		04/01/1979	1065	13.7	77.7	13.7	9.59	6.85	22,259	31,163		90	247	346	
		09/01/1979	**1080**	**8.9**	**121.3**	**8.9**	**6.23**	**4.45**	**34,750**	**48,650**	**49,500**	**90**	**386**	**541**	**550**
		08/19/1980	**1178**	**12**	**98.2**	**12**	**8.4**	**6**	**28,132**	**39,385**	**49,500**	**90**	**313**	**438**	**550**
		08/22/1980	914	29.6	30.9	29.6	20.72	14.8	8,852	12,393		90	98	138	
		11/18/1981	919	48	19.1	48	33.6	24	5,472	7,660		90	61	85	
		12/01/1981	1277	13.4	95.3	13.4	9.38	6.7	27,301	38,222		90	303	425	
		03/14/1983	868	35	24.8	35	24.5	17.5	7,105	9,947		90	79	111	
		08/24/1983	1287	16.7	77.1	16.7	11.69	8.35	22,087	30,922		90	245	344	
		07/24/1984	832	48.1	17.3	48.1	33.67	24.05	4,956	6,939		90	55	77	
		08/02/1984	1232	14.5	85	14.5	10.15	7.25	24,351	34,091		90	271	379	
		10/22/1985	756	46.2	16.4	46.2	32.34	23.1	4,698	6,578		90	52	73	
		10/24/1985	1217	15.1	80.6	15.1	10.57	7.55	23,090	32,326		90	257	359	
		09/22/1998	904	10.2	88.6	10.2	7.14	5.1	25,382	35,535		90	282	395	

Notes:

Kh = horizontal hydraulic conductivity

T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

TABLE B-4

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Upper Soledad Canyon, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
SCWC	N. Oaks West	06/05/1972	1245	17.8	69.9	17.8	12.46	8.9	20,025	28,035		90	222	311	
		08/05/1972	1527	18.6	82.1	18.6	13.02	9.3	23,520	32,928		90	261	366	
		03/20/1974	1578	17.8	88.7	17.8	12.46	8.9	25,411	35,575		90	282	395	
		04/07/1975	1407	12.6	111.7	12.6	8.82	6.3	32,000	44,799		90	356	498	
		04/15/1976	1232	10.6	116.2	10.6	7.42	5.3	33,289	46,604		90	370	518	
		08/24/1977	578	7.2	80.3	7.2	5.04	3.6	23,004	32,206		90	256	358	
		06/07/1978	1392	12	116	12	8.4	6	33,231	46,524		90	369	517	
		04/01/1979	1298	10.8	120.2	10.8	7.56	5.4	34,435	48,209		90	383	536	
		09/01/1979	1185	9.7	122.2	9.7	6.79	4.85	35,008	49,011		90	389	545	
		08/02/1980	1317	11.4	115.5	11.4	7.98	5.7	33,088	46,324		90	368	515	
		12/01/1981	1598	13.4	119.3	13.4	9.38	6.7	34,177	47,848		90	380	532	
		03/07/1983	**1598**	**12.5**	**127.8**	**12.5**	**8.75**	**6.25**	**36,612**	**51,257**	**49,500**	**90**	**407**	**570**	**550**
		07/31/1984	**1558**	**12**	**129.8**	**12**	**8.4**	**6**	**37,185**	**52,059**	**49,500**	**90**	**413**	**578**	**550**
		10/23/1985	**1538**	**11.4**	**134.9**	**11.4**	**7.98**	**5.7**	**38,646**	**54,104**	**49,500**	**90**	**429**	**601**	**550**
		09/17/1998	1405	11.7	120.1	11.7	8.19	5.85	34,406	48,168		90	382	535	
SCWC	N. Oaks Central	03/26/1974	989	3.8	260.3	3.8	2.66	1.9	74,570	104,398		90	829	1,160	
		04/07/1975	823	3	274.3	3	2.1	1.5	78,581	110,013		90	873	1,222	
		04/13/1976	861	3.3	260.9	3.3	2.31	1.65	74,742	104,639		90	830	1,163	
		07/14/1977	759	4.5	168.7	4.5	3.15	2.25	48,329	67,660		90	537	752	
		05/18/1978	1023	3.6	284.2	3.6	2.52	1.8	81,417	113,984		90	905	1,266	
		04/01/1979	953	3.7	257.6	3.7	2.59	1.85	73,797	103,316		90	820	1,148	
		09/01/1979	930	1.3	715.4	1.3	0.91	0.65	204,947	286,925		90	2,277	3,188	
		08/27/1980	1021	3.5	291.7	3.5	2.45	1.75	83,566	116,992		90	929	1,300	
		11/19/1981	1078	3.8	283.7	3.8	2.66	1.9	81,274	113,783		90	903	1,264	
		03/07/1983	1139	3.4	335	3.4	2.38	1.7	95,970	134,358		90	1,066	1,493	
		07/26/1984	1164	3.5	332.6	3.5	2.45	1.75	95,283	133,396		90	1,059	1,482	
		10/23/1985	1087	3	362.3	3	2.1	1.5	103,791	145,307		90	1,153	1,615	
		09/17/1998	**1450**	**4.8**	**302.1**	**4.8**	**3.36**	**2.4**	**86,545**	**121,163**	**49,500**	**90**	**962**	**1,346**	**550**
SCWC	N. Oaks East	11/27/1963	1099	8.9	123.5	8.9	6.23	4.45	35,380	49,532		90	393	550	
		08/24/1965	707	42.1	16.8	42.1	29.47	21.05	4,813	6,738		90	53	75	
		06/02/1972	1169	8.5	137.5	8.5	5.95	4.25	39,391	55,147		90	438	613	
		03/20/1974	1016	6.5	156.3	6.5	4.55	3.25	44,777	62,687		90	498	697	
		04/15/1975	842	4.8	175.4	4.8	3.36	2.4	50,248	70,348		90	558	782	
		04/13/1976	873	5.3	164.7	5.3	3.71	2.65	47,183	66,056		90	524	734	
		07/14/1977	699	6.3	111	6.3	4.41	3.15	31,799	44,519		90	353	495	
		06/07/1978	750	4.4	170.5	4.4	3.08	2.2	48,845	68,382		90	543	760	
		04/01/1979	578	3.1	186.5	3.1	2.17	1.55	53,428	74,799		90	594	831	
		09/01/1979	510	2.2	231.8	2.2	1.54	1.1	66,406	92,968		90	738	1,033	
		08/25/1980	531	3.2	165.9	3.2	2.24	1.6	47,527	66,537		90	528	739	
		11/19/1981	1312	10.6	123.8	10.6	7.42	5.3	35,466	49,652		90	394	552	
		03/23/1983	**1312**	**7.6**	**172.6**	**7.6**	**5.32**	**3.8**	**49,446**	**69,225**	**49,500**	**90**	**549**	**769**	**550**
		07/30/1984	1261	8	157.6	8	5.6	4	45,149	63,209		90	502	702	
		11/18/1985	1143	7.3	156.6	7.3	5.11	3.65	44,862	62,807		90	498	698	
		09/17/1998	1091	18.4	59.3	18.4	12.88	9.2	16,988	23,783		90	189	264	

TABLE B-4

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer in Upper Soledad Canyon, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft^2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
SCWC	Sierra	**03/20/1974**	**1679**	**5.7**	**294.6**	**5.7**	**3.99**	**2.85**	**84,396**	**118,155**	**49,500**	**90**	**938**	**1,313**	**550**
		04/08/1975	1425	5.3	268.9	5.3	3.71	2.65	77,034	107,848		90	856	1,198	
		04/14/1976	1418	5.8	244.5	5.8	4.06	2.9	70,044	98,061		90	778	1,090	
		07/12/1977	1291	8.9	145.1	8.9	6.23	4.45	41,568	58,195		90	462	647	
		05/16/1978	**1574**	**5.4**	**291.5**	**5.4**	**3.78**	**2.7**	**83,508**	**116,912**	**49,500**	**90**	**928**	**1,299**	**550**
		04/01/1979	1538	4.9	313.9	4.9	3.43	2.45	89,926	125,896		90	999	1,399	
		09/01/1979	1507	5.5	274	5.5	3.85	2.75	78,495	109,893		90	872	1,221	
		08/25/1980	1558	4.6	338.7	4.6	3.22	2.3	97,030	135,842		90	1,078	1,509	
		11/30/1981	1448	4.2	344.8	4.2	2.94	2.1	98,778	138,289		90	1,098	1,537	
		03/15/1983	**1950**	**5.5**	**354.5**	**5.5**	**3.85**	**2.75**	**101,557**	**142,179**	**49,500**	**90**	**1,128**	**1,580**	**550**
		07/26/1984	1860	16.8	110.7	16.8	11.76	8.4	31,713	44,398		90	352	493	
		10/29/1985	**1840**	**6.4**	**287.5**	**6.4**	**4.48**	**3.2**	**82,362**	**115,307**	**49,500**	**90**	**915**	**1,281**	**550**
		09/16/1998	851	3.3	257.9	3.3	2.31	1.65	73,883	103,436		90	821	1,149	
SCWC	Mitchell	07/19/1965	536	11.4	47	11.4	7.98	5.7	13,464	18,850		90	150	209	
		08/07/1972	1250	6.5	192.3	6.5	4.55	3.25	55,090	77,126		90	612	857	
		03/26/1974	627	2.8	223.9	2.8	1.96	1.4	64,142	89,799		90	713	998	
		04/08/1975	529	2.6	203.5	2.6	1.82	1.3	58,298	81,618		90	648	907	
		08/25/1977	**709**	**5**	**141.8**	**5**	**3.5**	**2.5**	**40,623**	**56,872**	**49,500**	**90**	**451**	**632**	**550**
		07/25/1978	613	7.7	79.6	7.7	5.39	3.85	22,804	31,925		90	253	355	
		04/01/1979	653	8.7	75.1	8.7	6.09	4.35	21,515	30,120		90	239	335	
		09/01/1979	660	9	73.3	9	6.3	4.5	20,999	29,398		90	233	327	
		08/25/1980	602	9.8	61.4	9.8	6.86	4.9	17,590	24,626		90	195	274	
		11/23/1981	664	11	60.4	11	7.7	5.5	17,303	24,225		90	192	269	
		05/23/1983	674	12.3	54.8	12.3	8.61	6.15	15,699	21,979		90	174	244	
		08/02/1984	689	25.8	26.7	25.8	18.06	12.9	7,649	10,709		90	85	119	
		10/24/1985	694	39	17.8	39	27.3	19.5	5,099	7,139		90	57	79	
		09/22/1998	593	14.3	41.5	14.3	10.01	7.15	11,889	16,644		90	132	185	
SCWC	Lost Canyon 2	04/01/1979	743	17.3	42.9	17.3	12.11	8.65	12,290	17,206	36,000	90	137	191	400
		09/01/1979	885	28	31.6	28	19.6	14	9,053	12,674		90	101	141	
		09/16/1998	799	22.1	36.2	22.1	15.47	11.05	10,371	14,519		90	115	161	
SCWC	Lost Canyon 2A	10/29/1997	834	12.4	67.3	12.4	8.68	6.2	19,280	26,992	36,000	90	214	300	400
SCWC	Sand Canyon	07/02/1975	648	2.7	240	2.7	1.89	1.35	68,755	96,257		90	764	1,070	
		04/01/1979	540	2.5	216	2.5	1.75	1.25	61,879	86,631		90	688	963	
		09/01/1979	**825**	**2.6**	**317.3**	**2.6**	**1.82**	**1.3**	**90,900**	**127,259**	**36,000**	**90**	**1,010**	**1,414**	**400**
		08/22/1980	709	3.2	221.6	3.2	2.24	1.6	63,484	88,877		90	705	988	
		11/18/1981	684	3.4	201.2	3.4	2.38	1.7	57,639	80,695		90	640	897	
		05/23/1983	714	3.2	223.1	3.2	2.24	1.6	63,913	89,479		90	710	994	
		07/24/1984	**774**	**4.2**	**184.3**	**4.2**	**2.94**	**2.1**	**52,798**	**73,917**	**36,000**	**90**	**587**	**821**	**400**
		10/22/1985	658	3.3	199.4	3.3	2.31	1.65	57,124	79,973		90	635	889	
		09/16/1998	**1147**	**9.3**	**123.3**	**9.3**	**6.51**	**4.65**	**35,323**	**49,452**	**36,000**	**90**	**392**	**549**	**400**
NCWD	Pinetree1	04/02/1999	297	13.7	21.7	13.7	9.59	6.85	6,217	8,703	31,500	90	69	97	350
NCWD	Pinetree3	**04/02/1999**	**554**	**4.7**	**117.9**	**4.7**	**3.29**	**2.35**	**33,776**	**47,286**	**31,500**	**90**	**375**	**525**	**350**
NCWD	Pinetree4	**04/02/1999**	**497**	**4.8**	**103.5**	**4.8**	**3.36**	**2.4**	**29,650**	**41,511**	**31,500**	**90**	**329**	**461**	**350**

Notes:

Kh = horizontal hydraulic conductivity

T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

TABLE B-5

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer Along Castaic Creek, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
VWC	D	05/29/1984	503	6	83.8	6	4.2	3	24,007	33,610		100	240	336	
		04/27/1988	**1171**	**10.1**	**115.9**	**10.1**	**7.07**	**5.05**	**33,203**	**46,484**	**35,000**	**100**	**332**	**465**	**350**
		05/29/1990	990	9.5	104.2	9.5	6.65	4.75	29,851	41,791		100	299	418	
		07/06/1994	**1119**	**9.6**	**116.6**	**9.6**	**6.72**	**4.8**	**33,403**	**46,765**	**35,000**	**100**	**334**	**468**	**350**
		04/29/1996	1105	9.8	112.8	9.8	6.86	4.9	32,315	45,241		100	323	452	
		09/15/1997	1135	9.7	117	9.7	6.79	4.85	33,518	46,925		100	335	469	
		11/03/1998	**1086**	**9.6**	**113.1**	**9.6**	**6.72**	**4.8**	**32,401**	**45,361**	**35,000**	**100**	**324**	**454**	**350**
		11/13/1998	1086	9.6	113.1	9.6	6.72	4.8	32,401	45,361		100	324	454	
NLF	E	**04/10/1984**	**1726**	**7.8**	**221.3**	**7.8**	**5.46**	**3.9**	**63,398**	**88,757**	**35,000**	**100**	**634**	**888**	**350**
		05/21/1986	1613	7.1	227.2	7.1	4.97	3.55	65,088	91,123		100	651	911	
		10/14/1987	1151	15.6	73.8	15.6	10.92	7.8	21,142	29,599		100	211	296	
		10/05/1988	766	11	69.6	11	7.7	5.5	19,939	27,914		100	199	279	
		07/11/1989	877	8.2	107	8.2	5.74	4.1	30,653	42,914		100	307	429	
		05/30/1990	1291	13.9	92.9	13.9	9.73	6.95	26,614	37,259		100	266	373	
		04/17/1991	1187	15.8	75.1	15.8	11.06	7.9	21,515	30,120		100	215	301	
		06/03/1992	**1732**	**7.9**	**219.2**	**7.9**	**5.53**	**3.95**	**62,796**	**87,914**	**35,000**	**100**	**628**	**879**	**350**
		07/20/1993	1613	7.4	218	7.4	5.18	3.7	62,452	87,433		100	625	874	
		07/20/1994	1603	7.6	210.9	7.6	5.32	3.8	60,418	84,586		100	604	846	
		07/12/1995	1644	7.4	222.2	7.4	5.18	3.7	63,655	89,118		100	637	891	
		05/14/1996	1613	7.9	204.2	7.9	5.53	3.95	58,499	81,898		100	585	819	
		04/23/1997	1583	9.9	159.9	9.9	6.93	4.95	45,808	64,131		100	458	641	
		05/06/1998	1501	6.8	220.7	6.8	4.76	3.4	63,226	88,516		100	632	885	
		05/04/1999	1501	6.9	217.5	6.9	4.83	3.45	62,309	87,233		100	623	872	
		05/21/1999	1501	6.9	217.5	6.9	4.83	3.45	62,309	87,233		100	623	872	
		04/21/2000	1378	11.4	120.9	11.4	7.98	5.7	34,635	48,489		100	346	485	
NLF	E2	07/29/1938	1921	20.7	92.8	20.7	14.49	10.35	26,585	37,219		100	266	372	
		08/05/1938	1625	18.5	87.8	18.5	12.95	9.25	25,153	35,214		100	252	352	
		08/11/1938	1630	18.2	89.6	18.2	12.74	9.1	25,668	35,936		100	257	359	
		07/25/1939	1530	15.7	97.5	15.7	10.99	7.85	27,932	39,104		100	279	391	
		08/01/1939	1846	19.1	96.6	19.1	13.37	9.55	27,674	38,743		100	277	387	
		06/13/1941	1905	13.2	144.3	13.2	9.24	6.6	41,339	57,874		100	413	579	
		07/16/1945	**1635**	**9.9**	**165.2**	**9.9**	**6.93**	**4.95**	**47,326**	**66,257**	**35,000**	**100**	**473**	**663**	**350**
		12/18/1946	**1819**	**10**	**181.9**	**10**	**7**	**5**	**52,110**	**72,955**	**35,000**	**100**	**521**	**730**	**350**
		10/28/1947	1760	16.2	108.6	16.2	11.34	8.1	31,112	43,556		100	311	436	
		06/23/1949	1225	12.5	98	12.5	8.75	6.25	28,075	39,305		100	281	393	
		06/07/1950	1070	11	97.3	11	7.7	5.5	27,874	39,024		100	279	390	
		04/11/1951	1095	37.7	29	37.7	26.39	18.85	8,308	11,631		100	83	116	
		08/07/1953	1103	22.4	49.2	22.4	15.68	11.2	14,095	19,733		100	141	197	
		02/10/1955	1481	14.9	99.4	14.9	10.43	7.45	28,476	39,866		100	285	399	
		08/12/1955	1103	22.4	49.2	22.4	15.68	11.2	14,095	19,733		100	141	197	
		09/20/1956	998	28.2	35.4	28.2	19.74	14.1	10,141	14,198		100	101	142	
		07/16/1957	938	29.2	32.1	29.2	20.44	14.6	9,196	12,874		100	92	129	
		10/09/1957	828	11	75.3	11	7.7	5.5	21,572	30,201		100	216	302	
		07/25/1958	1582	12.5	126.6	12.5	8.75	6.25	36,268	50,775		100	363	508	
		10/24/1958	1532	16.6	92.3	16.6	11.62	8.3	26,442	37,019		100	264	370	
		09/03/1959	1329	24.8	53.6	24.8	17.36	12.4	15,355	21,497		100	154	215	
		07/29/1960	1084	39.2	27.7	39.2	27.44	19.6	7,935	11,110		100	79	111	
		08/03/1961	888	20.2	44	20.2	14.14	10.1	12,605	17,647		100	126	176	
		07/17/1962	1503	18.5	81.2	18.5	12.95	9.25	23,262	32,567		100	233	326	
		05/07/1963	1487	16.2	91.8	16.2	11.34	8.1	26,299	36,818		100	263	368	

TABLE B-5

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer Along Castaic Creek, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
		07/16/1964	759	47.8	15.9	47.8	33.46	23.9	4,555	6,377		100	46	64	
		08/05/1965	652	34.2	19.1	34.2	23.94	17.1	5,472	7,660		100	55	77	
		11/01/1966	536	60.1	8.9	60.1	42.07	30.05	2,550	3,570		100	25	36	
		08/10/1967	842	9.6	87.7	9.6	6.72	4.8	25,124	35,174		100	251	352	
		09/26/1968	1161	62.5	18.6	62.5	43.75	31.25	5,328	7,460		100	53	75	
		06/23/1972	1345	12.8	105.1	12.8	8.96	6.4	30,109	42,152		100	301	422	
		07/08/1974	1287	17.3	74.4	17.3	12.11	8.65	21,314	29,840		100	213	298	
		05/06/1976	1065	25.5	41.8	25.5	17.85	12.75	11,975	16,765		100	120	168	
		03/14/1977	1056	43.7	24.2	43.7	30.59	21.85	6,933	9,706		100	69	97	
		08/10/1978	725	4.8	151	4.8	3.36	2.4	43,258	60,561		100	433	606	
		12/21/1989	1086	34.6	31.4	34.6	24.22	17.3	8,995	12,594		100	90	126	
		05/30/1990	1205	36.1	33.4	36.1	25.27	18.05	9,568	13,396		100	96	134	
		04/17/1991	1056	48.5	21.8	48.5	33.95	24.25	6,245	8,743		100	62	87	
		06/03/1992	1235	22.9	53.9	22.9	16.03	11.45	15,441	21,618		100	154	216	
		07/20/1993	**1312**	**8.3**	**158.1**	**8.3**	**5.81**	**4.15**	**45,292**	**63,409**	**35,000**	**100**	**453**	**634**	**350**
		07/21/1994	**1305**	**6.3**	**207.1**	**6.3**	**4.41**	**3.15**	**59,330**	**83,061**	**35,000**	**100**	**593**	**831**	**350**
		07/12/1995	**1395**	**6.2**	**225**	**6.2**	**4.34**	**3.1**	**64,458**	**90,241**	**35,000**	**100**	**645**	**902**	**350**
		06/05/1996	**1473**	**5.8**	**254**	**5.8**	**4.06**	**2.9**	**72,765**	**101,872**	**35,000**	**100**	**728**	**1,019**	**350**
		04/23/1997	1087	6.4	169.8	6.4	4.48	3.2	48,644	68,102		100	486	681	
		06/26/1998	1055	8.3	127.1	8.3	5.81	4.15	36,411	50,976		100	364	510	
		05/04/1999	1079	6.6	163.5	6.6	4.62	3.3	46,839	65,575		100	468	656	
		05/21/1999	1079	6.6	163.5	6.6	4.62	3.3	46,839	65,575		100	468	656	
		04/21/2000	1052	6.7	157	6.7	4.69	3.35	44,977	62,968		100	450	630	
WHR	8	04/10/1969	849	5.8	146.4	5.8	4.06	2.9	41,940	58,717	35,000	100	419	587	350
WHR	16	10/06/1955	1205	8.3	145.2	8.3	5.81	4.15	41,597	58,235		100	416	582	
		11/13/1957	1052	7.6	138.4	7.6	5.32	3.8	39,649	55,508		100	396	555	
		05/28/1959	810	6.3	128.6	6.3	4.41	3.15	36,841	51,578		100	368	516	
		06/19/1959	**1436**	**9.9**	**145.1**	**9.9**	**6.93**	**4.95**	**41,568**	**58,195**	**35,000**	**100**	**416**	**582**	**350**
		06/26/1962	**1150**	**7**	**164.3**	**7**	**4.9**	**3.5**	**47,068**	**65,896**	**35,000**	**100**	**471**	**659**	**350**
		12/04/1963	1073	6.9	155.5	6.9	4.83	3.45	44,547	62,366		100	445	624	
WHR	11	11/10/1954	1401	10.9	128.5	10.9	7.63	5.45	36,812	51,537		100	368	515	
		10/06/1955	**1444**	**10.4**	**138.8**	**10.4**	**7.28**	**5.2**	**39,763**	**55,668**	**35,000**	**100**	**398**	**557**	**350**
		03/07/1962	1125	8.5	132.4	8.5	5.95	4.25	37,930	53,102		100	379	531	
		10/31/1962	1288	10.6	121.5	10.6	7.42	5.3	34,807	48,730		100	348	487	
		12/04/1963	1172	8.2	142.9	8.2	5.74	4.1	40,938	57,313		100	409	573	
WHR	18	01/27/1959	1244	9	138.2	9	6.3	4.5	39,591	55,428		100	396	554	
		05/28/1959	**1369**	**9.3**	**147.2**	**9.3**	**6.51**	**4.65**	**42,170**	**59,037**	**35,000**	**100**	**422**	**590**	**350**
		06/26/1962	1262	8	157.8	8	5.6	4	45,206	63,289		100	452	633	
		12/04/1963	940	6	156.7	6	4.2	3	44,891	62,848		100	449	628	
WHR	17	**10/06/1955**	**576**	**3.2**	**180**	**3.2**	**2.24**	**1.6**	**51,566**	**72,193**	**35,000**	**100**	**516**	**722**	**350**
		03/06/1962	539	3.3	163.3	3.3	2.31	1.65	46,782	65,495		100	468	655	
		10/31/1962	536	3.2	167.5	3.2	2.24	1.6	47,985	67,179		100	480	672	
		12/04/1963	**595**	**3.3**	**180.3**	**3.3**	**2.31**	**1.65**	**51,652**	**72,313**	**35,000**	**100**	**517**	**723**	**350**
WHR	10	10/06/1955	442	18.5	23.9	18.5	12.95	9.25	6,847	9,586	35,000	100	68	96	350
		03/06/1962	452	11.1	40.7	11.1	7.77	5.55	11,660	16,324		100	117	163	
		10/31/1962	480	15	32	15	10.5	7.5	9,167	12,834		100	92	128	
		12/03/1963	508	23.6	21.5	23.6	16.52	11.8	6,159	8,623		100	62	86	
		11/13/1964	467	27.1	17.2	27.1	18.97	13.55	4,927	6,898		100	49	69	

TABLE B-5

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer Along Castaic Creek, Santa Clarita Valley

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
WHR	15	10/06/1955	815	3.6	226.4	3.6	2.52	1.8	64,859	90,802		100	649	908	
		11/13/1957	1231	6.6	186.5	6.6	4.62	3.3	53,428	74,799		100	534	748	
		06/18/1958	1353	6.8	199	6.8	4.76	3.4	57,009	79,813		100	570	798	
		05/28/1959	**1655**	**9.6**	**172.4**	**9.6**	**6.72**	**4.8**	**49,389**	**69,144**	**35,000**	**100**	**494**	**691**	**350**
		06/18/1959	1353	6.8	199	6.8	4.76	3.4	57,009	79,813		100	570	798	
		06/26/1962	1260	6	210	6	4.2	3	60,160	84,225		100	602	842	
		12/05/1963	1180	7.6	155.3	7.6	5.32	3.8	44,490	62,286		100	445	623	
WHR	5	03/06/1962	684	9.7	70.5	9.7	6.79	4.85	20,197	28,275	35,000	100	202	283	350
		12/03/1963	693	8.8	78.8	8.8	6.16	4.4	22,574	31,604		100	226	316	
NCWD	Castaic1	03/31/1986	580	51.6	11.2	51.6	36.12	25.8	3,209	4,492	25,200	100	32	45	315
		04/23/1999	644	55.2	11.7	55.2	38.64	27.6	3,352	4,693		100	34	47	
NCWD	Castaic4	04/23/1999	271	87.6	3.1	87.6	61.32	43.8	888	1,243	25,200	100	9	12	315
NCWD	Castaic3	04/23/1999	470	41.3	11.4	41.3	28.91	20.65	3,266	4,572	25,200	100	33	46	315
NCWD	Castaic2	04/01/1986	428	37.9	11.3	37.9	26.53	18.95	3,237	4,532	25,200	100	32	45	315

Notes:

Kh = horizontal hydraulic conductivity

T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

TABLE B-6

Specific Capacity Data From Edison Tests, and Transmissivity and Hydraulic Calculations: Alluvial Aquifer In Tributary Canyons, Santa Clarita Valley, CA

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Owner	Well Name	Test Date	Pumping Rate (gpm)	Measured Drawdown (ft)	Specific Capacity (gpm/ft)	Formation Drawdown (ft) (E=100%)	Formation Drawdown (ft) (E=70%)	Formation Drawdown (ft) (E=50%)	T (ft^2/day) (E=70%)	T (ft^2/day) (E=50%)	Modeled T (ft2/day)	Typical Saturated Thickness (ft)	Kh (ft/day) (E=70%)	Kh (ft/day) (E=50%)	Modeled Kh (ft/day)
NLF	W4	02/05/1992	592	9.4	63	9.4	6.58	4.7	18,048	25,267		100	180	253	
		08/12/1994	**957**	**10.8**	**88.6**	**10.8**	**7.56**	**5.4**	**25,382**	**35,535**	**10,500**	**100**	**254**	**355**	**105**
VWC	W6	11/22/1991	720	36	20	36	25.2	18	5,730	8,021		100	57	80	
		01/27/1992	636	40.5	15.7	40.5	28.35	20.25	4,498	6,297		100	45	63	
		05/11/1994	504	75	6.7	75	52.5	37.5	1,919	2,687		100	19	27	
		04/23/1996	531	71.3	7.4	71.3	49.91	35.65	2,120	2,968		100	21	30	
		07/15/1997	539	69.5	7.8	69.5	48.65	34.75	2,235	3,128		100	22	31	
		12/28/1998	468	83.2	5.6	83.2	58.24	41.6	1,604	2,246		100	16	22	
VWC	W9	04/23/1996	946	10.1	93.7	10.1	7.07	5.05	26,843	37,580		100	268	376	
		07/15/1997	958	10.5	91.2	10.5	7.35	5.25	26,127	36,578		100	261	366	
		12/28/1998	**990**	**10.2**	**97.1**	**10.2**	**7.14**	**5.1**	**27,817**	**38,944**	**10,500**	**100**	**278**	**389**	**105**
SCWC	Guida	**03/18/1974**	**1016**	**6.4**	**158.8**	**6.4**	**4.48**	**3.2**	**45,493**	**63,690**	**12,600**	**90**	**505**	**708**	**140**
		04/17/1975	990	6.2	159.7	6.2	4.34	3.1	45,751	64,051		90	508	712	
		04/19/1976	940	5.6	167.9	5.6	3.92	2.8	48,100	67,340		90	534	748	
		07/06/1977	890.7	5.2	171.3	5.2	3.64	2.6	49,074	68,703		90	545	763	
		05/09/1978	915	5.5	166.4	5.5	3.85	2.75	47,670	66,738		90	530	742	
		04/01/1979	990	6.5	152.3	6.5	4.55	3.25	43,631	61,083		90	485	679	
		09/01/1979	990	3.6	275	3.6	2.52	1.8	78,782	110,294		90	875	1,225	
		08/20/1980	1000	7	142.9	7	4.9	3.5	40,938	57,313		90	455	637	
		11/24/1981	1009	7.2	140.1	7.2	5.04	3.6	40,136	56,190		90	446	624	
		03/15/1983	1024	6.9	148.4	6.9	4.83	3.45	42,513	59,519		90	472	661	
		07/25/1984	**1014**	**6.4**	**158.4**	**6.4**	**4.48**	**3.2**	**45,378**	**63,529**	**12,600**	**90**	**504**	**706**	**140**
		10/28/1985	1044	7.8	133.8	7.8	5.46	3.9	38,331	53,663		90	426	596	
		09/23/1998	1066	9.4	113.4	9.4	6.58	4.7	32,487	45,481		90	361	505	
SCWC	Clark	**06/06/1972**	**814**	**4**	**203.5**	**4**	**2.8**	**2**	**58,298**	**81,618**	**22,050**	**90**	**648**	**907**	**245**
		03/18/1974	587	3.8	154.5	3.8	2.66	1.9	44,261	61,965		90	492	689	
		05/27/1975	541	3.7	146.2	3.7	2.59	1.85	41,883	58,636		90	465	652	
		04/12/1976	490	3.3	148.5	3.3	2.31	1.65	42,542	59,559		90	473	662	
		07/06/1977	500.3	3	166.8	3	2.1	1.5	47,785	66,898		90	531	743	
		05/08/1978	488	3.1	157.4	3.1	2.17	1.55	45,092	63,128		90	501	701	
		04/01/1979	600	3	200	3	2.1	1.5	57,296	80,214		90	637	891	
		09/01/1979	600	2.6	230.8	2.6	1.82	1.3	66,119	92,567		90	735	1,029	
		08/20/1980	573	2.9	197.6	2.9	2.03	1.45	56,608	79,251		90	629	881	
		11/24/1981	602	2.7	223	2.7	1.89	1.35	63,885	89,439		90	710	994	
		03/08/1983	608	2.6	233.8	2.6	1.82	1.3	66,979	93,770		90	744	1,042	
		07/25/1984	608	2.3	264.3	2.3	1.61	1.15	75,716	106,003		90	841	1,178	
		09/23/1998	677	4.4	153.9	4.4	3.08	2.2	44,089	61,725		90	490	686	

Notes:

Kh = horizontal hydraulic conductivity

T = transmissivity

Bold font indicates tests that are least affected by well efficiency issues and therefore provide the best estimate of aquifer parameter values at the given well location.

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APPENDIX C

Surface Water Routing Model

A Surface Water Routing Model (SWRM) was developed to support groundwater flow modeling efforts in the Santa Clarita Valley of Southern California. The SWRM was developed as a pre- and post-processor for the Santa Clarita Valley Groundwater Model (hereafter called the Regional Model), which was constructed by the Upper Basin Water Purveyors. The Regional Model will be briefly described in this appendix; however, the reader should refer to the main body of this report for a more detailed description of the Regional Model.

C.1 Introduction

The Regional Model simulates monthly groundwater conditions from 1980 through 1999 over a 120 square mile (mi^2) area within a portion of the Santa Clara River Valley East Groundwater Subbasin. This subbasin lies within the Upper Santa Clara River Hydrologic Area, which is a watershed of approximately 460 mi^2 that lies in northwest Los Angeles County and a small portion of eastern Ventura County (Figure C-1).

The outer limits of the Regional Model correspond to the outer limits of the Santa Clarita Valley's groundwater systems, which consist of the Alluvial Aquifer and the Saugus Formation. These aquifers lie in the south-central portion of the hydrologic area, and the watershed extends upstream beyond the outer limits of the groundwater systems. Geologic formations located within the watershed, but outside of the Regional Model area, consist of bedrock and do not transmit significant quantities of groundwater flow due to their low permeability. However, an understanding of the availability of surface water runoff and infiltration within and upstream of the Regional Model area is critical to accurately simulate the water budget through time within the Regional Model area. Therefore, a surface water routing tool was developed to estimate, on a monthly basis, the location, magnitude, and timing of surface water infiltration to groundwater within the Regional Model boundary.

The SWRM was written in the Visual Basic Editor within Microsoft® Excel 97. The remainder of this appendix is organized as follows:

a. A list of the sources of recharge that are evaluated by the SWRM

b. The design of the SWRM

c. Detailed discussions of the calculations of magnitudes of each surface water source and its associated infiltration rate to groundwater

C.2 Sources of Recharge

The sources of recharge to the groundwater system in the Santa Clarita Valley are:

a. Infiltration of applied water for urban and industrial outdoor uses and for irrigating golf courses. Sources of urban and golf course irrigation water are groundwater pumping from the Alluvial Aquifer and the Saugus Formation, and import of water from the State Water Project (SWP).

b. Infiltration of water that is used for agricultural irrigation within the Regional Model area. This source of water consists exclusively of groundwater pumping from the Alluvial Aquifer.

c. Infiltration of direct precipitation within the Regional Model area, which is derived from precipitation data.

d. Infiltration of stormwater and anthropogenic streamflows. These sources include the following:

    1. Surface water runoff and infiltration from portions of the Upper Santa Clara River Hydrologic Area located outside of the Regional Model boundary

    2. Santa Clara River flows that enter the valley from the east

    3. Water released from Castaic Lagoon into Castaic Creek by the California Department of Water Resources

    4. Treated water discharged into the Santa Clara River from two Los Angeles County Sanitation District (LACSD) water reclamation plants (WRP)

C.3 SWRM Design

At every node in the grid that forms the Regional Model domain, the SWRM estimates groundwater recharge terms using the following three basic steps:

1. Calculate the monthly volume of surface water from each water source within and upstream of the Regional Model area.

2. Calculate the monthly volume of water in a stream that leaks through the streambed and collects on the water table, based on an assigned streambed leakage rate at each Regional Model stream node.

3. Calculate the monthly volume of water in a stream that does not infiltrate because of gaining stream conditions (i.e., rejected stream leakage). Rejected stream leakage remains as surface water as it passes the mouth of the stream and flows into the next stream system. For the Santa Clara River, rejected stream leakage eventually exits the Regional Model area at the west end of the valley, at the County Line stream gage.

Flow volumes in streams and rates of infiltration to groundwater from all water sources vary both geographically and over time based on sets of rules programmed into the SWRM. One of the most significant rules in the SWRM is that the infiltration rates to groundwater are not allowed to exceed the total amount of water generated by all surface water sources

in a given month. The magnitude of each potential source of groundwater recharge is based on local hydrologic measurements that have been recorded over time.

Following are discussions of the data and methods that were used to estimate the source water volumes and the amount of infiltration from each of these sources.

C.4 Infiltration of Applied Water (Urban Use, Excluding Golf Courses)

A significant portion of water that is used outdoors goes to plant uptake and direct evaporation, and a smaller portion infiltrates to the underlying aquifer system. The magnitude of infiltration was estimated using recent water use and land use data (Figure C-2) for developed areas within the Santa Clarita Valley.

The average annual water demand provided by the Upper Basin Water Purveyors was approximately 49,000 acre-feet per year (AF/yr) from 1994 through 1998. On a long-term basis, outdoor water use in urbanized areas is approximately 66 percent of the total annual water demand, as indicated by records of total water demands and WRP flows (see Table C-1). Within urbanized areas that are industrial and retail land uses, the outdoor water use is estimated to be approximately 30 percent of the total water use. For all urbanized areas excluding golf courses, it was assumed that 10 percent of the applied water in areas of urban development could potentially recharge groundwater. This assumption means that a total of 90 percent of the applied water goes to evapotranspiration (ET) demands, surface runoff, and return flow to surface water.

Aerial photographs of the valley taken in 1999 were used to identify land uses in developed areas, and a geographic information system (GIS) was used to determine the acreage of each land use type. Table C-2 summarizes the derivation of estimated values of infiltration for urban irrigation water from land use and water use data. The table shows the average annual water use volumes, the land use acreage, and the calculated depths of annual infiltration to groundwater. As shown in the table, infiltration of urban irrigation water is estimated to be approximately 1 inch per year (in/yr) for retail and industrial land uses, and 2.2 in/yr for suburban residential land use and recreational land use (parks). These values were used as direct specified input to the SWRM and were not varied during calibration of the Regional Model.

An attempt was made to vary over time, the locations at which urban applied water was specified in the Regional Model. However, electronic records of historical land use data were unavailable. Consequently, to ensure that the total infiltration volume in urbanized areas reflected the increase in development and water use that occurred throughout the 1980s and 1990s, this infiltration was applied to the 1999 urbanized area, but at rates that were adjusted upward or downward in a given year according to the difference between water uses in that year and in 1999. Tables C-3 and C-4 show the actual rates that were applied to the 1999 urbanized area to account for the gradual increase in water use from 1980 through 1999.

C.5 Infiltration of Applied Water (Golf Course Irrigation)

From 1994 through 1998, the average annual water use for golf course irrigation was approximately 500 AF/yr. The majority of this water use was for irrigation and was specified in the SWRM as 100 percent of the total water use for the golf course.

The amount of return flow to groundwater resulting from golf course irrigation was estimated to be 30 percent of applied water, which is three times higher than the assumed rate for other urbanized areas. This estimate was based on information suggesting that golf courses irrigate beyond the water demand requirements of grassy areas to maintain the quality of the greens. As shown in Table C-2, this resulted in an estimated annual average infiltration rate of 4.6 in/yr. As with urban irrigation, the golf course irrigation was increased gradually from 1980 through 1999 to account for the increased population growth and urban water use in the urbanized Santa Clarita Valley (see Table C-5).

C.6 Infiltration of Applied Water (Agricultural)

Aerial photographs of the valley taken in 1999 indicate that approximately 877 acres are currently irrigated for agricultural uses in the model study area. Approximately 90 percent of these irrigated lands are underlain by the Alluvial Aquifer, while the remaining 10 percent lie on the terrace deposits or in areas where the Saugus Formation is exposed at the ground surface. The total area of irrigated agriculture has diminished substantially since the 1960s as a result of development in the area.

Agricultural land in the Santa Clarita Valley is used primarily to grow row crops. A review was performed of detailed records of agricultural pumping, crop types, the acreage of each crop type, and the water use requirements for each crop type (as listed in the California Irrigation Management Information System). This review was performed for the period 1996 through 2000 to estimate the amount of applied irrigation water that infiltrates to groundwater beneath irrigated agricultural lands. Figure C-3 shows the analysis, which compares crop water use requirements with applied water volumes and identifies the difference as being equal to the infiltration volume to groundwater. For the period 1996 through 2000, Figure C-3 shows the following:

a. The average applied water volume was 7,038 AF/yr

b. The average amount of water that was not consumptively used (and which therefore infiltrated to groundwater) was 2,583 AF/yr, which is approximately 37 percent of the applied water volume

c. The equivalent average infiltration rate over the 877-acre area was 2.9 AF/acre/yr (which is equivalent to 2.9 ft/yr)

The infiltration rate of 2.9 ft/yr corresponds to the 7,038 AF/yr average water use during 1996 through 2000. A higher infiltration rate would be expected during years of higher water use and lower rate during years of reduced water use. Table C-6 shows the corresponding infiltration rates for each year, based on the water use each year. The 500-foot spacing of the Regional Model grid resulted in slight over-estimation of the acreage within

the model (1,205 acres) compared with the actual irrigated acreage (877 acres). This adjustment is also shown in Table C-6.

C.7 Infiltration of Direct Precipitation

As water falls onto the land surface or onto a body of water, it follows the three following natural pathways:

1. **Evapotranspiration.** This is the process by which water passes from a liquid to a vapor state via direct evaporation and through transpiration by plants (crops, urban landscaping, and native vegetation).
2. **Surface water runoff.** This represents water occurring as overland flow or water flowing in a stream.
3. **Infiltration.** This is the process by which water moves from the land surface downward through the upper soil layers. The process of infiltration increases the soil moisture content. If the soil moisture content reaches its field capacity, then any additional infiltration that takes place displaces water in the vadose zone and collects on the water table as groundwater recharge (deep percolation of precipitation). For the sake of clarity, references to infiltration in the rest of Appendix C will be synonymous with deep percolation of precipitation.

To estimate the infiltration rate, an understanding of the spatial pattern of precipitation must first be developed. To estimate the total volume of precipitation that falls onto the watershed, one would ideally like to have long-term precipitation data from several active rain gages located on a fairly consistent spacing throughout the watershed. However, due to the expense and maintenance required to operate a rain gage, such an extensive network of rain gages within a single watershed is typically not available for an extended period in most watersheds, as is the case for the Santa Clarita Valley.

C.7.1 Precipitation Data

The SWRM used precipitation data from the rain gage at the Newhall County Water District (NCWD) office, which is located south of Newhall Creek, approximately 1.3 miles south of the Newhall-Soledad rain gage (Figure C-4). Table C-7 lists the monthly precipitation at the NCWD gage from 1980 through 1999.

Because data from a single rain gage is not ideal for estimating the total volume of precipitation that falls within the entire watershed area, an isohyet map of California was also used. Figure C-4 shows contours of long-term average annual rainfall (isohyets) based on data compiled by the U.S. Geological Survey (USGS), the California Department of Water Resources, the California Geologic Survey (formerly the California Division of Mines and Geology), and where available, county and/or other local agencies. The source maps that were used to create the isohyet map are based primarily on U.S. Weather Service data from approximately 800 precipitation stations statewide. The U.S. Weather Service data were supplemented with county and local agency precipitation data in the Los Angeles area. The precipitation data were collected by these agencies over a sixty-year period from 1900 to

1960. Further information on the source of the isohyet data is available at the California Spatial Information Library.[1]

Because these isohyet data represent long-term hydrologic conditions from 1900 to 1960, a methodology was developed to estimate monthly precipitation throughout the Upper Santa Clara River Hydrologic Area using the NCWD gage data and the isohyets. For each month during the 1980 through 1999 Regional Model calibration period, this was done both within the Regional Model area and in the portions of the watershed lying outside the Regional Model area. The long-term average annual precipitation distribution shown in Figure C-4 was electronically draped over the nodes that comprise the Regional Model grid using the ESRI® ArcMap™/ArcInfo™ 8.3 GIS software. The annual precipitation rates at the NCWD rain gage from 1980 through 1999 were computed and compared with the value presented on the 1900 to 1960 isohyet map at that same location. The percent difference between the annual precipitation value and the isohyet value was computed for the NCWD rain gage location and applied to all isohyet values assigned to the Regional Model nodes, to estimate the average spatial distribution of precipitation for that particular calendar year. For example, the 1900-1960 isohyet value at the NCWD rain gage was 20.50 inches, but the 1980 annual precipitation data indicate 31.95 inches fell that year. Therefore, the adjustment factor for the isohyet values at all Regional Model nodes for 1980 was 31.95 divided by 20.50 or 1.559. This adjustment factor was then multiplied by the isohyet values at all Regional Model node locations to estimate the spatial distribution of annual precipitation during 1980.

The derivation of infiltration rates from direct precipitation within the Regional Model boundary is described in Section C.7.2. The derivation of streamflow rates from precipitation occurring outside the regional model boundary is discussed in Section C.8.1.

C.7.2 Infiltration Within the Regional Model Area

Because the Regional Model is a groundwater flow model, it does not directly input precipitation data. Instead, the monthly component of infiltration is estimated by the SWRM and used as input for the Regional Model. The infiltration rate is computed by the SWRM, within the Regional Model area, as described in the following paragraphs.

Annual precipitation infiltration volumes within the Regional Model domain were estimated from annual precipitation data using a variation of the Turner (1986) method. Turner empirically derived a power-function equation that described the relationship between annual rainfall and ET rates, based on the measured yields from 68 different watersheds located throughout California. Rainfall that does not go to ET is available for surface water runoff and infiltration to groundwater. During the largest storm events, some of this water leaves the basin before it has a chance to infiltrate to groundwater. However, during all but the largest storm events, precipitation that is not consumed by ET eventually infiltrates to groundwater, as defined by the following equation (Turner, 1986):

$$\text{Infiltration} + \text{Runoff} = \text{Precipitation} - 2.32(\text{Precipitation})^{0.66} \qquad \text{(C-1)}$$

[1] http://gis.ca.gov/meta.epl?oid=286

Equation C-1 is plotted on Figure C-5 for a range of annual precipitation values expressed in units of inches. Because this expression was empirically derived based on a best-fit to data from 68 watersheds throughout California, it is not necessarily representative of the conditions in an individual watershed. Therefore, the two power-function coefficients were adjusted during the process of calibrating the Regional Model. A final set of power-function coefficients for the Regional Model produced the following relationship for the Santa Clarita Valley:

$$\text{Infiltration} + \text{Runoff} = \text{Precipitation} - 6.20(\text{Precipitation})^{0.33} \qquad \text{(C-2)}$$

Equation C-2 (Figure C-5) was then applied to the annual precipitation-adjusted isohyet values to estimate the annual rate of infiltration from 1980 through 1999. Finally, based on the percentage of annual precipitation that fell each month during that calendar year at the NCWD rain gage, the annual infiltration rates were converted into monthly rates for every node in the Regional Model.

C.8 Infiltration From Streams

The natural sources of water to streams within the Santa Clarita Valley are surface water runoff from portions of the Upper Santa Clara River Hydrologic Area watershed that lie outside of the Regional Model boundary, and flow in the Santa Clara River where it enters the valley. Additionally, DWR releases water into Castaic Creek from Castaic Lagoon in some years, and treated water is discharged into the river from two WRPs on a continual basis. Following are discussions of the volumes of these water sources and the method used to determine infiltration rates in stream beds, based on the magnitude of flow in each stream.

C.8.1 Surface Water Runoff Volume Outside the Regional Model Area

For the Regional Model to honor the water budget for the entire watershed, a method was developed to estimate the monthly availability of surface water runoff and subsurface inflow from areas that are tributary to the Regional Model boundary. To do this, GIS software was used to provide specific input data to the SWRM as follows:

a. First, GIS software was used to delineate the extents of selected subwatersheds within the Upper Santa Clara River Hydrologic Area, using 30-meter digital elevation model data obtained from the USGS. Figure C-6 depicts the extents of these subwatersheds. The extents of the subwatersheds were important to delineate because precipitation rates vary spatially (see Figure C-4); therefore, at any given time, each sub-watershed receives different magnitudes of precipitation, and yields different quantities of surface water runoff and subsurface inflow into the Regional Model area.

b. Once the selected subwatersheds were delineated, the spatial areas were computed by GIS software for the entire subwatershed and for the portion of the subwatershed lying outside the Regional Model boundary. The GIS software also computed the mean of the 1900 to 1960 precipitation (isohyet) distribution within each subwatershed. The areas and the 1900 to 1960 mean precipitation values for each subwatershed are listed in Table C-8. The means of the 1900-1960 precipitation data were then multiplied by the precipitation adjustment factor (discussed in Section C.7.1) for each calendar year to

estimate the average magnitude of precipitation that fell within each sub-watershed during that calendar year.

c. Equation C-2 was then applied to the adjusted annual precipitation values for each sub-watershed to estimate the annual rate of surface water runoff from 1980 through 1999. This provided an estimate of the annual volume of water from subwatersheds that is then available as potential groundwater recharge within the stream reach that lies within the Regional Model domain. These annual estimates were then converted to monthly estimates by multiplying by the monthly percentage of precipitation that fell at the Newhall County Water District rain gage.

C.8.2 Santa Clara River Streamflow at Eastern Regional Model Boundary

The eastern point of the Regional Model, the location at which the Santa Clara River enters the model area, marks the approximate location of the Lang gage (Figure C-6). Streamflow was measured at this gage by the USGS and Los Angeles County for a discontinuous period of 36 years starting in 1949. The gaging station was removed from service in October 1989. Because the Santa Clara River flow into the model domain is a critical boundary condition for the Regional Model, it was necessary to estimate this streamflow beginning in October 1989.

The following paragraphs describe the method used to estimate the monthly streamflow at the Lang gage. This process used the Lang gage data through September 1989 and monthly precipitation data from a rain gage in the Acton groundwater basin, which is immediately east and upgradient of the Regional Model area. Using a multiple linear regression method described below, a good correlation between monthly precipitation data from the U.S Forest Service's Acton rain gage and the Lang stream gage was achieved. The resulting regression equation was used to generate estimates of streamflow during the period that streamflow data were unavailable (October 1989 through December 1999).

C.8.2.1 Data Sources

Monthly precipitation data for 1949 to 2001 were obtained for the Acton, California rain gage maintained by the U.S. Forest Service from the Western Regional Climate Data Center. This gage was determined to be the closest rain gage to the center of the Acton watershed with a long enough period of record to complete the regression analysis. Average rainfall at the Acton rain gage was 10.3 inches during the period of record, which is approximately 58 percent of the 17.83-inch average measured from 1883 through 2000 at the Newhall-Soledad gage.

C.8.2.2 Streamflow Estimation Method

The streamflow estimation procedure for the Lang gage site assumed that a predictable relationship exists between streamflows at the Lang gage and precipitation at the Acton rain gage. This assumption was used to develop a multiple linear regression relationship and to test the quality of that relationship using historical data. A simple mathematical model was established in which the streamflow at the Lang gage during a given month was estimated from the precipitation during the prior month. A Microsoft® Excel spreadsheet was used to perform the multiple linear regression calculations and to determine the regression coefficients for each monthly rainfall value.

The regression model was calibrated using monthly streamflow data for the Lang gage during water years 1949 to 1956. The calibration was verified using streamflow and precipitation data for water years 1957 to 1989. Numerous iterations using different rainfall periods and durations were attempted before achieving a good correlation. The final regression model bases the streamflow estimates on the previous six monthly rainfall values to predict each monthly streamflow value at the Lang gage.

The final regression equation was of the form:

$$\text{Streamflow at the Lang gage} = C1*Rain_{month1} + C2*Rain_{month2} + \ldots + C6*Rain_{month6} \quad \text{(C-3)}$$

where C1, C2, ...C6 are the regression constants.

C.8.2.3 Accuracy of Streamflow Estimates

Once a regression equation is developed and its predictions are verified, streamflows are commonly estimated by applying the equation to any set of precipitation data that are similar in magnitude to those which were used to develop the regression relationship (in this case, the historic values at the Acton rain gage). To verify that the regression equations produced accurate streamflow predictions, streamflow rates calculated from the regression equations were plotted and compared against measured streamflow rates for the period of record at the Lang gage. Figure C-7 shows a comparison plot using the results of this analysis, along with the final regression equation. The plotted data indicate that the regression equation produced streamflow estimates that closely matched measured streamflows. Where differences are apparent between computed and measured streamflows, this results from one or more of the following influences:

a. **System Operation.** The effects of streamflow diversions, pump stations, and wet weather bypasses are not consistent from storm to storm, and can result in irregular streamflows under similar precipitation events.

b. **Rainfall Distribution.** The regression equations were generated from the rain gage that was thought to best represent the precipitation distributed over the entire Acton basin. However, variability of rainfall volume and intensity is normal across basins, resulting in differences in streamflow volume and timing.

c. **Gage Data.** It is common to have intermittent problems with streamflow measurement devices, particularly because of changes in the depth-versus-streamflow relationship at the gaging station over time. The regression equation was produced from storm events during periods where the Acton precipitation data appeared to be the most reliable. These data are reasonable and appropriate for the uses of this study.

d. **Antecedent Conditions.** Streamflow predicted by the regression equation will be most accurate when applied to periods when storm intensity, duration, and antecedent conditions are similar to those used to generate the regression equations. If the antecedent conditions differ significantly from those present in the historical record, then the ability to forecast streamflow characteristics may be hindered.

As Figure C-7 shows, the relationship between monthly precipitation at the Acton rain gage and streamflow at the Lang gage is fairly predictable and has been consistent over time. This

mathematical relationship would be expected to remain consistent unless significant changes occur within the basin to affect streamflows, such as major land use changes.

The Acton rain gage was removed from service at the end of August 2000, therefore streamflow predictions cannot be made beyond this date using the calibrated regression model parameters described above. Table C-9 lists the combined set of measured and computed monthly streamflow values for the Lang gage from 1980 through 1999.

The monthly availability of streamflows at the Lang gage were input into the SWRM and allowed to infiltrate based on the specified maximum stream leakage rate, as Section C.8.5 of this appendix will discuss.

C.8.3 Releases from Castaic Lake

As described in Section 2.6.3.4 in the main body of this report, Castaic Creek occasionally receives surface water releases from Castaic Lagoon (i.e., Castaic Lake). The SWRM treats this surface water as it would any other available surface water in a stream. Based on the volume of available water during each monthly stress period, that water is allowed to infiltrate the Castaic Creek streambed and recharge the underlying groundwater system at a rate equal to or less than the streambed infiltration capacity (see Section C.8.5). Table C-10 lists the monthly releases of state surface water into Castaic Creek.

C.8.4 Treated Wastewater

Another anthropogenic source of recharge to the groundwater system is treated wastewater from the two LACSD WRPs in the valley, Plant No. 32 near Valencia, known as the Valencia WRP, and Plant No. 26 near Bouquet Canyon known, as the Saugus WRP. Tables C-11 and C-12 list the monthly volumes of treated wastewater that are discharged to the Santa Clara River from the Valencia WRP and the Saugus WRP, respectively.

The SWRM treats this surface water component as it would any other available surface water in a simulated stream. The volume of available treated wastewater during each monthly stress period is simulated to infiltrate the Santa Clara River streambed and recharge the groundwater system at a rate equal to or less than the streambed infiltration capacity (see Section C.8.5).

C.8.5 Assignment of Stream Leakage

Once the monthly streamflows were established for the Santa Clara River and each of its selected tributaries, a method had to be developed to determine the rates and locations of surface water infiltration to the underlying Alluvial Aquifer system. The following paragraphs describe this method.

C.8.5.1 Stream Connectivity and Ranking System

For the SWRM to assign stream leakage rates accurately, a stream ranking convention was adopted (Figure C-8) as follows:

1. Santa Clara River
2. All modeled streams that merge with the Santa Clara River (2nd order streams)

3. All modeled streams that merge with the 2nd order streams (3rd order streams)
4. All modeled streams that merge with the 3rd order streams (4th order streams)
5. All modeled streams that merge with the 4th order streams (5th order streams)

For the entire model domain, the SWRM processes the assignment of stream leakage beginning with the highest ranking stream nodes and progressing sequentially downstream to the lowest ranking stream nodes for each subwatershed. This ensures a correct accounting of available stream leakage throughout the stream network in the Regional Model domain. Within a given stream, the connectivity relationships between each Regional Model grid node in that stream were established by ordering the Regional Model stream node number from upgradient nodes to downgradient nodes (Figure C-8). Additionally, the last stream node of a given stream was assigned a "next node number," which indicated the nearest node for the next downstream (lower ranking) stream that could receive any surface flows that remained in the higher ranking stream. This "next node number" attribute allowed the SWRM to simulate continued surface water infiltration in the lower ranking streams as long as the total volume of available recharge water was not consumed in upstream reaches of the simulated stream.

C.8.5.2 Stream Geometry at Each Node

Another necessary input for specifying infiltration rates from streams was the geometry of each individual stream node, specifically, the length, width, and area of each stream node (Figure C-8). This was required because the groundwater recharge module that was used within the Regional Model requires input in units of feet per day, then internally computes the volumetric groundwater recharge rate (in cubic feet per day) using the nodal area (in square feet). Thus, the SWRM requires input of simulated stream geometry assumptions to ensure that the correct volume of water is being recharged through the simulated streambeds.

C.8.5.3 Streambed Infiltration Capacity at Each Node

The streambed infiltration capacity was specified at each stream node in the SWRM. The streambed infiltration capacity is the maximum volume of water that can infiltrate through streambed sediments, assuming a sufficient volume of water in the stream. The streambed infiltration capacity is measured in cubic feet per second per stream mile and is a function of streambed sediment permeability and wetted width of the stream at any given time.

The wetted width of a stream at any given time will vary as a function of the amount of flow in the stream and will be less than the nodal width for all but the highest streamflows. Additionally, permeability of the streambed sediments will vary spatially and can even vary over time at any given location because of the scouring and deposition that occur during high flow events. Consequently, the streambed infiltration capacity of a stream at any given location can vary over time. For this reason, and because stream widths can vary in the field but not in the Regional Model, streambed infiltration capacity was allowed to vary over time in the SWRM.

A post-processor was written into the SWRM code to aid in the selection of time-varying streambed infiltration rates. The post-processor became a part of the calibration process of the Regional Model, in that differences between measured and simulated groundwater

elevations were used to help determine whether the streambed infiltration capacity of a given stream reach needed to be raised or lowered during any given month. Because this process required groundwater elevation data in the underlying groundwater system (in this case, the Alluvial Aquifer), the post-processor could only be applied along the Santa Clara River and Castaic Creek. Few, if any, records of groundwater elevations exist for the Alluvial Aquifer along the other streams, so streambed infiltration capacities were not varied over time along those streams. A complete description of the Regional Model calibration process and results can be found in Sections 4 and 5 in the main body of this report.

The monthly adjustment of the assumed streambed infiltration capacities during calibration of the Regional Model was performed in an iterative manner, using the following steps (which are also shown in Figure C-9):

1. Initial estimates of the maximum stream leakage rate were specified in the SWRM, which then generated monthly sets of groundwater recharge rates at each Regional Model node along the Santa Clara River and Castaic Creek during the 20-year simulation period.

2. The Regional Model was then run, and simulated groundwater elevations were recorded over time at selected calibration well locations along the Santa Clara River and Castaic Creek.

3. Simulated groundwater elevations were compared with measured elevations at each calibration well, and the differences (head residuals) were used to compute the surplus or deficit of water calculated by the Regional Model. For example, if a set of calibration wells in a particular area along the Santa Clara River indicated that simulated groundwater levels were 10 feet too high during a monthly stress period, then the computation would proceed as follows:

    a. Multiply the head residuals by the specific yield and the adjacent stream node area in the stream reach where the calibration well is located, to obtain the volume of surplus recharge water in the model.

    b. Reduce the assumed maximum stream leakage rate so that the calculated surplus recharge volume of water would not infiltrate in the stream reach associated with the calibration well during that particular monthly stress period. In other words, at a location where the model simulates too much stream leakage, the post-processor computes the volume of surplus recharge that, if eliminated, would allow the simulated groundwater elevations to better match the measured groundwater elevations. In this example, streamflow would be infiltrating the simulated streambed at a slower rate, thereby persisting as streamflow for a longer downstream reach of the stream channel.

4. Using the new values of streambed infiltration capacity, the SWRM was then run again to provide new groundwater recharge rates each month at the nodes where the post-processor was applied. The Regional Model was then run again with the new groundwater recharge rates, and this entire process was repeated until the assumed maximum stream leakage rate and/or the simulated groundwater elevations showed little to no change from one simulation to the next.

The streambed infiltration capacity that is assigned by the SWRM for each month is not necessarily the rate that surface water leaks into the Regional Model at any given location. The specified infiltration capacity simply allows stream leakage to occur as long as streamflows are available. For example, if the selected calibration wells are simulating groundwater elevations too low in comparison with measured groundwater elevations during a drought period, then the post-processor function within the SWRM would try to increase the assumed maximum stream leakage rate. However, during a drought, the availability of surface water is diminished. Therefore, even though the SWRM might increase the streambed infiltration capacity, there would be reaches where streamflows would be too low to allow water to infiltrate at a rate as high as the streambed infiltration capacity. The SWRM can only infiltrate the surface water if it is available, based on the complete water balance within the watershed. This rule allows the SWRM and the Regional Model to honor the watershed water budget.

C.9 Rejected Stream Leakage

As previously mentioned, the SWRM also tracks the volume of surface water in each simulated stream that does not infiltrate during each monthly stress period because of gaining stream conditions (i.e., rejected stream leakage). This rejected stream leakage remains as surface water in the Santa Clara River and eventually exits the Regional Model at the west end of the valley at the County Line stream gage. The monthly volumes of rejected stream leakage (calculated by the SWRM) and groundwater discharges to the river (calculated by the Regional Model) were used during the calibration process to compare these combined flow rates with streamflows measured at the County Line stream gage. This is discussed in detail in Sections 4.4.2 and 5.2.3 of the report.

Table C-13 lists the monthly streamflow measured from 1980 through 1999 at the County Line gage, which is located on the Santa Clara River at the western (downstream) end of the Santa Clarita Valley. Until October 1996, this gage was located just downstream of the Los Angeles-Ventura County line and just upstream of Blue Cut.[2] This gage continued operation through October 21, 1996, at which time it was permanently taken out of service. A new gage (USGS Gage No. 11109000) was put into service beginning on October 1, 1996 approximately 2.5 miles downstream, near Piru Junction, at the Las Brisas Bridge.

[2] Blue Cut is an area where the valley becomes substantially narrower in width and the river begins to bend toward the southern side of the valley. See Figure C-1 for this location.

C.10 References

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Tables

Table C-1

Comparison of WRP Discharges with Urban Water Demands

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	WRP Discharges to the Santa Clara River (AF/yr)	Urban Water Demands (AF/yr)	Percentage of Urban Demand Used Indoors (Routed to WRPs)	Percentage of Urban Demand Used Outdoors
1980	7,374	22,319	33.0	67.0
1981	7,950	24,822	32.0	68.0
1982	8,438	21,912	38.5	61.5
1983	9,422	21,386	44.1	55.9
1984	9,514	27,386	34.7	65.3
1985	9,616	28,482	33.8	66.2
1986	6,020	31,152	19.3	80.7
1987	11,843	33,877	35.0	65.0
1988	12,363	37,634	32.9	67.1
1989	13,560	42,813	31.7	68.3
1990	14,006	43,066	32.5	67.5
1991	14,108	39,793	35.5	64.5
1992	15,702	41,266	38.1	61.9
1993	17,178	43,352	39.6	60.4
1994	16,946	45,988	36.8	63.2
1995	17,823	45,673	39.0	61.0
1996	16,827	50,147	33.6	66.4
1997	15,775	54,173	29.1	70.9
1998	17,691	48,858	36.2	63.8
1999	17,847	57,250	31.2	68.8
1999	17,847	57,250	31.2	68.8
Statistics for 1980 through 1999				
Minimum	**6,020**	**21,386**	**19.3**	**55.9**
Maximum	**17,847**	**57,250**	**44.1**	**80.7**
Average	**13,231**	**38,981**	**34.2**	**65.8**
Median	**14,006**	**41,266**	**33.8**	**66.2**
Statistics for 1980 through 1999, Excluding 1986				
Minimum	**7,374**	**21,386**	**29.1**	**55.9**
Maximum	**17,847**	**57,250**	**44.1**	**70.9**
Average	**13,592**	**39,372**	**34.9**	**65.1**
Median	**14,057**	**42,040**	**34.3**	**65.7**

TABLE C-2
Calculation of Outdoor Irrigation Infiltration Rates to Groundwater for Non-Agricultural Water Uses
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Term	Value	Units	Reference or Calculation Method	Comment
NCWD Annual Water Use, 5-Year Average 1994 through 1998	8,150	AF/yr	Table III-6 in *1999 Annual Basin Report* (Luhdorff and Scalmanini Consulting Engineers, 2000)	16 percent of retailer-supplied water.
SCWD Annual Water Use, 5-Year Average 1994 through 1998	20,920	AF/yr		42 percent of retailer-supplied water.
VWC Total Annual Use, 5-Year Average 1994 through 1998	19,330	AF/yr		40 percent of retailer-supplied water.
LA County 36 Annual Water Use, 5-Year Average 1994 through 1998	570	AF/yr		1 percent of retailer-supplied water.
Valencia Country Club (VCC) Annual Water Use, 5-Year Average 1994 through 1998	490	AF/yr		1 percent of retailer-supplied water.
Annual Water Use, 5-Year Average 1994 through 1998	**49,460**	**AF/yr**		
Area of Water Use (excluding agriculture and undeveloped)	17,691	acres	Aerial photography (1999).	Area where retailer-supplied water is used.
Alluvial Aquifer Area of Water Use (excluding agriculture and undeveloped)	8,000	acres		Alluvial area where retailer-supplied water is used.
Saugus Area of Water Use (excluding agriculture and undeveloped)	9,691	acres		Saugus area where retailer-supplied water is used.
Alluvial Aquifer Lands – Suburban Residential Area	4,765	acres	Aerial photography (1999) and geologic mapping.	60 percent of alluvium area receiving applied water.
Alluvial Aquifer Lands – Retail – Office – Industrial Area	2,900	acres		36 percent of alluvium area receiving applied water.
Alluvial Aquifer Lands – Recreational Area	0	acres		No recreational areas were identified as overlying alluvium.
Alluvial Aquifer Lands – Golf Course Area	335	acres		4 percent of alluvium area receiving applied water.
Saugus Lands – Suburban Residential Area	8,192	acres		85 percent of Saugus area receiving applied water.
Saugus Lands – Retail - Office – Industrial Area	1,411	acres		15 percent of Saugus area receiving applied water.
Saugus Lands – Recreational Area	46	acres		Less than 1 percent of Saugus area receiving applied water.
Saugus Lands -- Golf Course Area	42	acres		Less than 1 percent of Saugus area receiving applied water.
Percent Annual Water Consumption for Outdoor Use -- Suburban Residential	65		Comparison of historical water use records and WRP flow records. See Table C-1.	
Percent Annual Water Consumption for Outdoor Use -- Retail/Office/Industrial	30			
Percent Annual Water Consumption for Outdoor Use -- Recreational	65			
Percent Annual Water Consumption for Outdoor Use -- Golf Course	100			
Percent Applied Water Going to Deep Percolation -- Suburban Residential	10		Assumed irrigation efficiency is 10 percent for all urban land uses where irrigation occurs.	
Percent Applied Water Going to Deep Percolation -- Retail/Office/Industrial	10			
Percent Applied Water Going to Deep Percolation -- Recreational	10			
Percent Applied Water Going to Deep Percolation -- Golf Course	30			
Percent Total Water Use Going to Deep Percolation -- Suburban Residential	6.5		Calculated.	Equals 65 percent times 10 percent.
Percent Total Water Use Going to Deep Percolation -- Retail/Office/Industrial	3.0			Equals 30 percent times 10 percent.
Percent Total Water Use Going to Deep Percolation -- Recreational	6.5			Equals 65 percent times 10 percent
Percent Total Water Use Going to Deep Percolation -- Golf Course	30.0			Equals 100 percent times 30 percent.
Alluvial Aquifer Annual Deep Percolation – Suburban Residential	866	AF/yr	Calculated from total water use (49,460 AF/yr), the area overlying the alluvium for each land use category, and the percentage of total water use going to recharge.	Equals 49,460 AF/yr * (4765 acres / 17691 acres) * 6.5 percent.
Alluvial Aquifer Annual Deep Percolation -- Retail/Office/Industrial	243	AF/yr		Equals 49,460 AF/yr * (2900 acres / 17691 acres) * 3.0 percent.
Alluvial Aquifer Annual Deep Percolation – Recreational	0	AF/yr		No recreational areas overlie alluvium.
Alluvium Annual Deep Percolation -- Golf Course	130	AF/yr		Equals 490 AF/yr * (335 acres / (335+42 acres)) * 30.0 percent.
Alluvial Aquifer Annual Deep Percolation	**1,239**	**AF/yr**		
Alluvial Aquifer 5-Year Deep Percolation (1994 through 1998)	**6,195**	**AF**		
Saugus Annual Deep Percolation – Suburban Residential	1,489	AF/yr	Calculated from total water use (49,460 AF/yr), the area overlying the Saugus for each land use category, and the percentage of total water use going to recharge.	Equals 49,460 AF/yr * (8192 acres / 17691 acres) * 6.5 percent.
Saugus Annual Deep Percolation – Retail/Office/Industrial	118	AF/yr		Equals 49,460 AF/yr * (1411 acres / 17691 acres) * 3.0 percent.
Saugus Annual Deep Percolation – Recreational	8	AF/yr		Equals 49,460 AF/yr * (46 acres / 17691 acres) * 6.5 percent.
Saugus Annual Deep Percolation – Golf Course	16	AF/yr		Equals 490 AF/yr * (42 acres / (335+42 acres) * 30.0 percent.
Saugus Annual Deep Percolation	**1,631**	**AF/yr**		
Saugus 5-Year Deep Percolation (1994 through 1998)	**8,155**	**AF**		
Average Area-Wide Deep Percolation -- Suburban Residential	2.2	in/yr	Calculated from applied water volumes in Alluvial and Saugus samples, as well as combined area in alluvium and Saugus occupied by each land use category.	Equals (12 in/ft)* (866+1,489 AF/yr) / (4,765+8,192 acres).
Average Area-Wide Deep Percolation -- Retail/Office/Industrial	1.0	in/yr		Equals (12 in/ft)* (243+118 AF/yr) / (2,900+1411 acres).
Average Area-Wide Deep Percolation – Recreational	2.2	in/yr		Equals (12 in/ft)* (0+8 AF/yr) / (0+46 acres).
Average Area-Wide Deep Percolation – Golf Course	4.6	in/yr		Equals (12 in/ft)* (130+16 AF/yr) / (335+42 acres).

Notes:

Applied water recharge to Saugus includes areas where terrace deposits are present at the ground surface.
in/ft = inches per foot

Table C-3

Irrigation Infiltration Rates over 1999 Suburban Residential Area

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Total Water Use (AF/yr)	Eq. Infiltration over 1999 Suburban Residential Area (in/yr)	Ratio Compared with 1999
1980	22,319	0.86	0.391
1981	24,822	0.95	0.432
1982	21,912	0.84	0.382
1983	21,386	0.82	0.373
1984	27,386	1.05	0.477
1985	28,482	1.09	0.495
1986	31,152	1.2	0.545
1987	33,877	1.3	0.591
1988	37,634	1.45	0.659
1989	42,813	1.65	0.75
1990	43,066	1.65	0.75
1991	39,793	1.53	0.695
1992	41,266	1.59	0.723
1993	43,352	1.67	0.759
1994	45,988	1.77	0.805
1995	45,673	1.76	0.8
1996	50,147	1.93	0.877
1997	54,173	2.08	0.945
1998	48,858	1.88	0.855
1999	57,250	2.2	1
2000	60,988	2.34	1.064

Note:

Eq. = equivalent

Table C-4

Irrigation Infiltration Rates over 1999 Retail and Industrial Area

Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Total Water Use (AF/yr)	Eq. Infiltration over 1999 Retail/Industrial Area (in/yr)	Ratio Compared with 1999
1980	22,319	0.39	0.39
1981	24,822	0.43	0.43
1982	21,912	0.38	0.38
1983	21,386	0.37	0.37
1984	27,386	0.48	0.48
1985	28,482	0.5	0.5
1986	31,152	0.54	0.54
1987	33,877	0.59	0.59
1988	37,634	0.66	0.66
1989	42,813	0.75	0.75
1990	43,066	0.75	0.75
1991	39,793	0.7	0.7
1992	41,266	0.72	0.72
1993	43,352	0.76	0.76
1994	45,988	0.8	0.8
1995	45,673	0.8	0.8
1996	50,147	0.88	0.88
1997	54,173	0.95	0.95
1998	48,858	0.85	0.85
1999	57,250	1	1

Table C-5
Irrigation Infiltration Rates over 1999 Golf Course Areas
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Total Water Use (AF/yr)	Eq. Infiltration over 1999 Golf Courses Area (in/yr)	Ratio Compared with 1999
1980	22,319	1.79	0.389
1981	24,822	1.99	0.433
1982	21,912	1.76	0.383
1983	21,386	1.72	0.374
1984	27,386	2.2	0.478
1985	28,482	2.29	0.498
1986	31,152	2.5	0.543
1987	33,877	2.72	0.591
1988	37,634	3.02	0.657
1989	42,813	3.44	0.748
1990	43,066	3.46	0.752
1991	39,793	3.2	0.696
1992	41,266	3.32	0.722
1993	43,352	3.48	0.757
1994	45,988	3.7	0.804
1995	45,673	3.67	0.798
1996	50,147	4.03	0.876
1997	54,173	4.35	0.946
1998	48,858	3.93	0.854
1999	57,250	4.6	1

Table C-6
Irrigation Infiltration Rates for Agricultural Lands
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Year	Agricultural Applied Water Volume (AF/yr)	Infiltration Rate (ft/yr)	Infiltration Rate for Modeled Acreage (ft/yr)	Percentage of 1996 through 2000 Average
1980	6,364	2.7	1.9	90
1981	7,433	3.1	2.2	106
1982	5,441	2.3	1.6	77
1983	4,487	1.9	1.3	64
1984	6,311	2.6	1.9	90
1985	5,241	2.2	1.5	74
1986	4,657	1.9	1.4	66
1987	3,662	1.5	1.1	52
1988	3,348	1.4	1.0	48
1989	3,511	1.5	1.0	50
1990	4,623	1.9	1.4	66
1991	3,958	1.7	1.2	56
1992	5,022	2.1	1.5	71
1993	4,508	1.9	1.3	64
1994	5,958	2.5	1.8	85
1995	6,276	2.6	1.8	89
1996	6,728	3.2	2.2	108
1997	7,528	3.0	2.1	102
1998	5,980	2.7	1.9	93
1999	7,479	2.9	2.1	99
2000	7,476	2.9	2.0	98
Average (1996 through 2000)	**7,038**	**2.9**	**2.1**	100

Note:
Actual acreage is 877 acres; modeled acreage is 1,205 acres.

TABLE C-7
Monthly Precipitation Measured at the Newhall County Water District Rain Gage
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	10.36	14.63	4.84	0.36	0.40	0.00	0.00	0.00	0.00	0.00	0.00	1.36	31.95
1981	4.76	1.66	5.50	0.46	0.00	0.00	0.00	0.00	0.00	0.58	3.62	0.22	16.80
1982	3.33	1.21	9.50	1.09	0.13	0.00	0.00	0.00	1.02	0.25	5.34	2.95	24.82
1983	8.67	6.85	13.07	4.61	0.20	0.00	0.00	1.17	1.85	1.74	5.04	5.13	48.33
1984	0.00	0.00	0.27	0.07	0.00	0.00	0.00	0.00	0.05	0.16	3.87	8.13	12.55
1985	0.78	1.20	1.04	0.14	0.07	0.00	0.06	0.00	0.12	0.54	5.11	0.70	9.76
1986	5.84	6.65	5.39	0.88	0.00	0.00	0.05	0.00	1.78	0.68	1.55	0.24	23.06
1987	2.10	0.61	1.69	0.14	0.00	0.00	0.09	0.02	0.00	3.47	3.84	4.80	16.76
1988	3.27	3.39	1.16	3.98	0.09	0.00	0.00	0.00	0.10	0.00	0.92	7.14	20.05
1989	0.89	4.13	1.30	0.30	0.00	0.00	0.00	0.00	0.62	0.86	0.37	0.00	8.47
1990	2.89	4.23	0.22	0.48	0.88	0.00	0.00	0.00	0.00	0.00	0.63	0.01	9.34
1991	1.11	5.72	11.33	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	5.95	24.61
1992	3.28	16.64	9.73	0.15	0.34	0.00	0.30	0.00	0.00	1.55	0.00	7.25	39.24
1993	17.11	11.73	4.27	0.00	0.00	0.65	0.00	0.00	0.00	0.57	0.75	1.00	36.08
1994	0.48	5.31	2.33	0.42	0.00	0.00	0.00	0.00	0.00	0.78	0.71	1.94	11.97
1995	21.98	1.93	8.30	0.72	0.26	0.76	0.00	0.00	0.00	0.00	0.00	2.33	36.28
1996	2.97	6.73	2.08	0.13	0.68	0.00	0.00	0.00	0.00	1.30	1.06	8.70	23.65
1997	6.67	0.23	0.00	0.00	0.00	0.00	0.05	0.00	0.53	0.00	3.73	6.72	17.93
1998	3.49	22.00	3.98	2.28	5.50	0.06	0.00	0.00	0.21	0.33	1.36	1.39	40.60
1999	2.08	0.65	3.00	3.78	0.00	0.48	0.00	0.00	0.01	0.00	0.00	0.05	10.05

Note:

All precipitation values are measured in inches.

TABLE C-8
Spatial Areas and Means of 1900 to 1960 Precipitation for Subwatersheds
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Canyon/Stream	Subwatershed Area (acres)	Contributing Area to Regional Model (acres)	Mean of Precipitation 1900 to 1960 within Each Contributing Area (in/yr)
Bee Canyon	1,163.38	970.06	11.41
Bouquet Canyon	11,995.90	9,100.66	14.09
Bouquet Canyon Tributary 1	409.84	291.36	12.81
Bouquet Canyon Tributary 2	683.75	577.67	13.25
Bouquet Canyon Tributary 3	459.20	393.53	13.18
Lower Castaic Creek	13,109.20	4,205.12	14.73
Upper Castaic Creek	98,417.60	98,417.60	19.62
Charlie Canyon	6,323.41	5,418.33	15.55
Dry Canyon	4,883.13	2,900.08	14.20
Gavin Canyon	3,608.62	2,913.39	21.32
Haskell Canyon	7,608.26	5,976.49	14.01
Hasley Canyon	5,609.59	385.96	14.25
Iron Canyon	1,734.63	1,401.94	18.92
Marple Canyon	6,031.13	4,980.94	17.09
Mint Canyon	5,711.30	4,155.07	12.45
Mint Canyon Tributary 1	615.56	367.82	12.14
Mint Canyon Tributary 2	1,697.89	1,438.90	12.22
Mint Canyon Tributary 3	304.45	296.87	12.61
Mint Canyon Tributary 4	234.88	231.90	12.93
Mint Canyon Tributary 5	118.01	114.80	13.01
Newhall Canyon	3,191.67	1,625.11	18.98
Oak Spring Canyon	3,628.60	2,721.91	16.21
Pico Canyon	4,404.42	2,853.93	19.47
Placerita Canyon	6,117.92	2,490.47	18.20
Plum Canyon	2,085.00	753.09	13.25
Pole Canyon	1,744.04	1,614.78	15.95
Potrero Canyon	2,865.18	1,074.76	15.88
Railroad Aqueduct Canyon	865.82	198.83	20.27

TABLE C-8
Spatial Areas and Means of 1900 to 1960 Precipitation for Subwatersheds
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Canyon/Stream	Subwatershed Area (acres)	Contributing Area to Regional Model (acres)	Mean of Precipitation 1900 to 1960 within Each Contributing Area (in/yr)
San Francisquito Canyon	31,388.60	26,878.10	16.51
San Martinez Canyon	2,117.60	1,384.49	13.67
Sand Canyon	5,489.51	4,191.58	19.39
Sand Canyon Road Tributary	554.03	508.56	13.12
Sand Canyon Tributary 1	644.26	251.41	15.97
Sand Canyon Tributary 2	338.66	221.79	16.99
Santa Clara River East	12,696.90	2,562.57	14.16
Santa Clara River West	17,105.90	3,169.86	13.76
Santa Clara River Tributary 1	1,278.18	927.13	16.97
Santa Clara River Tributary 2	277.82	264.96	13.64
Santa Clara River Tributary 3	219.50	189.19	13.65
Santa Clara River Tributary 4	101.25	91.84	13.54
Santa Clara River Tributary 5	114.80	106.31	13.44
South Fork Santa Clara River	5,491.11	655.74	17.62
Tapie Canyon	1,260.27	1,235.25	11.39
Texas Canyon	6,956.88	6,659.55	13.59
Tick Canyon	3,662.58	3,428.16	11.57
Tick Canyon Tributary	175.19	154.75	12.09
Towsley Canyon	3,681.64	3,606.56	21.43
Vasquer Canyon	2,743.26	2,151.81	12.66
Whitney Canyon	1,321.58	1,104.38	18.95
Area Totals	**293,241.89**	**217,615.36**	

TABLE C-9
Monthly Streamflows Measured in the Santa Clara River at the Lang Gage
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	1,310	7,449	1,213	568	218	78	6	0	37	274	467	553	12,175
1981	594	98	339	240	107	18	18	12	338	321	258	394	2,739
1982	333	1,420	785	283	238	0	0	0	0	95	178	855	4,188
1983	1,922	16,971	2,755	2,576	958	523	639	512	0	0	0	0	26,855
1984	0	596	405	240	143	166	228	411	154	220	904	578	4,044
1985	483	461	274	215	77	0	0	0	12	179	221	301	2,224
1986	483	1,138	488	283	107	6	0	12	6	12	80	129	2,744
1987	117	117	65	31	12	0	0	0	0	0	258	516	1,116
1988	222	209	506	117	77	68	0	0	0	0	12	25	1,236
1989	50	111	60	25	6	0	0	0	102	94	34	18	499
1990	212	276	230	46	46	5	0	0	0	27	36	147	1,025
1991	162	775	879	736	145	142	14	0	45	69	62	263	3,291
1992	336	534	429	398	117	84	16	5	108	144	498	1,446	4,115
1993	14,709	5,336	1,194	530	239	110	54	10	64	145	264	281	22,937
1994	388	493	497	319	163	80	20	7	37	102	193	941	3,239
1995	1,211	1,421	954	802	268	156	62	8	6	1	27	189	5,104
1996	666	896	730	315	151	46	7	0	54	154	307	510	3,836
1997	517	346	140	85	33	5	4	50	66	240	566	809	2,859
1998	18,997	8,508	3,837	961	667	347	81	91	70	139	190	186	34,074
1999	92	85	204	224	197	107	80	46	52	54	31	80	1,252

Note:

All monthly streamflows are measured in acre-feet.

TABLE C-10
Monthly Releases of Water from Castaic Lagoon to Castaic Creek
Regional Groundwater Flow Model Report for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	0	0	0	0	0	834	1,052	919	0	0	0	0	2,805
1981	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
1982	0	0	0	0	0	667	842	735	0	0	0	0	2,244
1983	0	0	0	0	0	1,168	1,473	1,287	0	0	0	0	3,928
1984	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	105	0	0	1,490	46	0	0	0	0	0	0	0	1,641
1987	105	0	0	1,490	46	0	0	0	0	0	212	0	1,853
1988	0	0	809	341	900	0	0	0	0	0	0	0	2,050
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	66	66
1992	0	0	580	3,052	667	127	24	0	0	0	0	0	4,450
1993	0	140	186	3,031	1,901	635	341	337	813	0	0	341	7,725
1994	210	0	0	2,979	93	0	0	0	0	0	0	0	3,282
1995	0	0	0	0	0	1,668	2,104	1,839	0	0	0	0	5,611
1996	0	0	0	4,961	671	0	0	0	0	0	0	0	5,632
1997	0	0	8701	873	0	0	0	0	0	0	0	310	9,884
1998	1,186	19,545	10,747	4,566	7,561	47	1,370	436	464	302	652	926	47,802
1999	612	691	0	3,187	1,191	149	0	0	0	0	0	0	5,830

Note:

All monthly releases are measured in acre-feet.

TABLE C-11
Monthly Treated Wastewater Discharge Measured at the Valencia Water Reclamation Plant
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	266	258	257	239	247	212	219	219	212	228	239	247	2,844
1981	248	220	249	235	244	237	253	255	248	263	285	270	3,006
1982	275	247	284	271	277	269	275	268	254	266	271	284	3,241
1983	286	261	301	288	296	277	287	296	282	286	276	295	3,432
1984	303	281	304	294	321	315	320	317	314	322	315	319	3,723
1985	309	283	316	316	333	331	354	359	348	361	357	341	4,006
1986	350	341	374	359	377	380	415	454	446	440	421	445	4,801
1987	455	415	472	489	550	567	603	594	579	633	600	624	6,582
1988	622	557	588	587	603	537	575	606	587	608	600	602	7,072
1989	622	593	695	666	671	708	714	731	668	678	673	676	8,095
1990	698	644	725	695	666	693	725	714	692	700	658	680	8,290
1991	715	662	702	627	668	646	647	691	709	743	717	748	8,276
1992	777	777	819	813	824	800	853	869	818	828	811	786	9,775
1993	778	733	863	858	869	925	910	846	816	834	818	858	10,107
1994	722	729	809	776	802	761	771	764	739	763	735	760	9,132
1995	889	777	935	887	884	848	853	814	826	834	823	855	10,225
1996	893	838	935	890	902	876	903	891	886	817	810	816	10,456
1997	815	713	866	829	852	879	860	851	824	826	778	775	9,867
1998	778	787	955	955	984	965	1,136	1,139	1,020	993	911	906	11,529
1999	930	868	962	953	985	968	1,003	1,018	961	1,020	1,040	987	11,695

Note:

All monthly releases are measured in acre-feet.

TABLE C-12
Monthly Treated Wastewater Discharge Measured at the Saugus Water Reclamation Plant
Regional Groundwater Flow Model Report for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	362	365	419	414	419	387	362	362	350	362	359	371	4,529
1981	382	337	390	398	444	412	417	429	431	434	412	460	4,945
1982	445	399	456	444	446	434	434	421	415	434	431	438	5,196
1983	460	421	514	541	562	545	520	477	458	481	477	534	5,990
1984	558	505	499	485	476	443	458	456	451	467	474	519	5,791
1985	503	461	505	458	448	444	452	459	452	470	460	498	5,610
1986	498	475	528	501	499	483	481	476	500	511	518	552	6,023
1987	524	475	542	487	425	383	391	403	395	397	411	430	5,264
1988	443	411	439	434	440	430	445	457	435	464	436	460	5,294
1989	462	410	441	450	464	436	476	479	462	471	451	466	5,468
1990	463	403	432	426	483	492	513	504	489	493	508	512	5,718
1991	495	423	479	427	491	516	557	525	486	474	470	493	5,835
1992	488	507	530	472	489	476	493	521	492	498	452	514	5,931
1993	595	534	616	581	615	587	622	604	578	609	567	567	7,075
1994	601	606	694	677	687	644	642	645	619	663	655	685	7,817
1995	657	578	676	705	699	631	641	635	617	613	568	581	7,602
1996	532	504	525	501	517	506	511	525	532	579	558	583	6,375
1997	564	516	515	461	469	417	442	474	475	503	521	553	5,911
1998	529	541	544	511	617	587	426	399	457	501	521	533	6,166
1999	542	485	551	391	544	512	547	532	521	527	487	514	6,153

Note:

All monthly discharges are measured in acre-feet.

TABLE C-13
Monthly Streamflows Measured in the Santa Clara River at the County Line Gage
Regional Groundwater Flow Model for the Santa Clarita Valley, Santa Clarita, California

Calendar Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	8,428	43,565	18,125	8,551	3,792	3,963	1,202	1,111	1,668	1,470	1,452	1,884	95,211
1981	3,376	1,533	5,415	1,815	1,662	1,279	942	906	1,139	1,488	2,138	2,539	24,232
1982	2,826	2,358	5,572	7,091	3,909	1,749	1,694	1,392	1,597	1,621	3,449	3,229	36,488
1983	7,787	9,122	67,712	11,240	10,320	3,828	2,102	2,678	2,053	3,443	5,040	5,911	131,236
1984	5,691	3,931	4,084	4,530	2,309	1,607	1,224	1,511	1,464	1,624	3,237	8,067	39,279
1985	3,116	2,561	2,852	1,974	1,694	1,365	1,178	1,365	1,551	1,880	2,102	2,828	24,466
1986	3,955	13,991	10,616	3,328	2,612	1,622	1,454	1,482	1,870	1,896	2,606	2,590	48,024
1987	2,485	2,325	2,575	1,841	1,908	1,710	1,650	1,470	1,412	2,309	2,057	4,457	26,198
1988	3,421	2,981	3,025	3,172	2,636	2,231	1,734	1,494	1,605	1,904	2,027	10,381	36,611
1989	2,644	3,340	2,584	2,055	1,740	1,920	1,732	1,345	1,535	2,146	1,964	1,795	24,799
1990	2,709	3,247	2,269	1,898	1,730	1,545	1,478	1,751	1,668	1,660	1,924	1,593	23,472
1991	2,051	3,219	15,981	1,837	1,519	1,113	1,144	831	912	948	1,014	4,332	34,901
1992	3,737	37,636	9,576	4,439	1,964	1,533	1,377	1,085	1,129	1,329	1,496	3,277	68,577
1993	47,199	44,749	25,738	9,459	4,860	3,324	2,797	2,771	2,949	3,005	2,686	3,247	152,783
1994	3,281	3,437	3,501	3,533	3,519	2,200	1,640	1,400	1,192	1,855	2,263	4,219	32,039
1995	31,125	3,828	19,662	8,452	3,901	2,527	1,843	2,192	1,855	1,716	2,075	3,235	82,409
1996	3,604	10,669	7,678	6,073	3,584	1,678	1,640	1,579	1,509	2,625	1,590	5,701	47,930
1997	5,375	3,913	7,884	3,370	1,680	1,240	1,571	1,371	1,230	1,662	2,636	4,848	36,780
1998	5,875	104,388	25,377	9,378	34,992	5,312	3,935	3,537	2,579	2,450	2,890	4,427	205,139
1999	4,328	4,128	4,322	6,526	4,760	3,590	1,125	1,439	2,164	1,888	2,243	2,434	32,382

Note:

All monthly streamflows are measured in acre-feet.

Figures

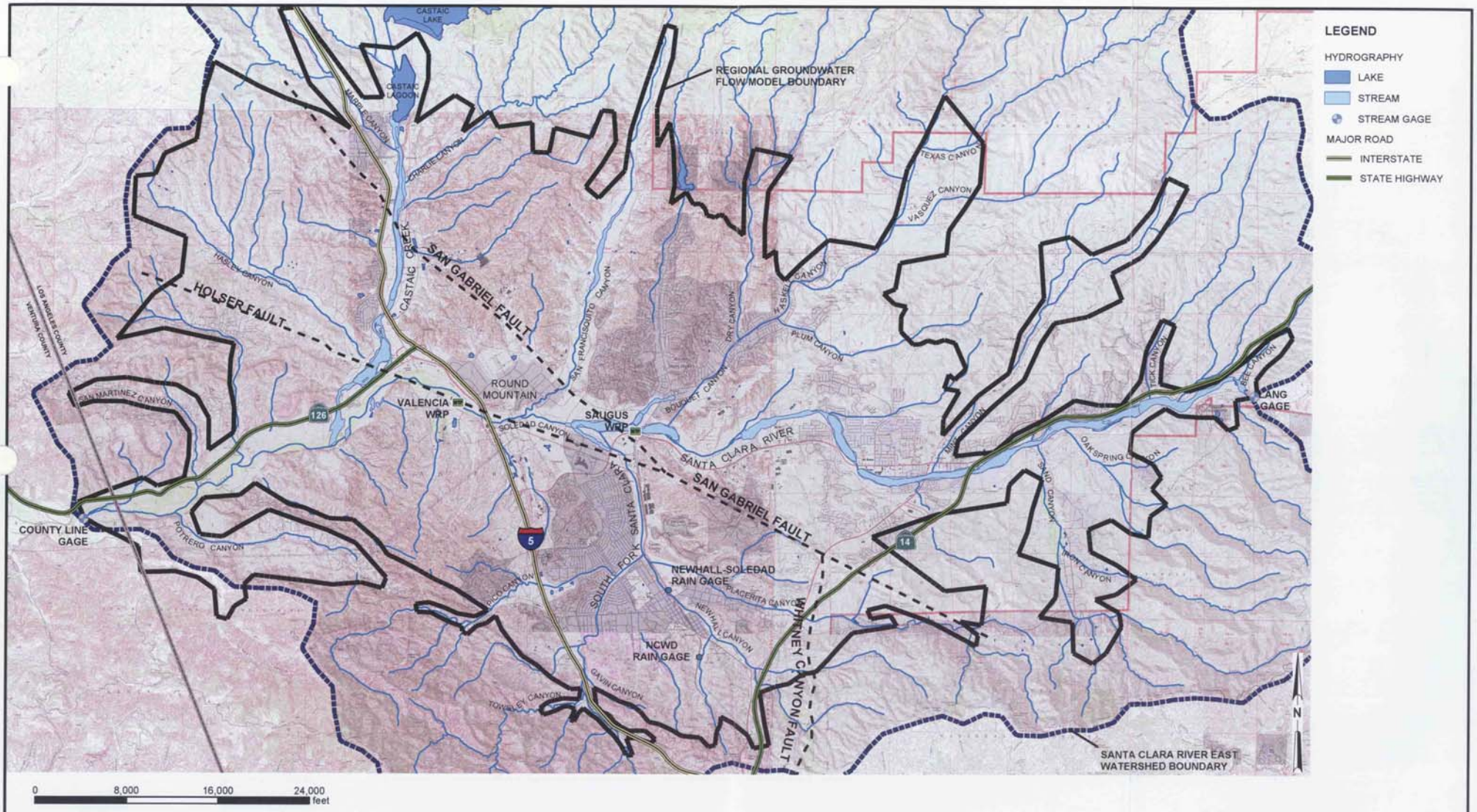

FIGURE C-1
MAP OF STUDY AREA
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIGC-01.MXD FIGC-01.PDF

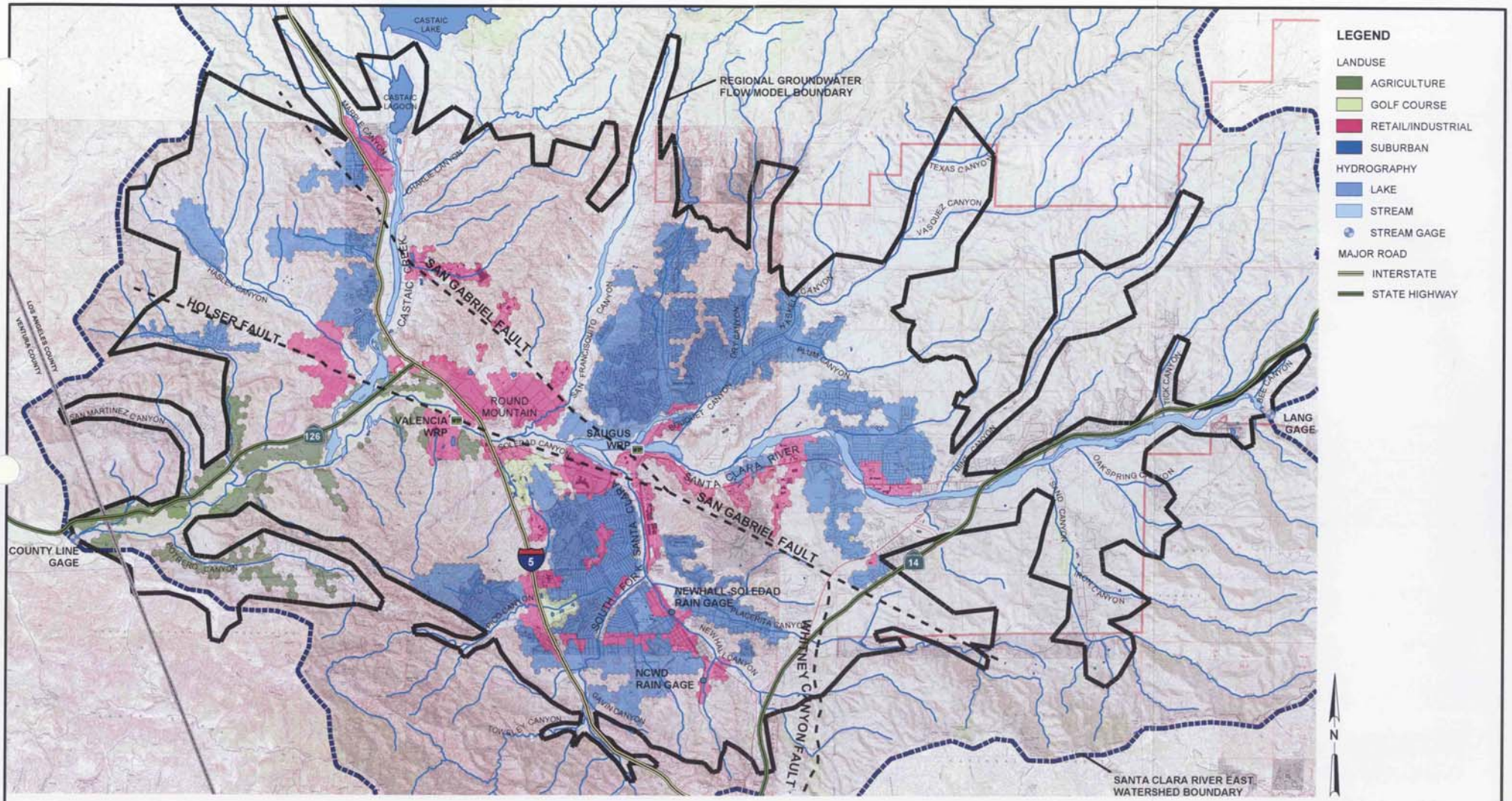

FIGURE C-2
LAND USE MAP
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIGC-06.MXD FIGC-02.PDF 02/03/2004 09:36:51

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Year	Acres				Acreage %		
	Alfalfa	Sudan	Vegetables	Total	Alfalfa	Sudan	Vegetables
1996	105	170	537	812	12.9%	20.9%	66.1%
1997	160	103	663	926	17.3%	11.1%	71.6%
1998	115	100	590	805	14.3%	12.4%	73.3%
1999	55	150	709	914	6.0%	16.4%	77.6%
2000	55	150	722	927	5.9%	16.2%	77.9%
Average	**98**	**134.6**	**644.2**	**876.8**	**11.3%**	**15.4%**	**73.3%**

Year	CIMIS AF/yr		
	Alfalfa	Sudan	Vegetables
1996	10.21	10.21	7.3
1997	10.22	10.22	7.3
1998	9.4	9.4	6.71
1999	10.51	10.51	7.51
2000	10.37	10.37	7.41
Average	**10.142**	**10.142**	**7.246**

Year	Water Use (AF/yr)			
	Alfalfa	Sudan	Vegetables	Total
1996	1,072	1,736	3,920	6,728
1997	1,635	1,053	4,840	7,528
1998	1,081	940	3,959	5,980
1999	578	1,577	5,325	7,479
2000	570	1,556	5,350	7,476
Average	**987**	**1,372**	**4,679**	**7,038**

Data Source: Appendix 2.5(m) of
Draft Additional Analysis to the Newhall Ranch Specific Plan and Water Reclamation Plant, Final Environmental Impact Report
Impact Sciences, Inc., April 2001)

Crop Efficiency		
Alfalfa	Sudan	Vegetables
50%	50%	70%

Year	Estimated Infiltration (AF/yr)			
	Alfalfa	Sudan	Vegetables	Total
1996	536	868	1,176	2,580
1997	818	526	1,452	2,796
1998	541	470	1,188	2,198
1999	289	788	1,597	2,675
2000	285	778	1,605	2,668
Average	**494**	**686**	**1,404**	**2,583**

Year	Estimated Infiltration (AF/acre/yr)			
	Alfalfa	Sudan	Vegetables	Total
1996	5.1	5.1	2.2	3.2
1997	5.1	5.1	2.2	3.0
1998	4.7	4.7	2.0	2.7
1999	5.3	5.3	2.3	2.9
2000	5.2	5.2	2.2	2.9
Average	**5.1**	**5.1**	**2.2**	**2.9**

This represents the average deep percolation on irrigated acreage during the past 5 years, consistent with the water application of an average 7,038 AF/yr during this period. Values are in AF/acre/year, which is equivalent to feet/year.

FIGURE C-3
ANALYSIS OF AGRICULTURAL WATER USE AND ASSOCIATED INFILTRATION TO GROUNDWATER
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

178973-409.xls\FigureC-3

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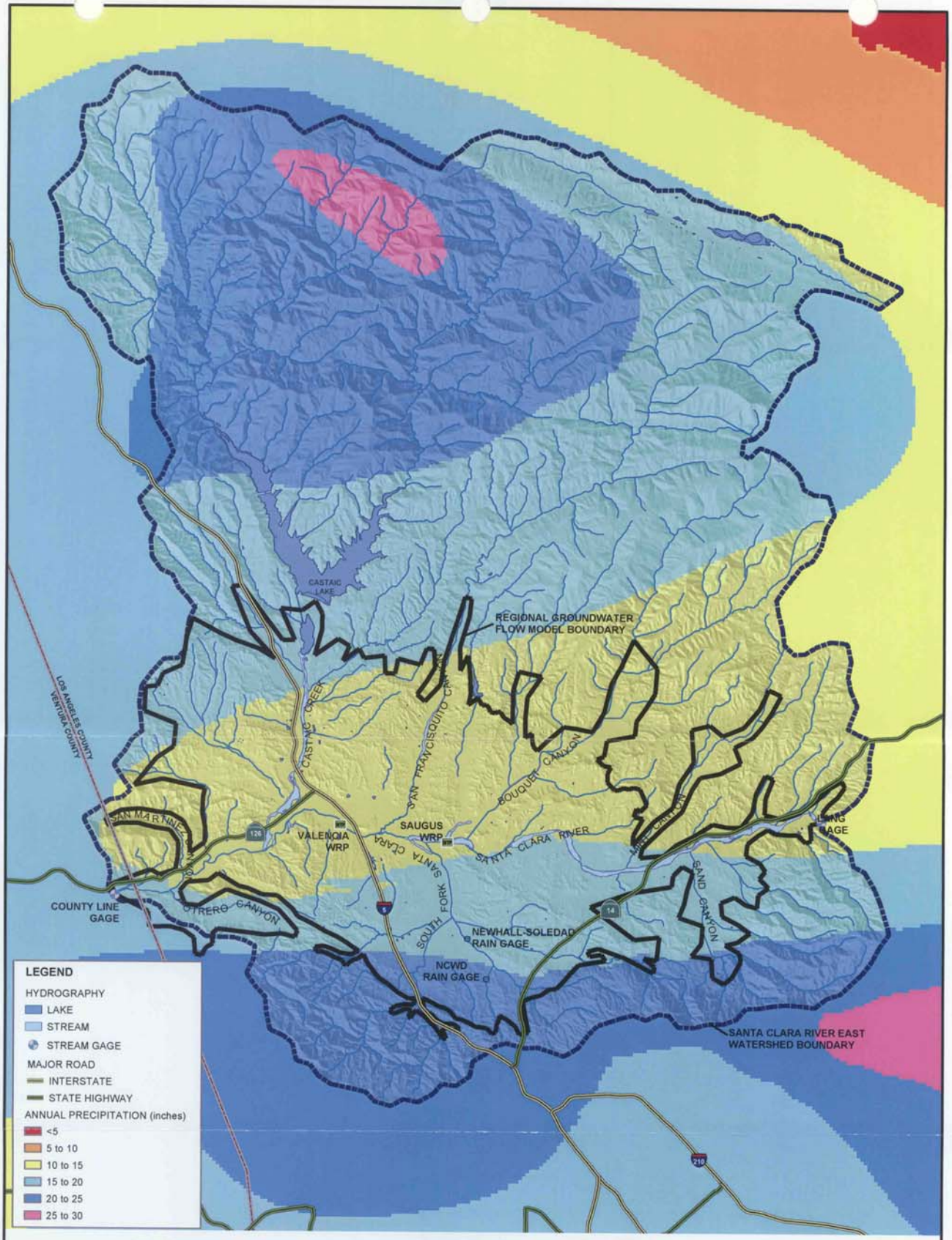

SOURCE: SEE THE INTERNET SITE HTTP://GIS.CA.GOV/META.EPL?OID=286 FOR MORE INFORMATION.

FIGURE C-4
ISOHYETAL MAP SHOWING AVERAGE ANNUAL PRECIPITATION PATTERN FROM 1900 TO 1960
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

RDD \\ODIN\PROJ2\55\SANTACLARITA_MOU\FIGURES\MXD\FIGC-07.MXD FIGC-07.PDF

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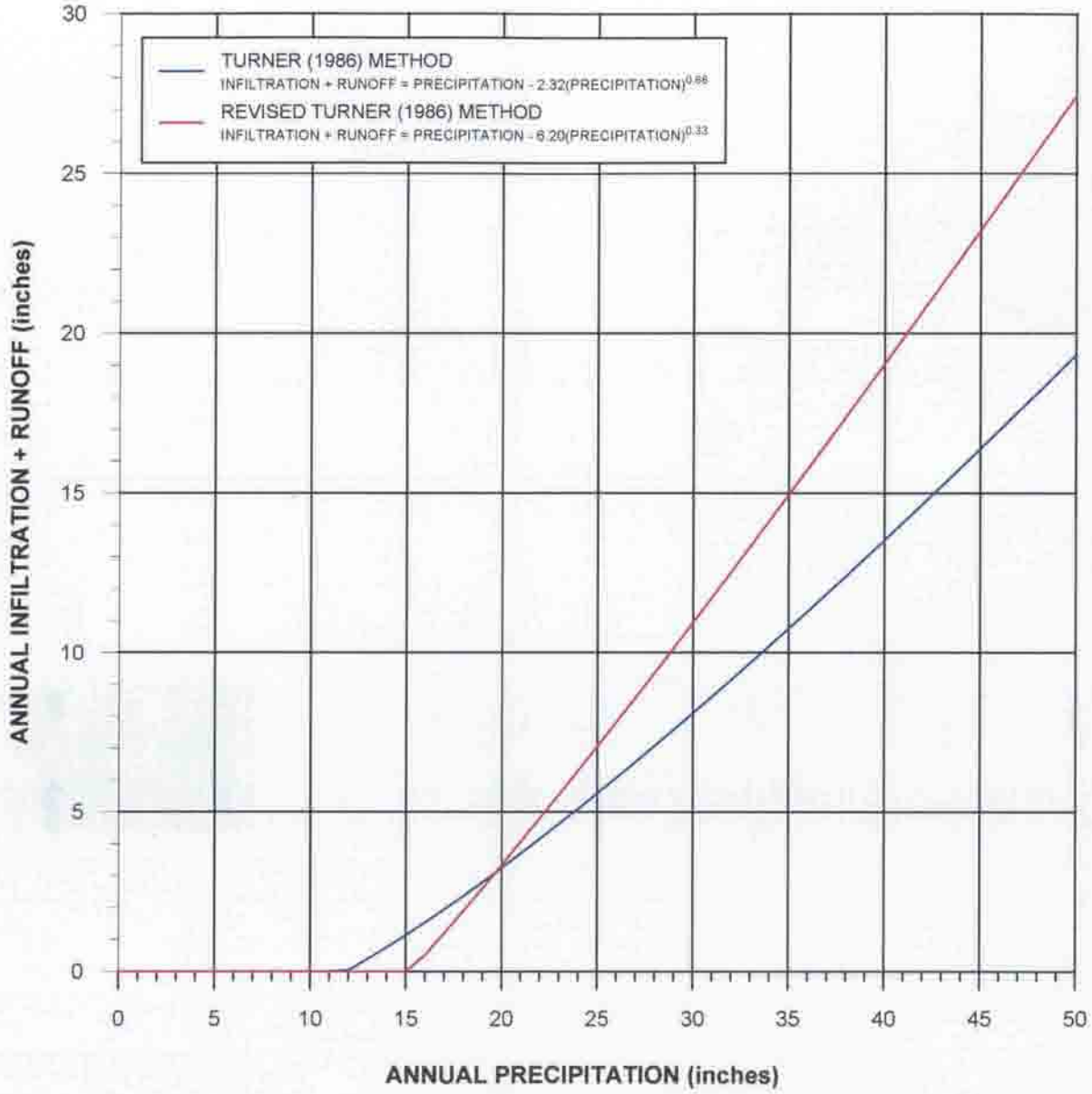

SOURCE:

TURNER, K.M. 1986. WATER LOSS FROM FOREST AND RANGE LANDS IN CALIFORNIA. *IN* PROCEEDINGS OF THE CHAPPARRAL ECOSYSTEMS CONFERENCE, SANTA BARBARA, CALIFORNIA, MAY 16-17, 1986, J. DEVRIES (EDITOR). WATER RESOURCES CENTER, REPORT 62, UNIVERSITY OF CALIFORNIA-DAVIS, CALIFORNIA, PP. 63-66.

FIGURE C-5
INFILTRATION AND RUNOFF AS A FUNCTION OF PRECIPITATION
REGIONAL GROUNDWATER MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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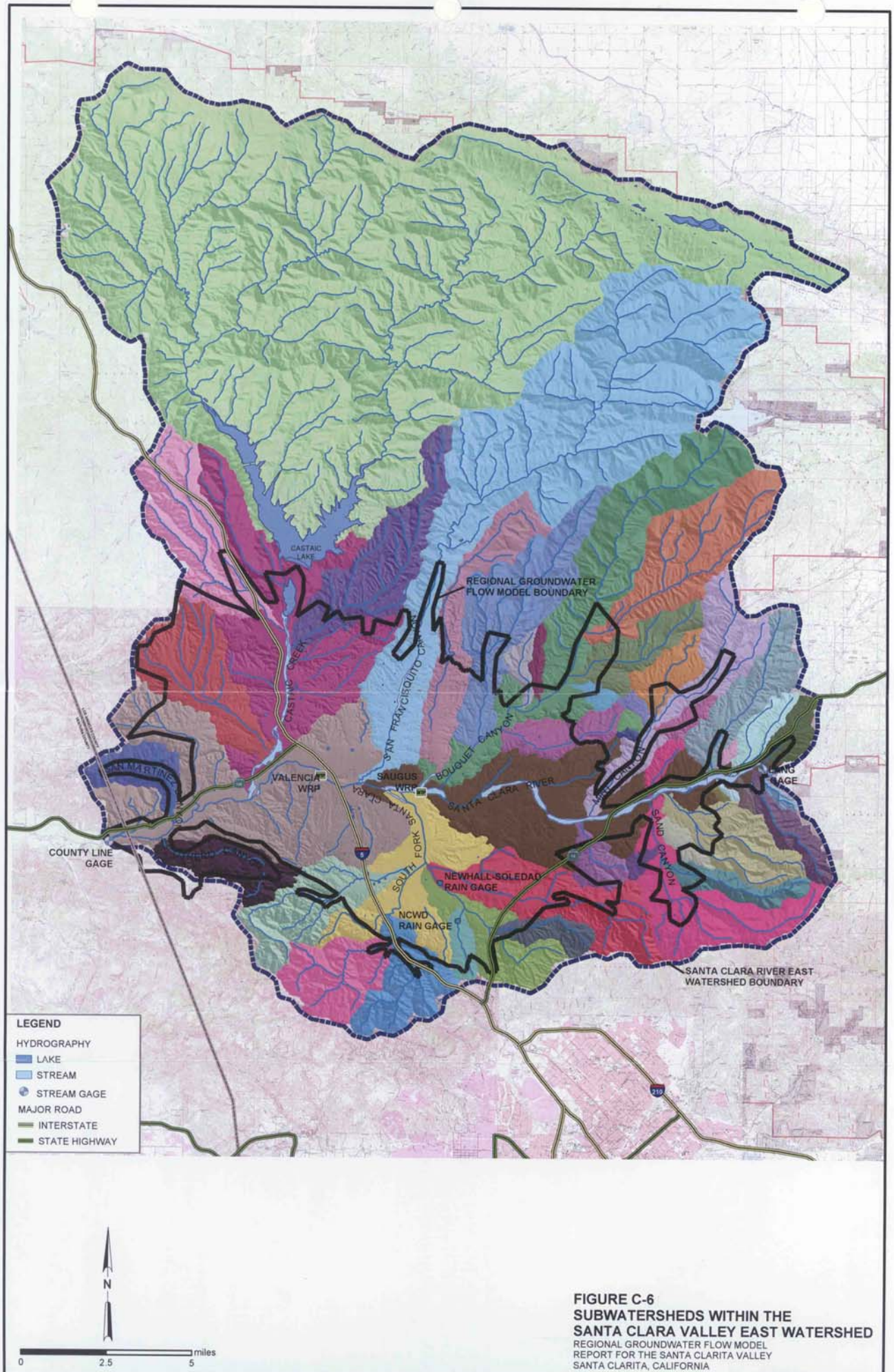

FIGURE C-6
SUBWATERSHEDS WITHIN THE SANTA CLARA VALLEY EAST WATERSHED
REGIONAL GROUNDWATER FLOW MODEL
REPORT FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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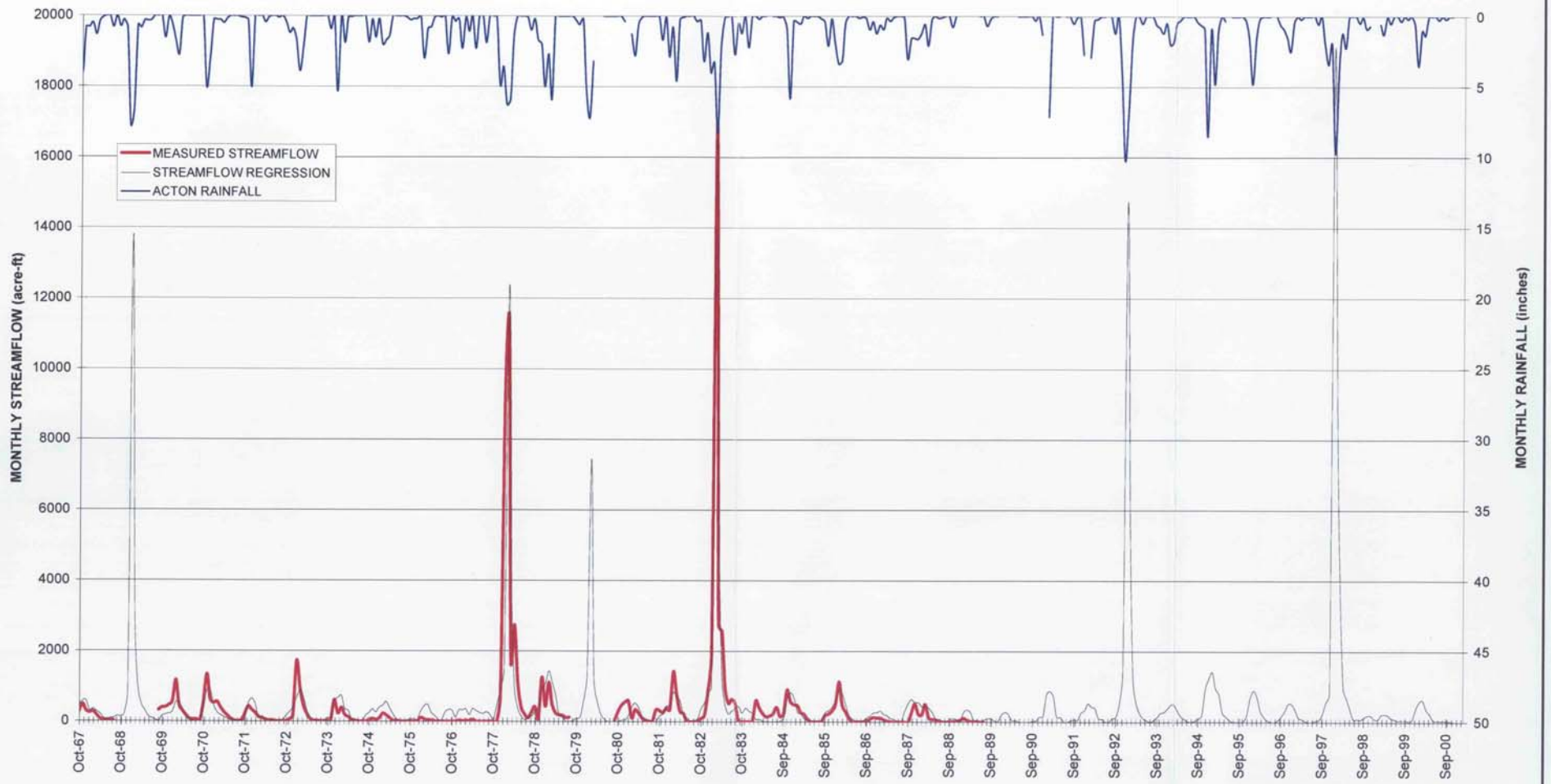

REGRESSION EQUATION:
MONTHLY STREAMFLOW AT LANG = 90.00*1 mo + 120.00*2 mo + 100.00*3 mo + 20.00*4 mo + 20.00*5 mo + 2.00*6 mo

FIGURE C-7
SANTA CLARA RIVER STREAMFLOW REGRESSION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

CH2MHILL

178973-408.xls/FIG C-7

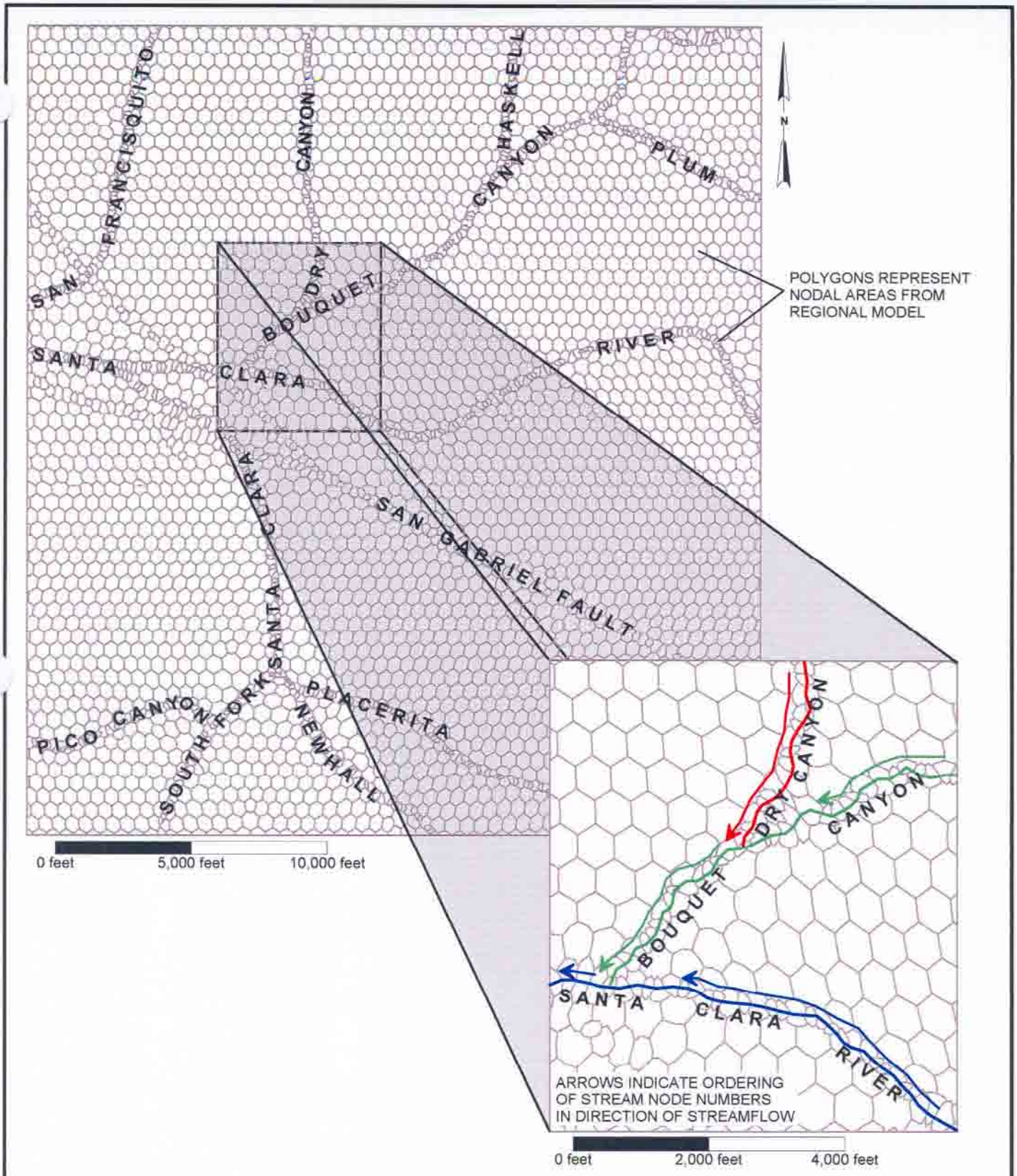

FIGURE C-8
MAP SHOWING EXAMPLE OF STREAM RANKING
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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178973-401.SRF

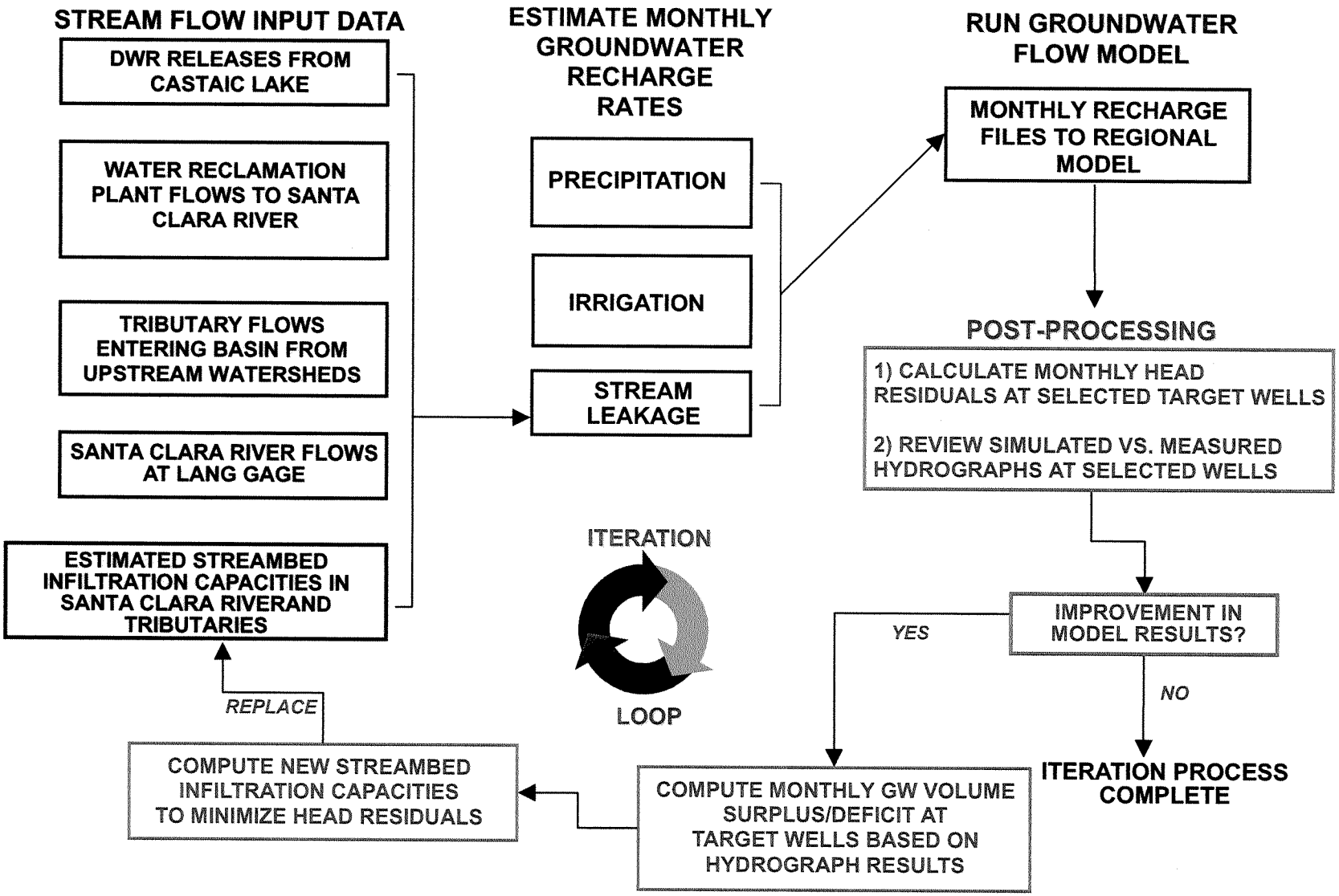

FIGURE C-9
FLOW CHART SHOWING ITERATIVE PROCESS USED TO VARY STREAMBED INFILTRATION CAPACITIES DURING MODEL CALIBRATION
REGIONAL GROUNDWATER FLOW MODEL
FOR THE SANTA CLARITA VALLEY
SANTA CLARITA, CALIFORNIA

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