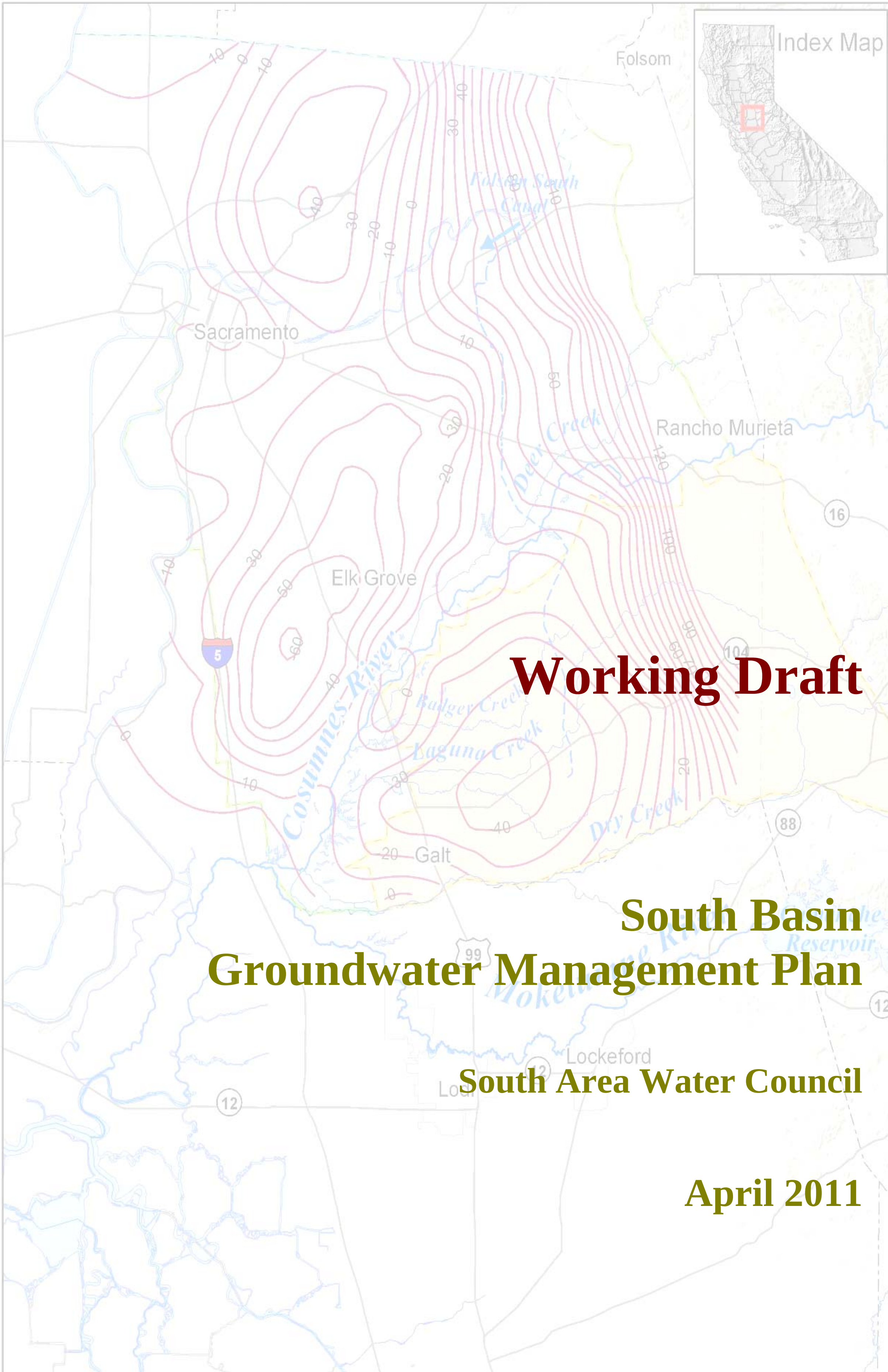

Working Draft

South Basin Groundwater Management Plan

South Area Water Council

April 2011

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South Basin Groundwater Management Plan

Prepared for:

South Area Water Council

April 2011

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Abbreviations and Acronyms

BMO	Basin Management Objectives
cfs	cubic feet per second
CWC	California Water Code
CVP	Central Valley Project
DP	deep percolation
DHS	Department of Health Services
DMS	data management system
DWR	California Department of Water Resources
GID	Galt Irrigation District
GMP	Groundwater Management Plan
IB	Boundary Inflow
JPA	Joint Powers Agreement
MSL	mean sea level
NGS	National Geodetic Survey
OHWD	Omochumne-Hartnell Water District
RMCSD	Rancho Murieta Community Services District
S	seepage from rivers
Se	baseflow to rivers
SacIGSM	Sacramento County Integrated Groundwater and Surface Water Model
SAWC	South Area Water Council
SCWA	Sacramento County Water Agency
SMUD	Sacramento Municipal Utility District
South Basin	South Sacramento County Groundwater Basin
TDS	total dissolved solids
TNC	The Nature Conservancy
Tp	pumping from groundwater
USGS	United States Geological Survey
Water Forum	Sacramento Area Water Forum
WWTP	Waste Water Treatment Plant

Executive Summary

Groundwater supports nearly 95 percent of all water demands in south Sacramento County Groundwater Basin (South Basin). Interested stakeholders formed the South Area Water Council (SAWC), which initiated the effort to develop a Groundwater Management Plan (GMP) for the south area of Sacramento County to protect the health and viability of this vital resource. A plenary committee of the SAWC recommended developing a Joint Powers Authority to implement the GMP.

The South Basin GMP provides a framework under which all users of the aquifer can move toward a commonly held set of goals and objectives concerning groundwater use and protection. The plan includes specific goals and objectives, and an action plan to provide a "road map" for the governance body as the steps necessary to manage the basin are taken in coordination with the various stakeholders. This Executive Summary is an outreach component of the South Basin GMP that brings forth the essence of the plan in a similar format but in a condensed manner that still allows a basic level of understanding. The reader is encouraged to refer to the body of the South Basin GMP document for more detail.

This GMP consists of five main sections: Land and Water Resources Setting, Basin Management Objectives, Monitoring Program, Implementation Plan, and Management Strategies Scenarios. A short description of each section is included in this executive summary.

Land and Water Resources Setting

This section provides stakeholders with a basic understanding of the groundwater conditions in the South Basin and the water demands and the sources that supply those demands. Information on water uses and supply sources is compared to groundwater and surface water available in the region.

Groundwater Conditions

In the last four decades, groundwater levels in wells outside the influence of the Cosumnes River have generally declined between 10 and 50 feet. The average annual decline in water levels in wells away from the Cosumnes River is approximately 1 foot; however, the more recent trend indicates less of a decline. Historical contour maps of the south basin show the cone of depression at the center of the basin deepened as a result of groundwater pumping.

Water Demand and Supply

Because of the scarcity of measured data, estimates of water demand rely on water demand duties applied to land use distribution surveys in the South Basin. There are approximately 158,000 acres in the South Basin. Agriculture occupies roughly 43,000 acres, grasslands and riparian areas occupy roughly 108,000 acres, and the remaining 7,000 acres is occupied by urban land uses. The water demands for these areas from 2000 to 2004 are summarized below. Data from this period represent the most current land use, crop patterns, and water demand in the basin.

Summary of water demands and supply sources for the South Basin, 2000–2004.

Category	Water Demand (acre-feet)	Water Supply Sources: Groundwater (acre-feet)	Reclaimed Water (acre-feet)	Surface Water (acre-feet)	Total Supply
Agricultural					
Irrigated Agriculture	132,100	125,300	2,700	4,100	132,100
Semi-Agriculture	11,700	11,700			11,700
Urban					
Galt	4,900	4,900			4,900
Rancho Murieta	2,000			2,000	2,000
Rural Residential	3,700	3,700			3,700
SMUD	1,600			1,600	1,600
Total:	156,000	145,600	2,700	7,700	156,000

Groundwater Balance

The groundwater balance for 2000–2004 indicates that the South Basin aquifer storage lost an average of 11,900 acre-feet of water annually due to drought conditions. But when we look into water demand for the longer period, 1980–2004, which contains both dry and wet years, the basin water balance indicates that the South Basin aquifer storage gained an average of 2,500 acre-feet of water annually during this period.

Basin Management Objectives

This section discusses four goals and related Basin Management Objectives (BMOs) proposed for the South Basin based on feedback from basin stakeholders. The goals and objectives focus on managing and monitoring the basin to benefit all groundwater users in the Basin. BMOs are used to help achieve groundwater basin goals.

The Stakeholders Plenary Group developed the following BMOs to meet the groundwater management plan goals listed below.

GOAL 1: Maintain Long-term Reliable Groundwater Supplies

BMO 1.1 – Understand the groundwater dynamics of the basin.

BMO 1.2 – Maintain or enhance groundwater elevations to meet the long-term needs of groundwater users within the Groundwater Management Area.

GOAL 2: Maintain or Improve Groundwater Quality

BMO 2.1 – Protect against adverse impacts to groundwater quality from man-made contaminants

BMO 2.2 – Protect against migration of contaminated groundwater.

BMO 2.3 – Monitor and control saline water intrusion.

BMO 2.4 – Facilitate implementation of policies and programs for wellhead protection, well abandonment and construction, by regulatory agencies.

GOAL 3: Maintain and Enhance Related Natural Resource Features of the South Basin.

BMO 3.1 – Enhance the understanding of groundwater-surface water interaction along the Cosumnes River and creeks in the Basin to protect against adverse impacts to surface water resources.

BMO 3.2 – Protect against inelastic land surface subsidence.

GOAL 4: Maintain Local Control of Groundwater management

BMO 4.1 – Coordinate development and optimize operation of, or implement as appropriate future water management projects.

BMO 4.2 – Actively develop and partner in conjunctive use projects of groundwater, surface water, and recycled water.

BMO 4.3 – Examine public agency's land use plans to identify potential impact on groundwater.

BMO 4.4 – Establish a procedure for sharing information with the public, appropriate resources management and regulation agencies on local, state, and federal levels.

Monitoring Program

This section describes a monitoring program capable of assessing the current status of the basin. The program includes:

- Monitoring groundwater elevations,
- Monitoring groundwater quality,
- Monitoring and assessing the potential for land surface subsidence resulting from groundwater extraction, and
- Monitoring Surface water- groundwater interaction which will lead to a better understanding of the relationship between surface water and groundwater along the rivers.

It is important to establish monitoring protocols to ensure the accuracy and consistency of data collected. Finally, the monitoring program includes a tool (Data Management System) for assembling and assessing groundwater-related data.

Implementation Plan

This section describes the structure and the method for implementing the Groundwater Management Plan after its adoption. The purposes of this implementation plan are to guide groundwater management efforts and carry out the proposed activities outlined in the BMOs section of this GMP.

The implementation plan components include:

Basinwide Management Actions – actions that are provided as suggested measures for facilitating the achievement of the BMOs described in the GMP.

Governing Structure

The plenary committee recommended that a new Implementation Authority be formed through a Joint Powers Authority to represent all the interests in the basin to carry out the implementation plan. The final structure of the governing body is still being negotiated by the stakeholders in the basin.

The primary roles of the implementation authority would include:

- Securing and providing funds for implementation of the GMP.
- Issuing and managing contracts necessary for implementation of the GMP.
- Overseeing the accuracy and quality of all reports associated with GMP implementation.

- Advancing and facilitating the goals and objectives identified in this GMP in a timely manner.
- Directing future updates to the GMP every 5 years, or more frequently if needed, to reflect changes in state laws or in local conditions/programs.
- Act as liaison between GMP implementation activities and agencies, individuals, and agencies represented by the group members.

Annual Review and Report

The Implementation Authority would be responsible for reporting on the progress of implementing the Southeast Sacramento County Groundwater Management Plan in an annual State of the Basin report. Prior to accepting the report, the Implementation Authority will consider comments from the general public.

Financing Mechanisms

Operational funding for Implementation Authority activities can be through annual member/participant contributions, county funding or state grants. The projects, policies, and programs that encompass the many groundwater-related management activities, can be funded through a variety of sources, which include, but are not limited to:

- Member/participant contributions
- Funding from other interested entities.
- In-kind services by other entities within the Basin.
- State or Federal grants programs

It is important to note that state grant programs or other sources of outside funding often require local financial support or contributions; therefore, local contributions may aid in the acquisition of outside funding to implement the plan.

Implementation Schedule

The Implementation Authority must initiate certain activities within the first year to fulfill statutory requirements for its formation. These activities include:

- Establish an authority board, its strategies, and structure.
- Monitoring groundwater status.
- Develop a Data Management System (DMS).
- Prioritize activities that can be undertaken immediately, taking into consideration public inputs.
- Acquire funding for first year activities.

The schedule for implementing the GMP must remain flexible to account for many factors that influence the implementation.

First year program start-up costs are estimated at $150,000 and the annual cost of plan operation is estimated at $75,000. The Implementation Authority will annually evaluate future programs.

Future Re-evaluation of GMP

The GMP and documents developed as part of the implementation are part of an on-going and evolving groundwater management program. The Implementation Authority will review the GMP and decide on updates based on new issues, changed conditions, and future technological advancements that will occur over time. Comprehensive review of the GMP will be scheduled every 5 years, unless the Authority decides it should be more frequently.

Management Strategies Scenarios

The Plenary Committee developed and evaluated alternatives for groundwater management that will facilitate achieving some of the BMOs, primarily conjunctive use and groundwater recharge. Alternatives are projects that could be reasonably implemented solely by the Authority or in conjunction with other stakeholders in the study area.

The SacIGSM Model simulated baseline and three alternative groundwater management strategies. The focus of these simulations was a comparative analysis. The results of these simulations showed groundwater elevation changes at several observation wells, changes in groundwater contours, and changes to the groundwater budget.

Comparison of simulations, particularly the baseline case, showed potential benefits of pursuing a particular management strategy. The model simulated 35 years of hydrology (1970 to 2004) with initial conditions of December 2004. The model delineated three aquifer layers based on DWR Bulletin 118-3, U.S. Geological Survey reports, numerous well logs, and California Division of Oil and Gas geographical logs. The top two aquifer layers—Upper Aquifer (Model Layer 1) and Lower Aquifer (Model Layer 2)—are fresh-water bearing aquifers.

Four simulations covered a range of potential management scenarios or options:

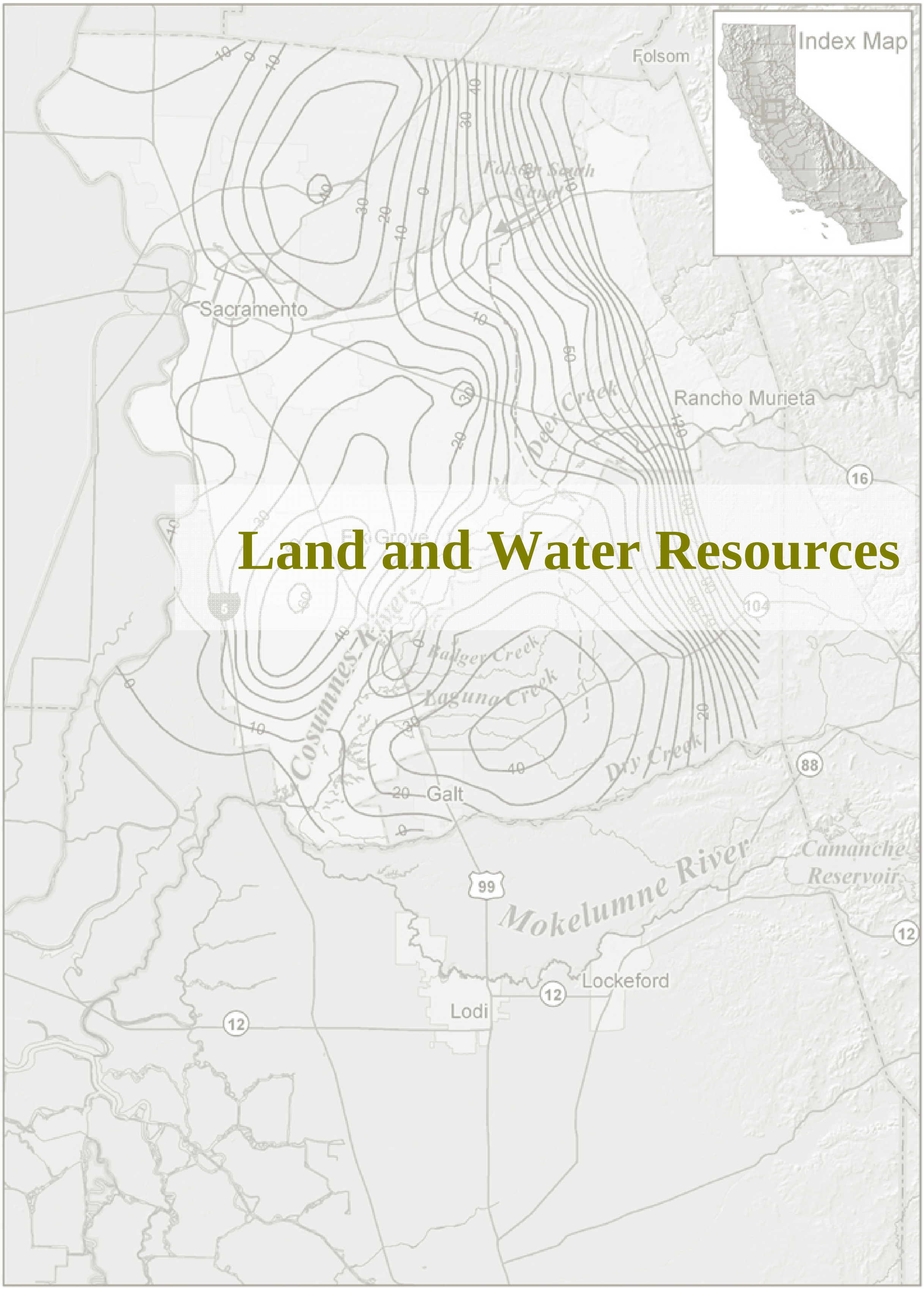
1. Continuation of existing conditions with no projects (baseline).
2. Conjunctive use - utilize available surface water supplies in lieu of pumping.
3. Direct Groundwater Recharge - spread available surface water supplies onto percolation basins and existing channels to directly recharge groundwater.

4. Combination of In-lieu Recharge and Direct Recharge - utilize available surface water supplies in lieu of pumping groundwater and directly recharge groundwater.

The results of the four scenarios showed:

- Higher groundwater elevations and increased average annual groundwater storage in the three management scenarios when compared to the baseline scenario.
- The combination of conjunctive use and direct recharge has the significant impact on the aquifer regarding both groundwater storage and the spatial distribution of the rise in water elevations when compared to the other management scenarios.
- The baseline conditions show somewhat stable, if not slightly increasing, water levels.
- Each of the alternatives would benefit neighboring areas almost equally as it benefits the targeted Planning and Jurisdictional areas by reducing the long-term subsurface boundary flow into the basin.

Land and Water Resources



1 Land and Water Resources

1.1 Introduction

Groundwater is one of California's most valuable resources and requires protection and proper management to maintain its beneficial uses. The South Area Water Council (SAWC) has initiated the effort to develop a Groundwater Management Plan (GMP) for the south area of Sacramento County. Groundwater supports nearly 95 percent of all water demands in south Sacramento County Groundwater Basin (South Basin). Therefore, to protect the health and viability of this vital resource, interested stakeholders have come together to develop a GMP.

The purpose of developing this Land and Water Resources section is to provide stakeholders with a basic understanding of the groundwater conditions in the south basin and the water demands and the sources that supply those demands. Information on water uses and supply sources is then compared to groundwater and surface water available in the region. This comparison allows a determination of the balance between demand and available supply.

1.1.1 Groundwater Conditions

In general, wells near the Cosumnes River showed a stable groundwater level trend, while wells away from the river showed a declining trend.

In the last four decades, groundwater levels in wells outside the influence of the Cosumnes River have generally declined between 10 and 50 feet. The average annual decline in water levels in wells away from the Cosumnes River is approximately 1 foot. Historic contour maps of the south basin developed by different agencies, showed an increase in the size of the cone of depression at the center of the basin as a result of increased pumping.

1.1.2 Water Demand and Supply

Water demand data is scarce in the South Basin because most water uses are supplied from private wells that serve this predominately rural agricultural area and these wells are not metered. Therefore, estimates of water demand are based primarily on water demand duties applied to land use distributions surveys in the South Basin. There are approximately 158,000 acres in the South Basin and agriculture occupies roughly 43,000 acres, grasslands and riparian areas occupy roughly 108,000 acres, and the remaining 7,000 acres is occupied by urban land uses. The water demands for these areas for the period from 2000 to 2004 are summarized in **Table 1-1**. Data from this period represent the most current land use, crop patterns, and water demand in the basin.

Table 1-1. Summary of water demands and supply sources for the South Basin (Planning Area) 2000–2004.

Category	Water Demand (acre-feet)	Water Supply Sources: Groundwater (acre-feet)	Reclaimed Water (acre-feet)	Surface Water (acre-feet)	Total Supply
Agricultural					
Irrigated Agriculture	132,100	125,300	2,700	4,100	132,100
Semi-Agriculture	11,700	11,700			11,700
Urban					
Galt	4,900	4,900			4,900
Rancho Murieta	2,000			2,000	2,000
Rural Residential	3,700	3,700			3,700
SMUD	1,600			1,600	1,600
Total:	156,000	145,600	2,700	7,700	156,000

A groundwater and surface water balance can be performed based on estimated water demands and available water supply sources in the South Basin. The water balance will allow local planners and stakeholders to determine the long-term viability of the resource.

1.1.3 Groundwater Balance

The information for the groundwater balance is derived from the data presented in Table 1-1 and from data extracted from a regional groundwater model. The groundwater balance components are expressed in acre-feet in **Table 1-2**.

This balance shows the inflows and withdrawals from the regional groundwater aquifer based on water demand data from 2000–2004. This information indicates that the South Basin aquifer storage lost an average of 11,900 acre-feet of water annually during this period due to drought conditions. But when we look into water demand for the longer 1980–2004 period, which contains both dry and wet years, the basin water balance indicates that the South Basin aquifer storage gained an average of 2,500 acre-feet of water annually during this period.

Table 1-2. Summary of modeled groundwater balance in the South Basin.				
Inflow (acre-feet)	**1980–2004**		**2000–2004**	
Infiltration (rainfall & irrigation)	+59,500		+48,400	
Seepage from streams	+60,200		+52,300	
Sub surface inflow from adjacent basins	+3,300		+33,000	
Subtotal		157,000		+133,700
Outflow (acre-feet)				
Groundwater withdrawals	-154,500		-145,600	
Subtotal		154,400		-145,600
Change in groundwater storage		+2,500		-11,900

Table 1-3. Summary of modeled surface water balance in the South Basin.		
Inflow (acre-feet)		
Inflow to local Rivers & creeks	+537,000	
Local runoff to creeks	+65,000	
Locally generated discharge	+15,000	
Subtotal		+617,000
Outflow (acre-feet)		
Seepage to aquifer	-52,300	
Irrigation and urban	-9,700	
Outflow to the Delta	555,000	
Subtotal		+617,000
Balance		0

1.1.4 Surface Water Balance

A similar, simplified, balance can be performed for surface water resources. The surface water balance of the South Basin is summarized in T**able 1-3.**

This surface water balance provides an average estimate of the available water from local streams, rainfall, and local discharges. Because there is limited data on many of the creeks in the basin, it is difficult to develop an accurate balance. However, this simplified balance shows that very little surface water is used to meet irrigation and urban demands compared to the amount of surface water flowing through the area. Currently, the most significant benefit of surface water is recharge to the local aquifer.

Streamflow is seasonal in the South Basin, that is, most of the flow in the local rivers and creeks occurs during the winter when there is no demand for irrigation water. During the summer, with the exception of locally generated discharges, the rivers and creeks that cross the basin are typically dry and therefore do not support irrigation demands.

1.2 Study Area Boundaries

The study area for this GMP includes several regionally important planning boundaries that define the area covered by this GMP. **Figure 1-1** depicts the overlap of the various planning areas related to this GMP.

Throughout this document reference will be made to Jurisdiction and Planning areas. Information on land uses, water demands, and other physical characteristics will often be shown for both areas. Segregation of this information will help in developing appropriate basin management objectives in the South Basin, and provide a basis for developing a cooperative management strategy for the water resources of the area.

As Figure 1-1 shows, the GMP Planning Area for this effort is the area of the Cosumnes subbasin (as defined by California Department of Water Resources (DWR)) within Sacramento County. This area includes all of the South Basin and a portion of the Central Basin, as defined by the Water Forum Agreement. Outside of the South Basin, the Planning Area includes the Cosumnes River corridor, which encompasses Rancho Murieta, Omochumne-Hartnell Water District (OHWD), and the Cosumnes River Preserve—all of which lie within the Central Basin. This overlapping area is of joint interest to both the Central and South basins and will be cooperatively managed in the future.

The GMP Jurisdiction Area is that portion of the South Basin entirely within Sacramento County (**Figure 1-2**). The Jurisdiction Area is so named because it is the area over which the GMP will have management jurisdiction. The portion of the Planning Area within the Central Basin is managed by the Sacramento Central Groundwater Authority, which has developed and adopted a GMP for the Central Basin.

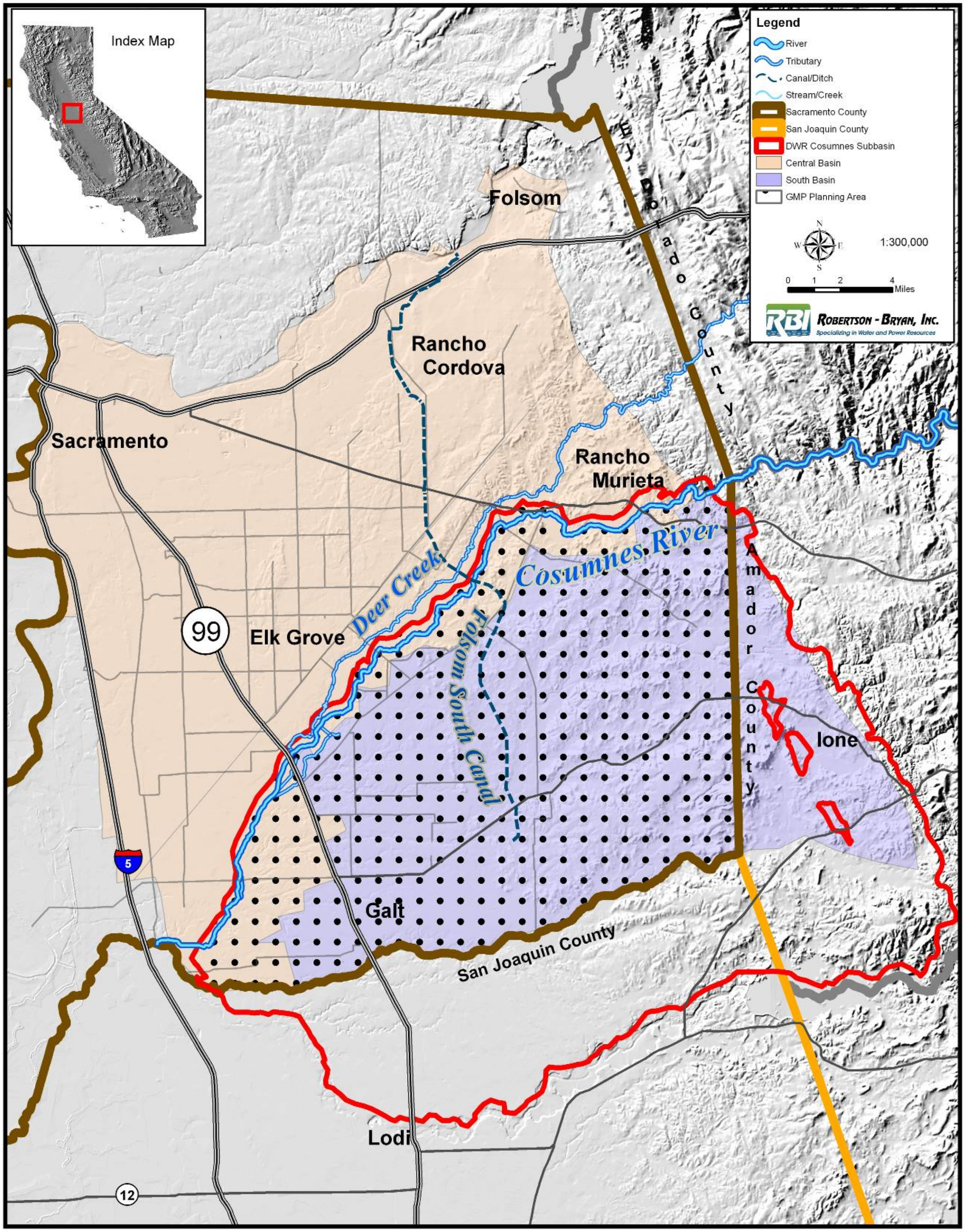


Figure 1-1. Planning Area for the South Sacramento County GMP.

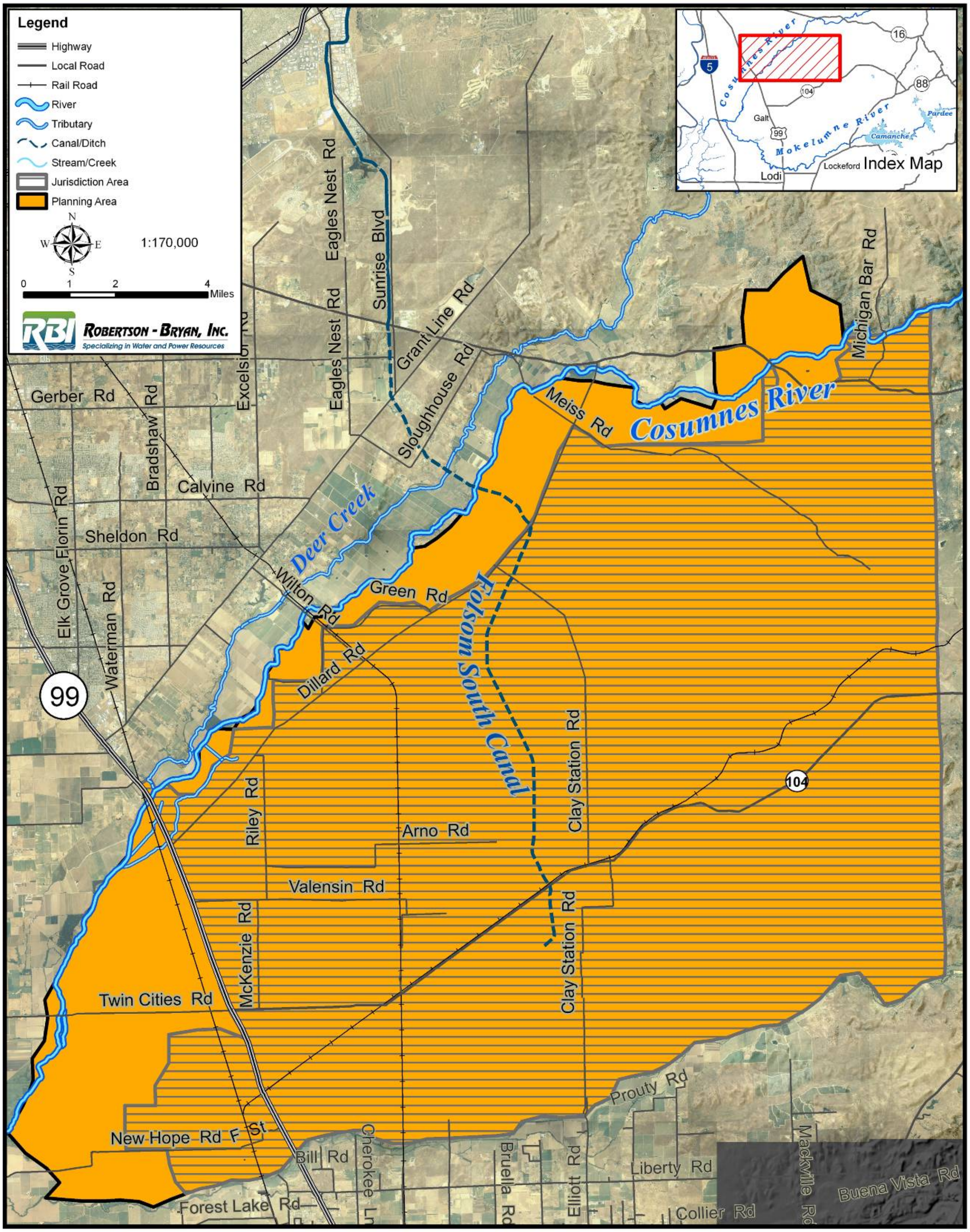


Figure 1-2. Planning and Jurisdiction areas of the South Sacramento GMP.

1.3 Hydrologic Characterization of the South Basin

The hydrologic setting section describes the current understanding of surface and subsurface hydrologic conditions in the south area. This section provides an overview of the surface water and groundwater resources available in the area.

Groundwater is the major supply source for nearly all agricultural, residential, and municipal users in southern Sacramento County. Characteristics of the local hydrogeology and groundwater-level trend in the area are described to provide readers an understanding of impacts of past, current, and future demands on this resource.

1.3.1 Hydrology

The South Basin is bounded by the Cosumnes River on the north and west and Dry Creek on the south. The Amador County line is the eastern boundary of the South Basin. Several small creeks—Deer, Badger and Laguna—drain portions of the basin westward (**Figure 1-3**). No flow monitoring stations exist on either Badger Creek or Laguna Creek; therefore, no historical flow data is available.

Annual precipitation in the South Basin ranges from approximately 15 inches on the west to about 22 inches on the east (DWR 2003). Winter storms between November and March account for about 80 percent of the annual precipitation in the basin. As Table 1-3 shows, local runoff generated by precipitation (65,000 acre-feet), inflow from rivers, streams, and creeks (537,000 acre-feet), and locally generated discharge from irrigation and other manmade activities (15,000 acre-feet) generate an average annual surface flow from the South Basin of 617,000 acre-feet. The Cosumnes River is the major source of surface flow to the south area with an average annual flow of 312,000 acre-feet per year, and is a major source of groundwater recharge for the Central and South basins. Other creeks in the basin—Deer, Badger, Laguna, and Dry—contribute the balance (225,000 acre-feet) at the estimated annual stream flow in the South Basin (537,000 acre-feet).

Flows on the Cosumnes River are unregulated and result primarily from winter storms and seasonal snowmelt. Approximately 16 percent of the watershed lies above the typical snow-level elevation of 5,000 feet. Consequently, only a small portion of the upper reaches of the watershed receives significant snowfall; and the flow regime of the river is influenced primarily by rainfall.

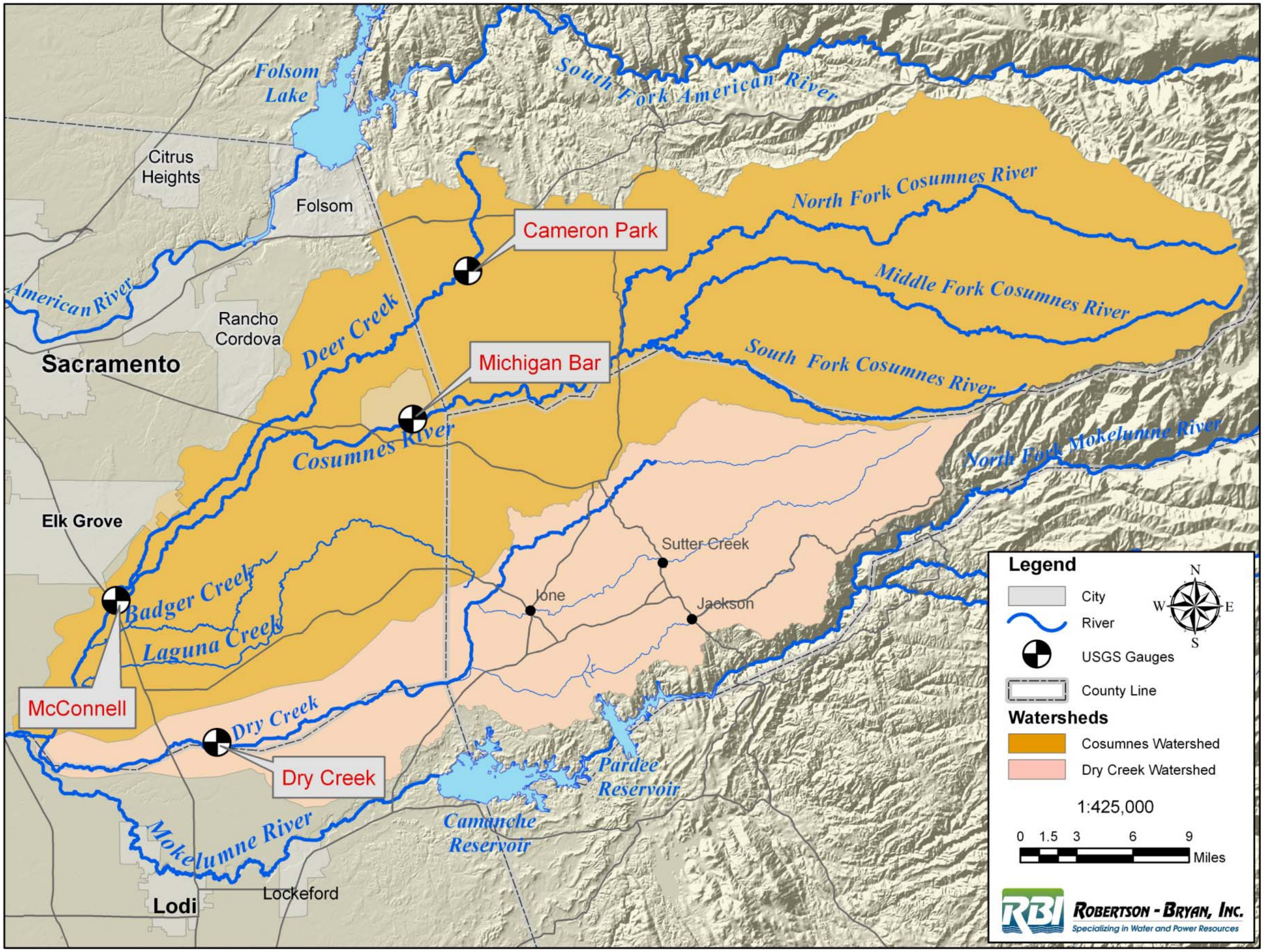


Figure 1-3. Cosumnes River and Dry Creek Watershed.

The historical average daily flow of the Cosumnes River at the U.S. Geological Survey (USGS) gauge at Michigan Bar is shown in **Figure 1-4** for water years 1907 to 2008, and the average monthly flow pattern is shown in **Figure 1-5**. **Table 1-4** provides the average monthly flow by water year type for the 1907 to 2008 period of record. The Cosumnes River exceedance diagram in **Figure 1-6** indicates a highly variable flow pattern for each season, with flow primarily occurring in the winter and spring and minimal flow in the summer and fall. The flow record for Michigan Bar includes all upstream operations, including released from Sly Park Reservoir for agricultural use along the lower reaches of the Cosumnes River.

A comparison of historical flows in the Cosumnes River between the USGS gauges at Michigan Bar and McConnell (Figure 1-3) illustrates that the river loses flow in its lower reaches. This loss is attributable to seepage to the groundwater aquifer, evaporation, and evapotranspiration. These two gauges can be compared between October 1, 1941, and September 30, 1982, when the McConnell gauge was in operation. During this period, flow at Michigan Bar is compared to flow at McConnell for days when flow at Michigan Bar is less than or equal to 100 cubic feet per second (cfs) and the flow difference between two consecutive days is less than 10 cfs, to avoid periods when flows were increasing due to precipitation. It was assumed that for flows less than 100 cfs, it would take two days for the flow at Michigan Bar to reach McConnell and hence a lag of two days was used for the comparison. Comparison of average daily flow at Michigan Bar and McConnell is shown in **Figure 1-7**, which illustrates that the river loses flow between the two gauges. For instance, an average daily flow of 40 cfs at Michigan Bar typically results in only 10 cfs at McConnell. The data also show that when flow at Michigan Bar is less than or equal to 30 cfs, 85 percent of the time there is no flow at McConnell.

Deer Creek

Deer Creek drains an area of low foothills approximately 9 miles northeast of Highway 16. Historically, Deer Creek and the Cosumnes River were part of the same connected floodplain downstream of Dillard Road, but are now separated by a system of levees. Historical flow data for Deer Creek is limited. Sacramento County maintains a stage gauge on Deer Creek at Wilton Road and Scott Road. The purpose of these gauges is to provide flood level warnings; they do not provide flow values. In 2004 the USGS installed a flow monitoring station on Deer Creek near Cameron Park. **Figure 1-8** shows the average monthly flow for Deer Creek for the data available since April 2004.

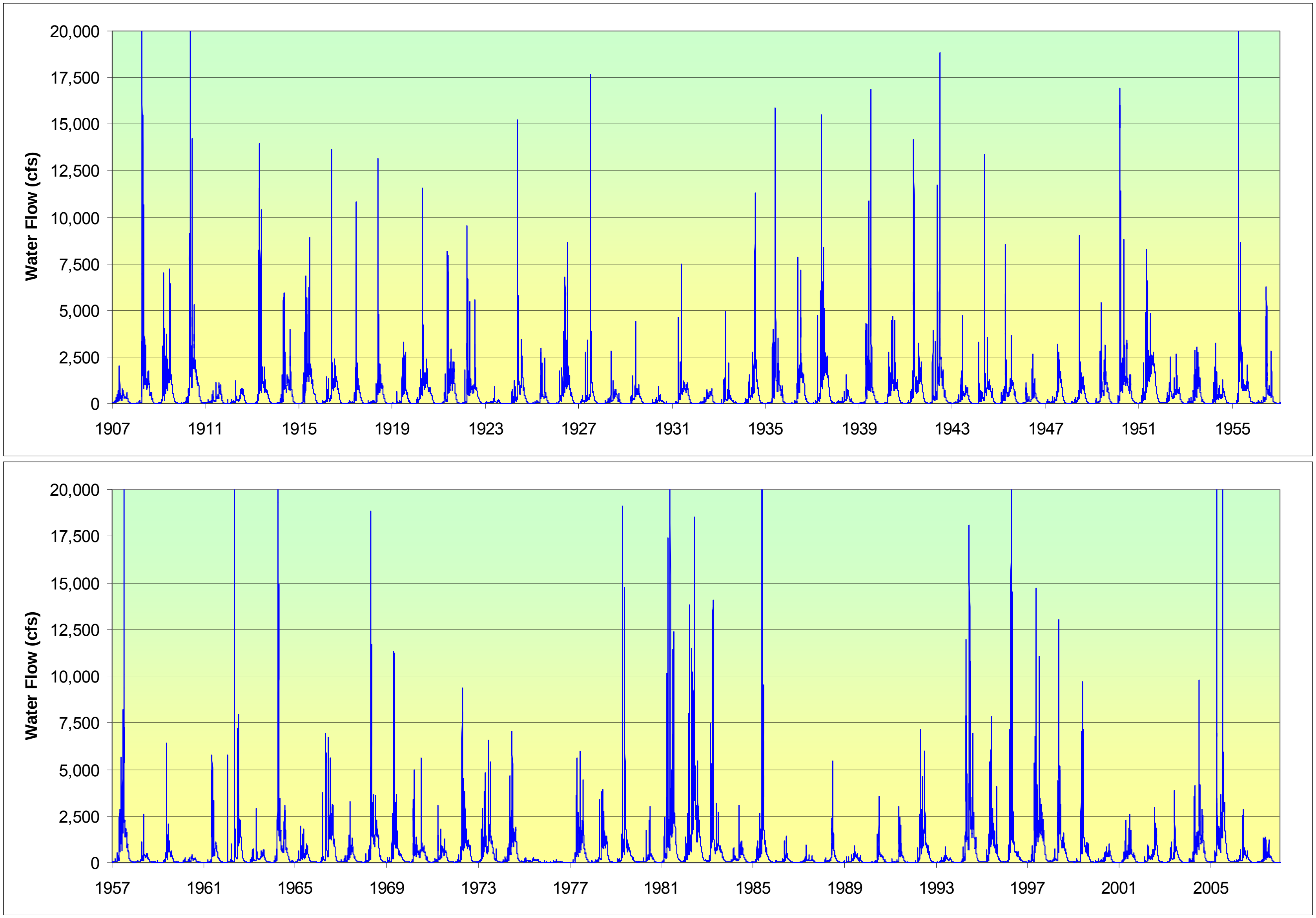


Figure 1-4. Average daily streamflow for Cosumnes River Water Years 1907 to 2008.

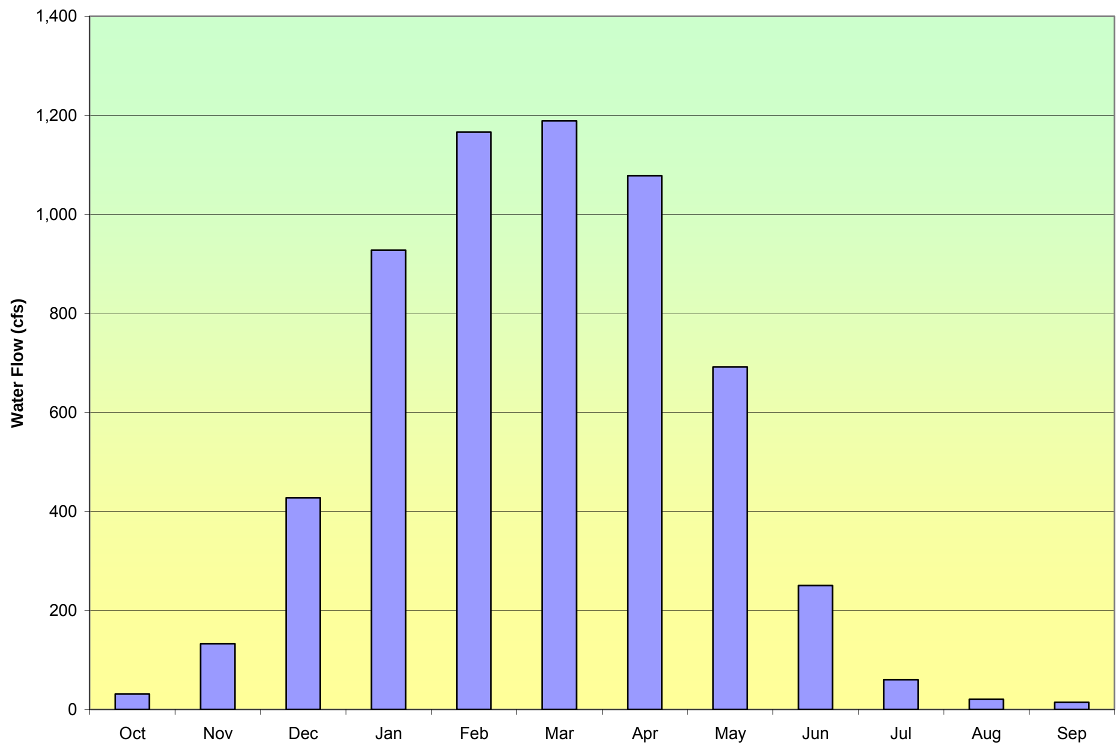


Figure 1-5. Average monthly streamflow for Cosumnes River Water Years 1907 to 2008.

Table 1-4. Average monthly streamflow for Cosumnes River by Water Year Type for Water Years 1907 to 2008.

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Flow
	cubic feet per second												acre-feet
Period Average	32	134	378	748	1,020	1,042	959	602	213	50	18	13	312,070
Wet	29	121	698	1,946	1,989	2,032	1,764	1,213	470	117	38	27	626,260
Above Normal	49	344	773	1,108	1,700	1,261	1,246	695	230	54	21	15	448,128
Below Normal	24	79	185	274	665	954	994	636	214	42	13	11	245,419
Dry	33	87	162	266	457	532	483	284	90	24	13	7	146,021
Critical	23	40	71	148	290	431	308	184	59	14	5	4	94,520

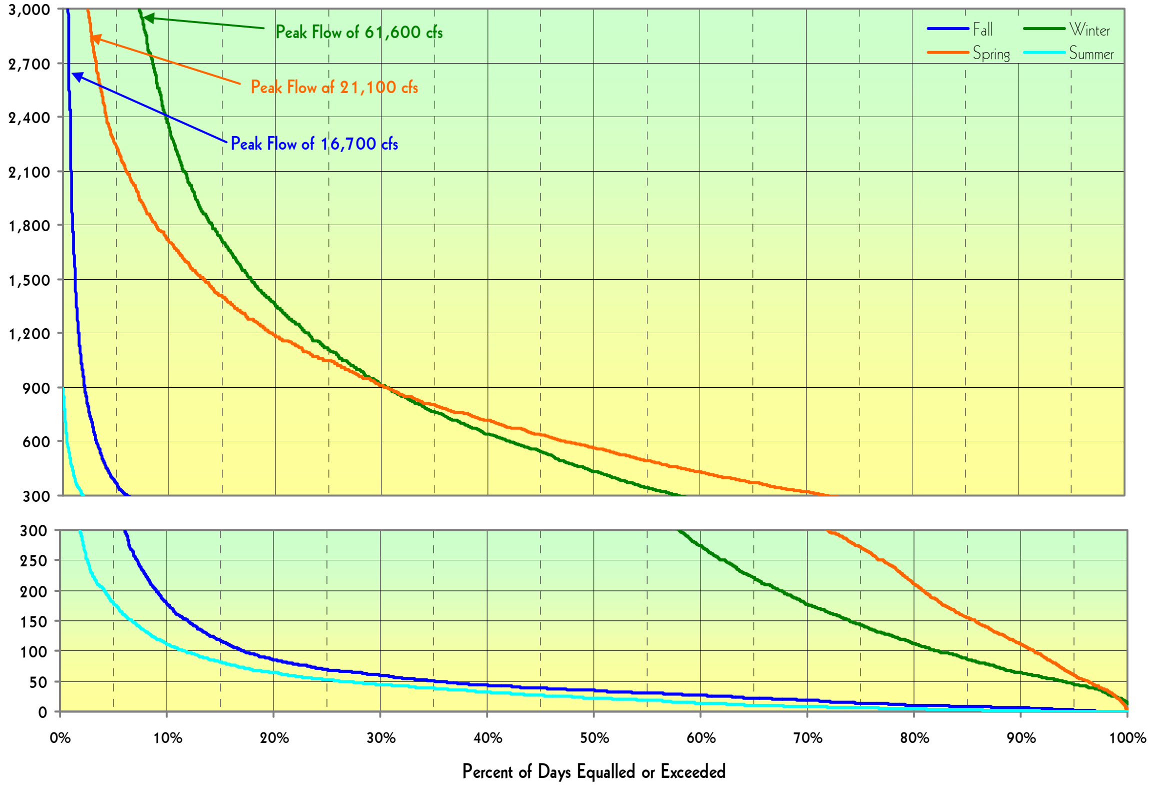


Figure 1-6. Seasonal exceedance of Cosumnes River at Michigan Bar.

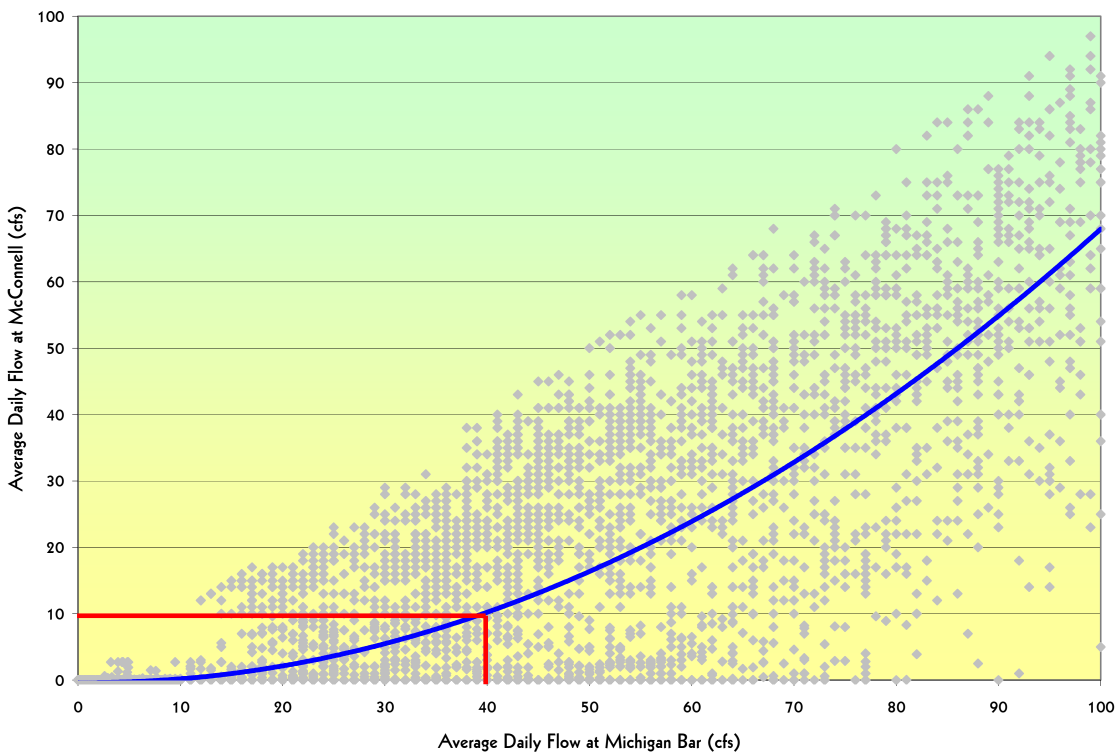


Figure 1-7. Comparison of flow between Cosumnes River at Michigan Bar and McConnell.

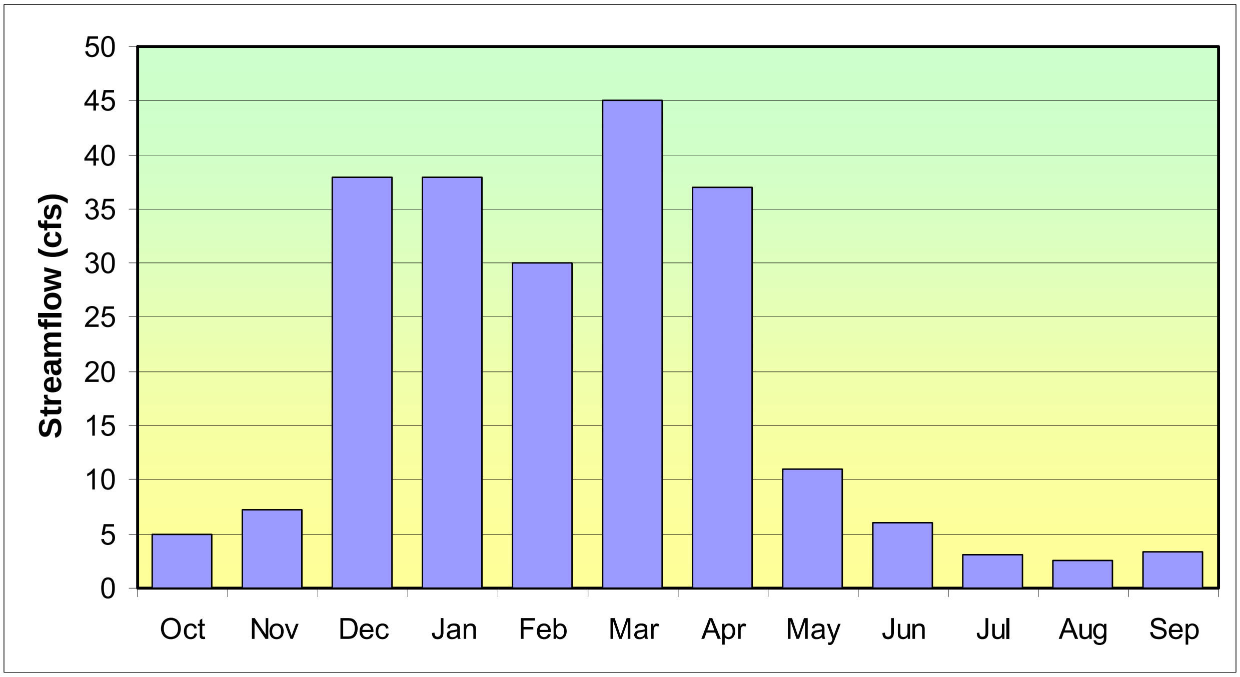


Figure 1-8. Average monthly streamflows on Deer Creek near Cameron Park for 2004 to present (USGS data).

Dry Creek

Dry Creek, a tributary to the Cosumnes River, drains about 348 square miles of the Sierra Nevada and Central Valley between the Cosumnes and Mokelumne watershed. The upper Dry Creek watershed has a peak elevation of approximately 3,300 feet in an area characterized by relatively steep slopes. Dry Creek historically connected to the Mokelumne River, but was routed through Grizzly Slough to the Cosumnes River before 1910, when levees along the lower Cosumnes and Mokelumne rivers were constructed to convert sloughs and wetlands to arable land (PWA 2004). The USGS maintained a streamflow gauging station on Dry Creek near Galt from 1926 to 1997, where the gauge recorded approximately 50 years of data. The USGS abandoned the gauge after it was damaged by flooding in 1997. Based on data available from the USGS, the average monthly flow for Dry Creek is shown in **Figure 1-9**.

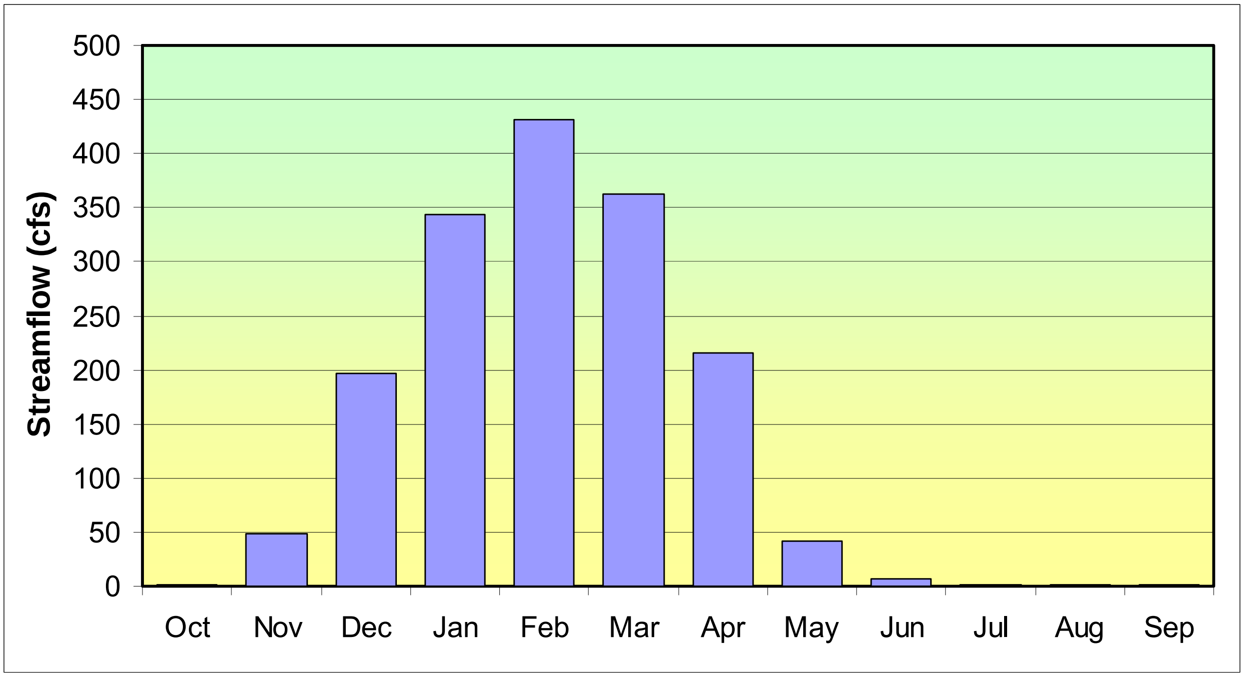


Figure 1-9. Average monthly streamflow on Dry Creek near Galt for 1926 to 1997 (USGS data).

1.3.2 Hydrogeology of the South Basin

The South Basin is within the Cosumnes subbasin (DWR Basin Number 5-22.16). DWR estimates that the total groundwater storage capacity of the entire Cosumnes subbasin is 6 million acre-feet based on 1967 and 1974 data (DWR 2003). This estimate is based on a surface area of 281,000 acres, an aquifer thickness above the Mehrten formation of 290 feet (20- to 310-foot depths), and an average specific yield of 7.4 percent.

Specific Yield

The ratio of the volume of water draining out of a volume of material to the total volume of material drained; used to calculate the quantity of water recoverable from underground storage.

The geologic formations that contain groundwater in the South Basin are described below and their distribution is shown in **Figure 1-10.**

- **Floodplain Formations:** A younger alluvium layer that includes recent sediments deposited along the channels of active streams along the Cosumnes River, Deer Creek, and Dry Creek. The young alluvium layer consists primarily of unconsolidated silt, fine-to-medium grained sand, and gravel. The maximum thickness of this layer is 100 feet with a specific yield ranging from 6 percent to 12 percent. The sand and gravel zones in this layer are highly permeable and yields significant quantities of water to wells.

- **Laguna and Riverbank Formations:** Older alluvium layers that make up the unconfined aquifer of the area (formerly known as Victor). These layers consist of loosely to moderately compacted sand, silt and gravel deposits with discontinuous interbedded lenses of clay. The thickness of this layer ranges between 100 feet and 650 feet and has a specific yield ranging from 6 percent to 7 percent (Olmstead and Davis 1961). Wells tapping sand layers in the Laguna Formation yield high amounts of groundwater.

- **The Mehrten Formation**: This layer is of volcanic origin, underlying the Laguna formation and makes up the second aquifer in the area. It consists of black volcanic sand, silt, and clay interbedded with intervals of dense tuff breccia. The sand intervals in this formation are highly permeable and wells in them can have moderate to high yield. The tuff breccia intervals act as confining layers. Thickness of the layer is between 200 and 1,200 feet. Specific yields for this layer range from 6 percent to 12 percent (Olmstead and Davis 1961).

Tuff Breccia

A pyroclastic rock consisting of more or less equal amounts of ash, cinder, and larger fragments.

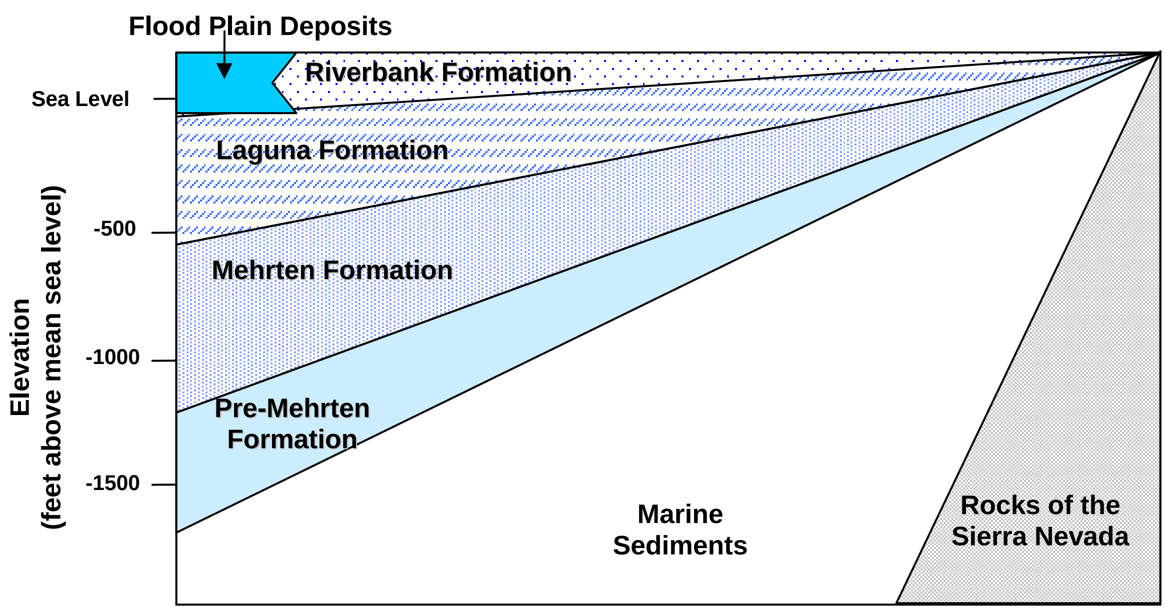


Figure 1-10. Generalized depiction of South Basin geologic formations. Modified from Central Sacramento County Groundwater Management Plan.

Historical and Current Groundwater Levels

The condition of a groundwater basin can be evaluated by reviewing historical groundwater level data collected from active wells or from dedicated monitoring wells. Historical well data can be viewed as hydrographs, which describe groundwater levels over time for a single well. Well data can also provide the basis of groundwater contour maps, which provides a regional picture of groundwater levels at a specific point in time. This section reviews the historical well data to show the overall trend of groundwater conditions in the South Basin.

Current and historical groundwater levels in the South Basin are available from data collected by DWR, Sacramento County, and other agencies. DWR provides data for more than 100 wells in the South Basin (DWR Water Data Library: http://wdl.water.ca.gov/). However, the data for many of these wells is sporadic because of inconsistency in data collection, access to wells, and well abandonment. About 30 wells within the basin have continuous data records for at least 25 years. In general, wells near the Cosumnes River showed a stable groundwater trend, while wells further away from the river show a declining trend. Four wells that are particularly illustrative of groundwater trends of the aquifer away from major recharge sources, such as the Cosumnes River, were selected to provide a characterization of the historical trend in groundwater elevation in these areas. The hydrographs of these wells, and their locations, are shown in **Figure 1-11**. These wells show the reaction of the groundwater basin to groundwater pumping over the past 50 years.

> **Groundwater Contour Maps**
>
> Groundwater level contours are lines on 2-dimensional maps representing points of equal groundwater elevations. The contour map provides a snapshot of groundwater elevation over a region. When a map is made with equal interval contour lines (every 1 foot, 2 feet, or 5 feet, etc.), the spacing of contour lines provides a visual clue to the change in water level slopes (hydraulic gradients). Closely spaced contour lines represent steep slopes; widely spaced contour lines represent gentle slopes

In spite of the partial seasonal recovery of groundwater levels during the non-irrigation season, the groundwater levels in wells outside the influence of the Cosumnes River have generally declined between 10 and 50 feet from 1963 to 2007 as shown in Figure 1-11. No groundwater levels record was available for wells in the South Basin before the 1960s. Water levels declined from the mid-1960s to early 1980s and recovered slightly through 1986. During the 1987 through 1992 drought, water levels once again declined and continued to decline through 1995. From 1996 through 2000, much of the basin has recovered to water levels near those in the mid-1980s (DWR 2003). Groundwater levels declined again in recent years between 2000 and 2007.

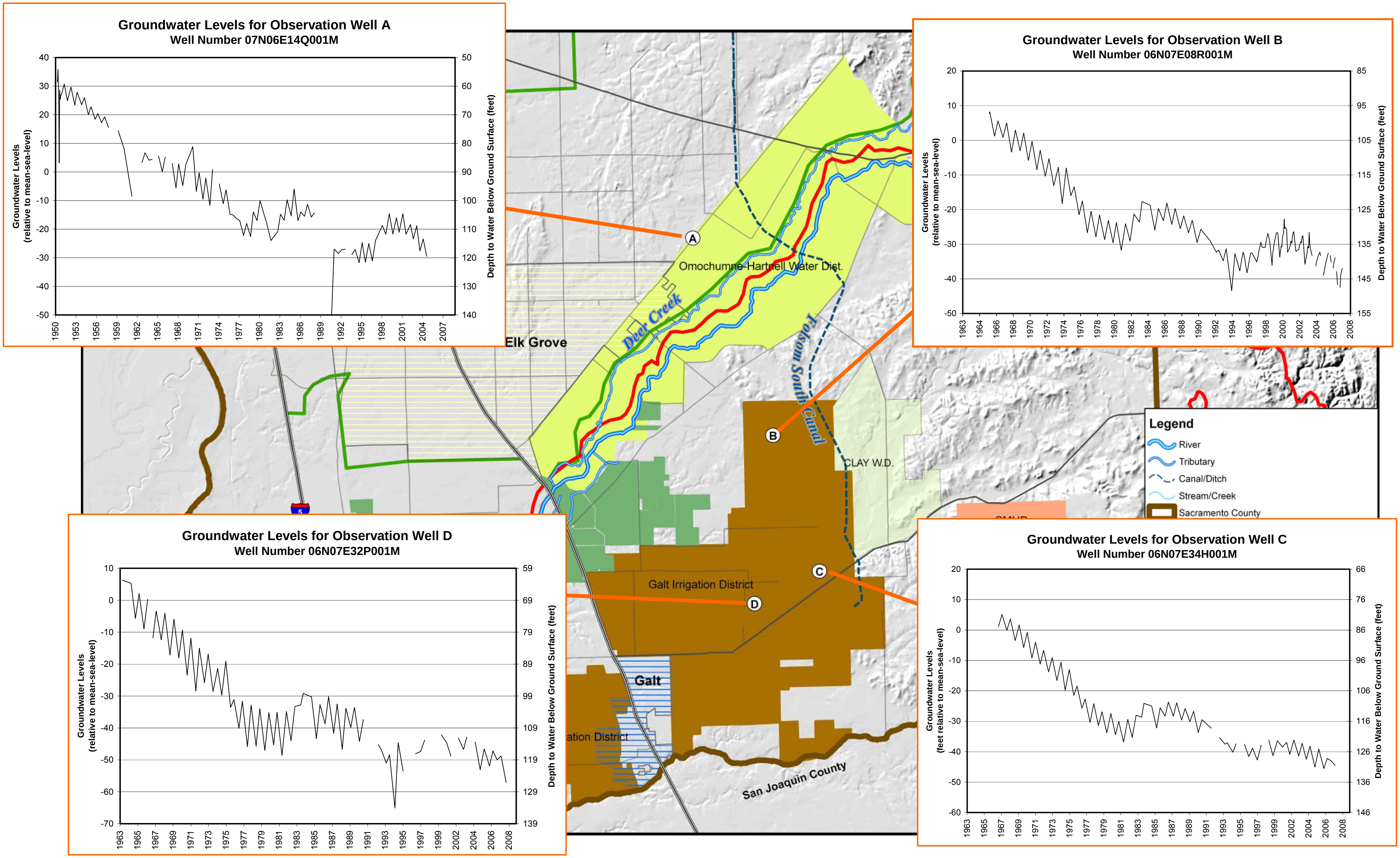


Figure 1-11. South Sacramento Basin well hydrographs – wells outside the influence of the Cosumnes River.

Using data from many wells, Sacramento County generates periodic groundwater contour maps to show groundwater elevation on a regional scale for a specific point in time. **Figure 1-12** shows groundwater contours for the fall of 1969. This figure shows a relatively small regional cone of depression in the central western portion of the South Basin where water levels were 40 feet below mean sea level (MSL). **Figure 1-13** shows a contour map for the spring of 2000. This figure shows that the location of the regional cone of depression has shifted toward the center of the basin and has increased in size. These two contour maps—separated by 31 years—show that groundwater levels in the South Basin have generally declined throughout the basin with more severe depressions occurring near the communities of Galt and Elk Grove.

An interesting aspect of the contour maps shown in Figures 12 and 13 is that groundwater levels near the Cosumnes River have not fallen to the degree that groundwater levels have fallen away from the river. Because the Cosumnes River is a major source of recharge for the regional aquifer, groundwater levels in close proximity to the river benefit from the consistent source of recharge from the river. Hydrographs of wells near the river verify the relative stability and recovery in this area of recharge. **Figure 1-14** shows two hydrographs for wells located near the Cosumnes River.

Water Quality

Groundwater in the water-bearing deposits underlying most of Sacramento County is of excellent mineral quality for irrigation and domestic use. Calcium-magnesium and calcium-sodium bicarbonate water types are most common within the South Basin. Based on analyses of several water supply wells in the area, total dissolved solids (TDS) range from 140 to 438 mg/L and averages about 218 mg/L. No sites with significant impairments have been identified within the Cosumnes subbasin (Bulletin 118, DWR 2003).

The quality of groundwater in the South Basin is generally acceptable to all users and there are no known areas of contaminated groundwater within the South Basin. However, there are a limited number of wells with a record of historical water quality data because only a few wells in the basin are used for public water supply; these wells are:

- City of Galt water system,
- Elk Grove Unified School District wells in Wilton, and
- Arcohe Elementary School in Herald.

Based on these available data, there are no significant water quality changes over time. Specifically, there are no major contamination problems.

As efforts continue to develop a better understanding of the local groundwater basin and its water quality, additional data should be collected from ag-residential and agricultural wells.

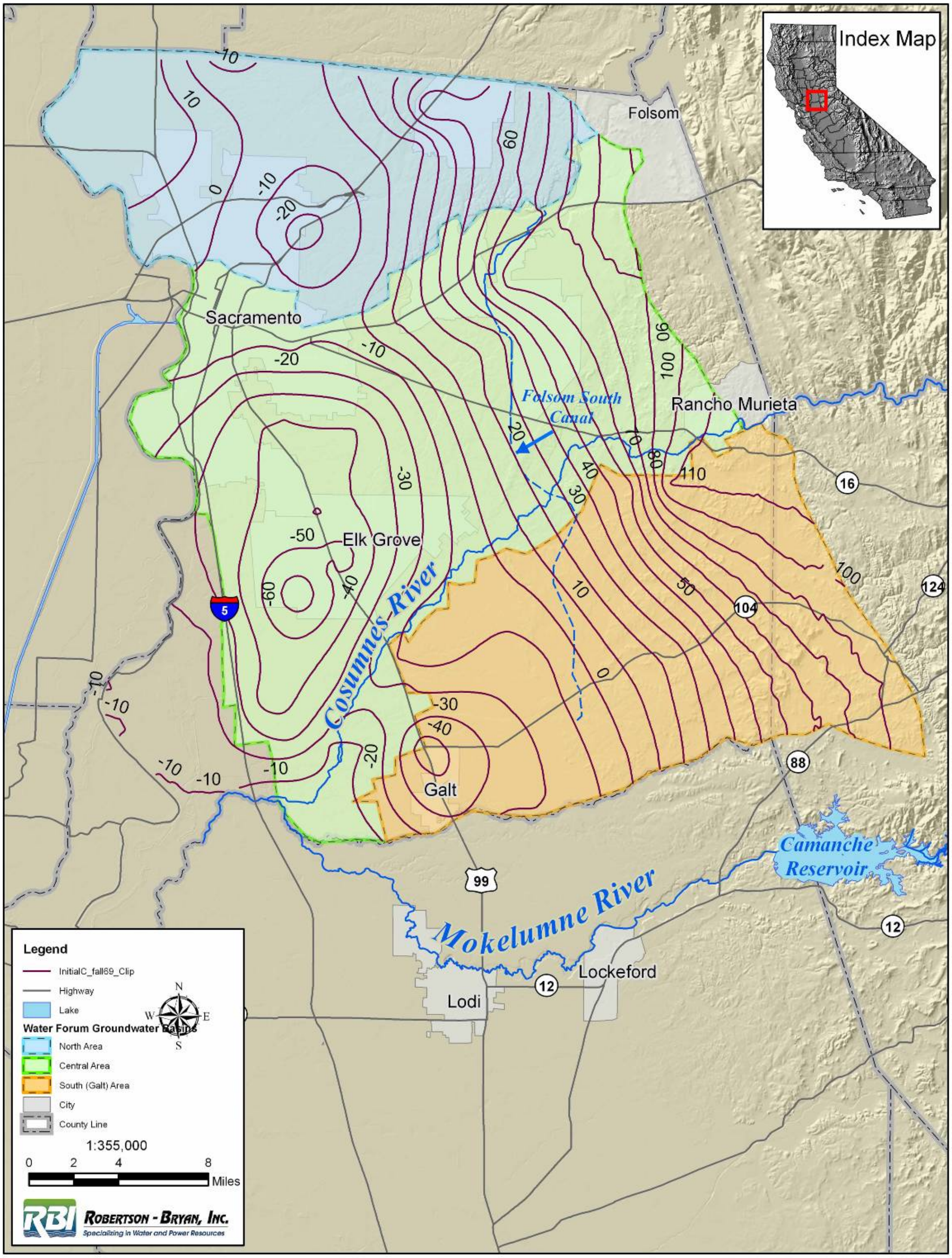


Figure 1-12. Fall 1969 groundwater elevation contour map (Sacramento County Water Agency).

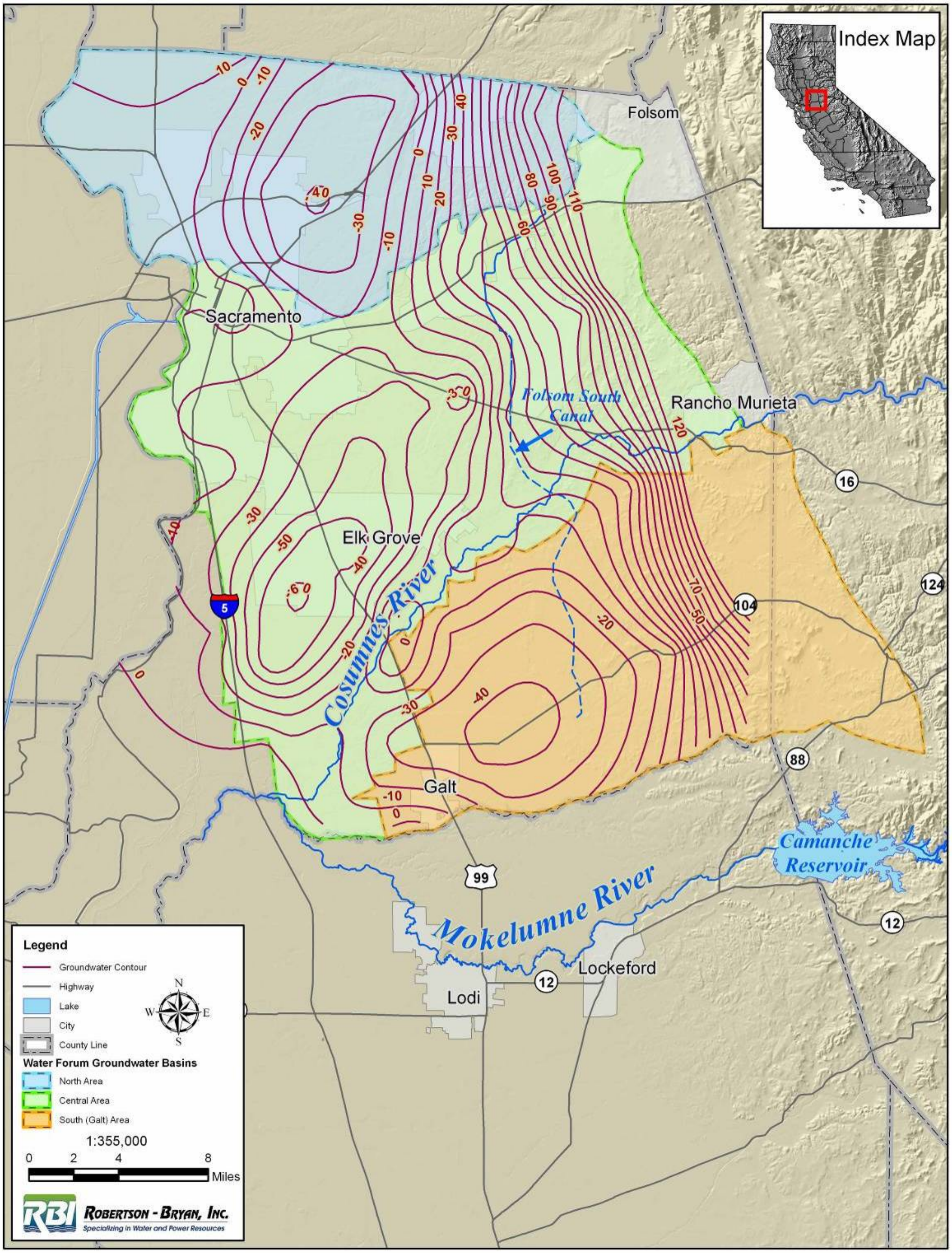


Figure 1-13. Spring 2000 groundwater elevation contour map (Sacramento County Water Agency).

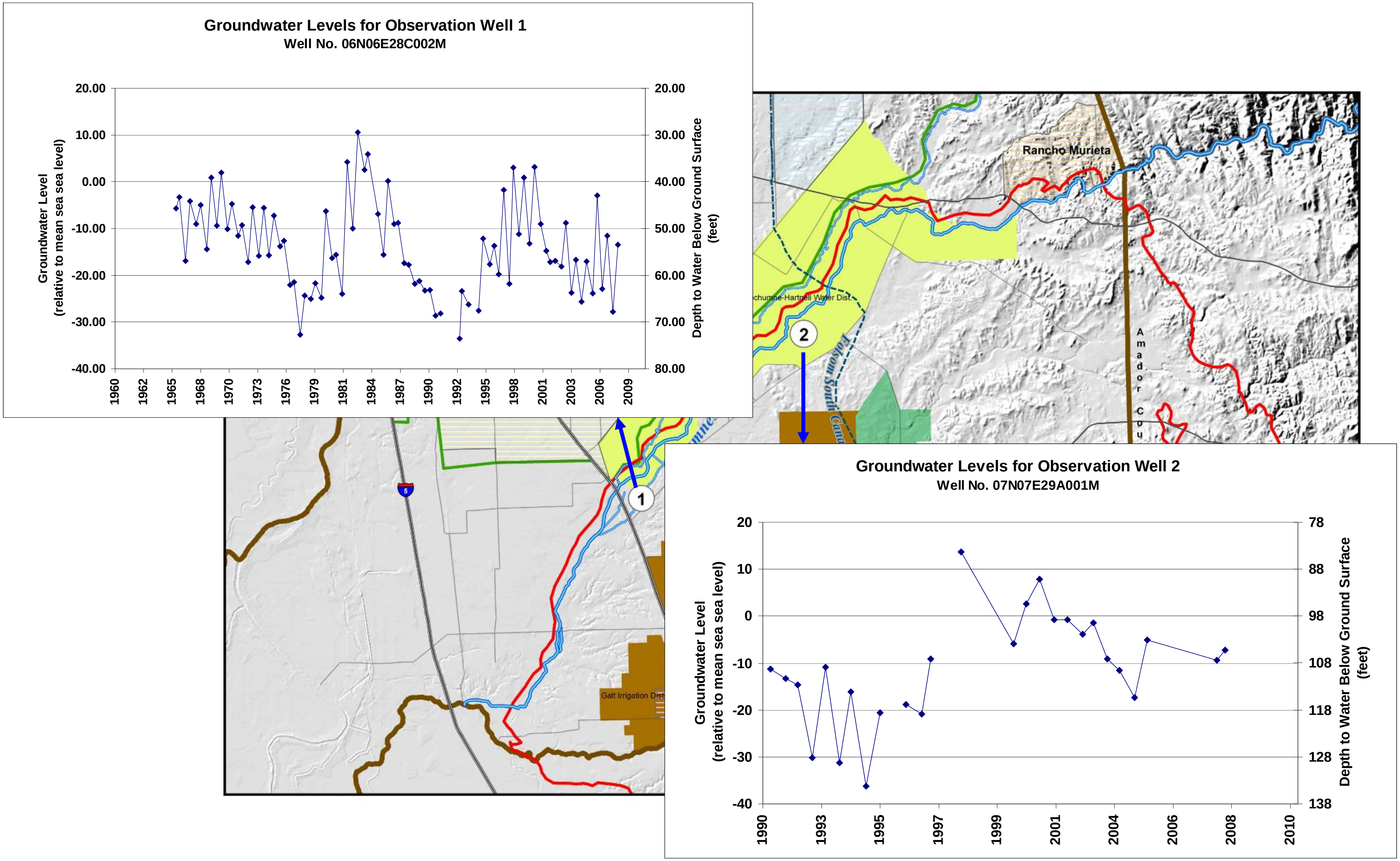


Figure 1-14. Hydrographs of wells near the Cosumnes River.

1.4 Basin Land Use

The California Department of Water Resources (DWR) performs land use surveys for most of California, including Sacramento County, to quantify acreage of irrigated land and planted crop types. DWR develops the base data for land use surveys from aerial photography or satellite imagery, which is superimposed on a cartographic base and verified as needed with site visits to identify or verify crop types. The latest available land use survey data for Sacramento County was collected by DWR in the year 2000. DWR's data was augmented with Sacramento County land use planning data from 2004 by WRIME Inc. to develop a more current land use picture. The land use data is summarized below and provides the basis of developing water use values for the South Basin.

DWR classified land uses within the South Basin into five land use classes:

- **Irrigated agricultural land** consists of areas irrigated and used for agricultural crop production. Irrigated agriculture in the Planning Area includes citrus and subtropical; deciduous fruits; field crops; grain and hay crops, truck, nursery, and berry crops; and vineyards.

- **Semi-agricultural land** is land occupied by agricultural activities other than crop production. Semi-agricultural includes farmsteads, dairies, poultry farms, livestock feedlots, and fish farms. Fish farms were added to the class of semi-agriculture because it is a significant agricultural activity in south Sacramento County. Within DWR's classification scheme, existing fish farms were classified as urban high water use.

- **Urban land** uses within the GMP Planning Area occur mainly in Galt and Rancho Murieta. This category also includes ag-residential land in the basin, such as in the communities of Wilton and Herald.

- **Grassland** classification includes non-irrigated grass lands and areas that have not been developed. Land in the classification includes non-irrigated or dry land pasture. [Note: DWR classifies this land use as "Native Vegetation Land."]

- **Riparian vegetation land** consists of areas along waterways covered with riparian vegetation. Most of the riparian vegetation in the Planning Area is associated with the Cosumnes River and its floodplain.

1.4.1 Land Use Patterns

GMP Planning Area Land Use Patterns

Land use patterns have been developed based on the 2004 data. The Planning Area covers a total of 158,068 acres that include Clay Water District, Galt Irrigation District, The Nature Conservancy, City of Galt, Rancho Murieta community, a portion of Omochumne-Hartnell Water District, and other unincorporated areas. **Figure 1-15** shows the distribution of land uses in the Planning Area.

Table 1-5. Land use classification in Planning Area.

Land use	Area (acres)	Percentage
Irrigated Agriculture	40,514	26
Semi-Agriculture	2,467	1
Riparian Vegetation	2,528	2
Grassland	105,508	66
Urban	7,051	5
Total Area	158,068	100

Table 1-5 shows the acreages and percent distribution of the five major land use classes found in the Planning Area. **Figure 1-16** provides a graphic representation of the percentage distribution of land uses. Grassland is the primary land use classification in the Planning Area, occupying 66 percent of the total area, followed by irrigated agriculture, which occupies 26 percent of the total area (Table 1-5). **Table 1-6** shows the distribution of crop types in irrigated agriculture classification for the Planning Area.

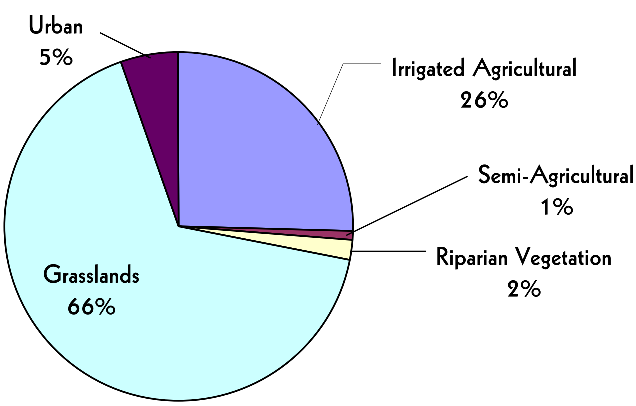


Figure 1-16. Graphic representation of land use distribution in the Planning Area.

Table 1-6. Distribution of irrigated agriculture lands in the Planning Area.

Irrigated Agriculture Sub-category	Area (acres)	Percentage
Citrus and Subtropical	22	<1
Deciduous Fruits	1,035	3
Field Crops	10,256	25
Grain and Hay Crops	2,232	6
Pasture Crops	13,376	33
Truck, Nursery, and Berry	908	2
Vineyards	12,685	31
Total	40,514	100

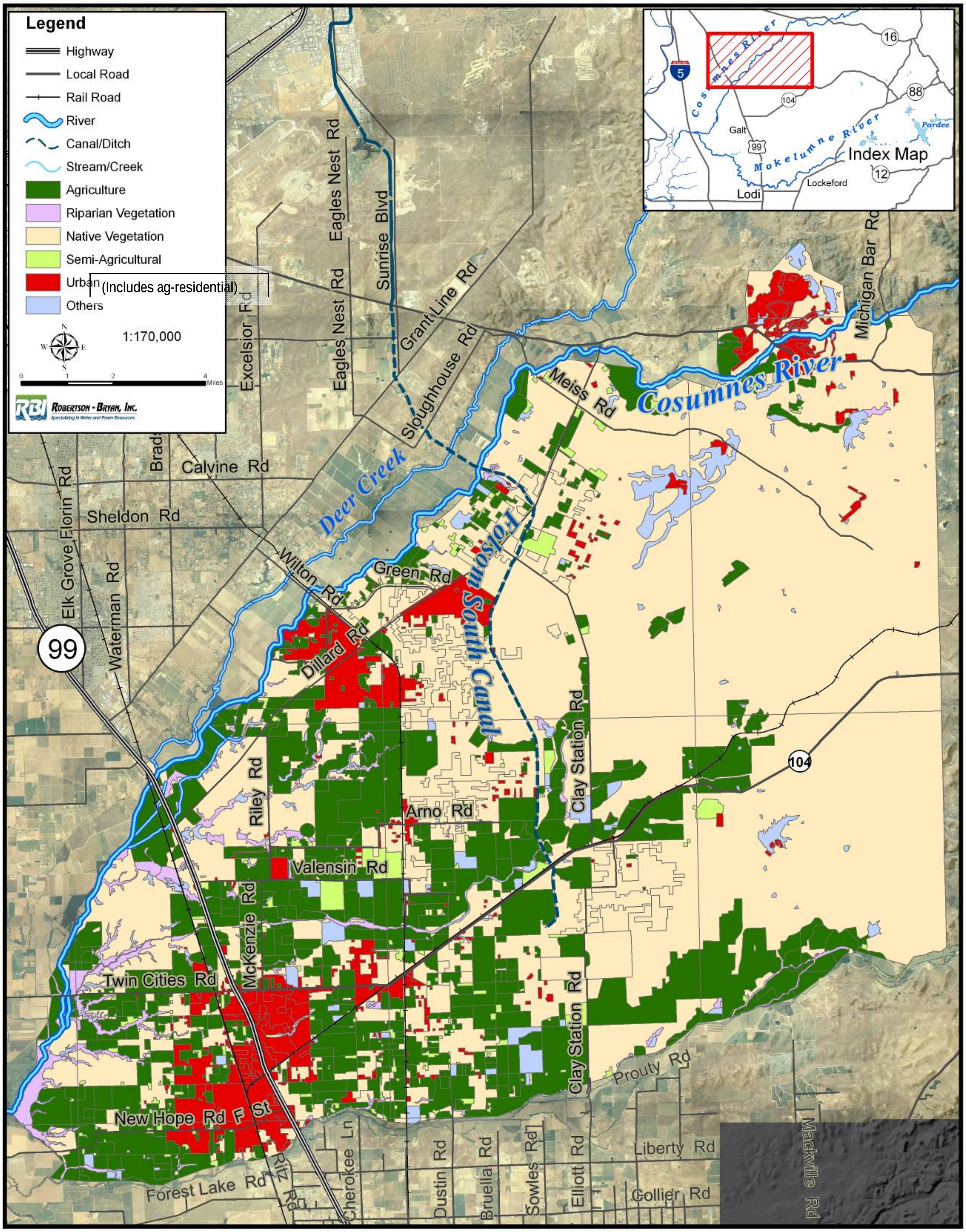


Figure 1-15. Distribution of land use in the Planning Area.

Jurisdiction Area Land Use Patterns

The Jurisdiction Area is comprised of Clay Water District, Galt Irrigation District, a portion of the Cosumnes River Preserve, the City of Galt, and unincorporated areas of the county (Figure 1-2). The Jurisdiction Area covers a total area of 131,321 acres. **Figure 1-17** shows the distribution of land uses in the Jurisdiction Area. **Table 1-7** shows the acreages and percent distribution of the five major land use classifications found in the Jurisdiction Area.

Table 1-7. Land use classification in the Jurisdiction Area.

Land use	Area (acres)	Percentage
Agricultural	31,343	24
Semi-Agricultural	2,106	2
Riparian Vegetation	1,494	1
Grassland	90,637	69
Urban	5,741	4
Total Area	131,321	100

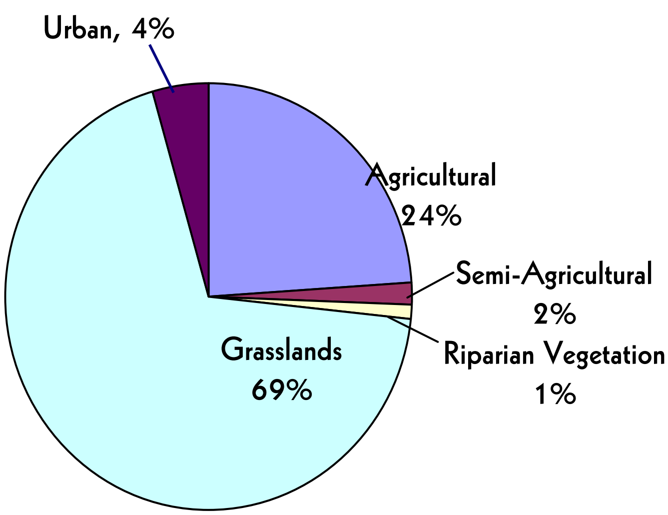


Figure 1-17. Distribution of percentage of land use in the Jurisdiction Area.

Figure 1-18 is a graphic presentation of the percentage distribution of land uses in the GMP Jurisdiction Area. Grasslands, the primary land use category in the area, occupy 69% of the total area; followed by irrigated agriculture, which occupies 24% of the total area. Vineyards, pasture crops, and field crops occupy about 91% of the total irrigated agricultural land in the Jurisdiction Area (**Table 1-8**). This crop mix percentage is different from those of the mid-1970s, when pasture crops, field crops and grains occupied about 94% of the total irrigated agricultural land and vineyards occupied only 1%. The comparison between the crop mix in 2004 and 1976 is shown in **Figure 1-19**.

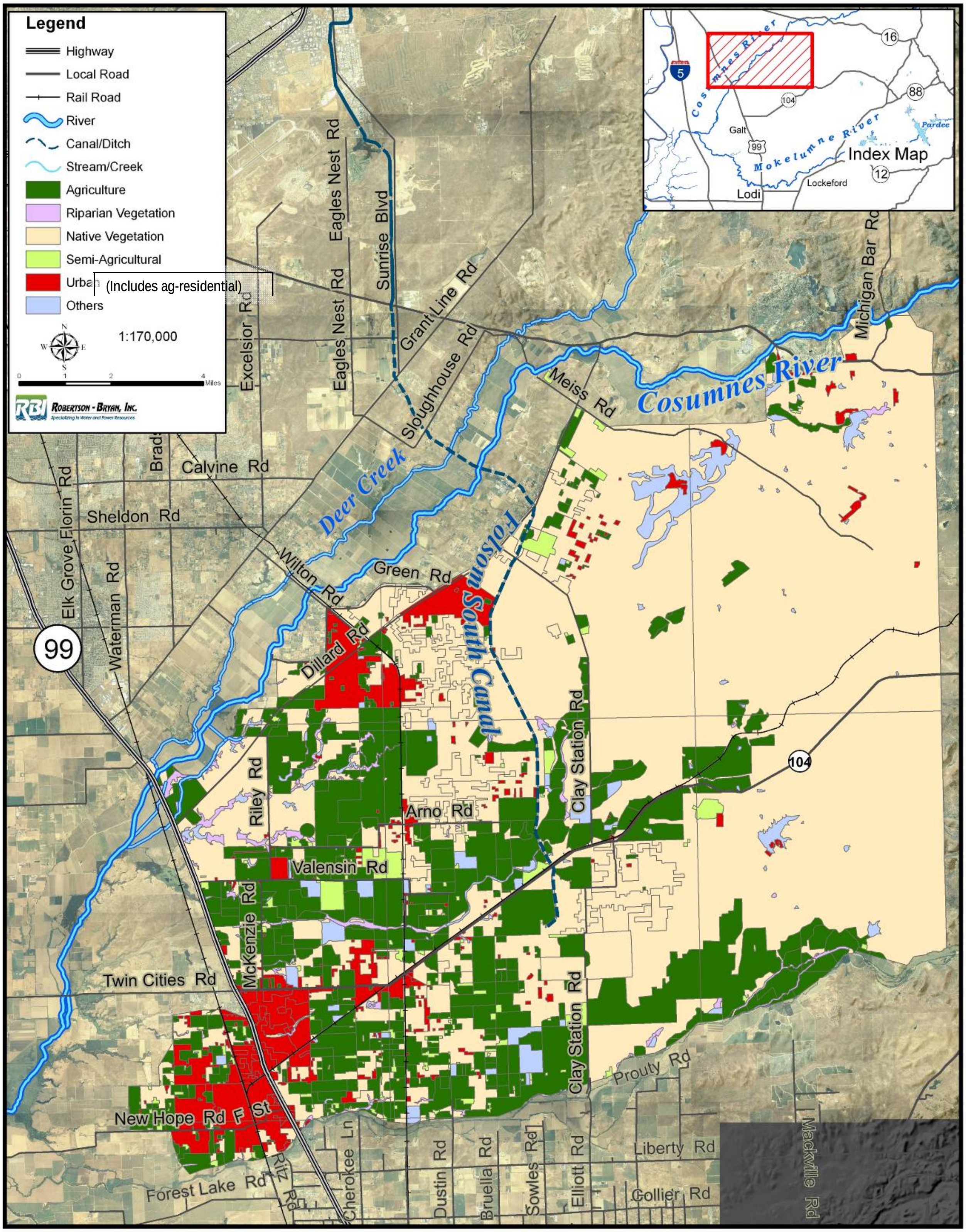


Figure 1-18. Distribution of land use in the Jurisdiction Area.

Table 1-8. Distribution of irrigated agriculture lands in the Jurisdiction Area.		
Irrigated Agriculture Sub-Category	Area (acres)	Percentage
Citrus and Subtropical	22	0
Deciduous Fruits	959	3
Field Crops	7,851	25
Grain and Hay Crops	1,273	4
Pasture Crops	9,985	32
Truck, Nursery, and Berry	489	2
Vineyards	10,764	34
Total	31,343	100%

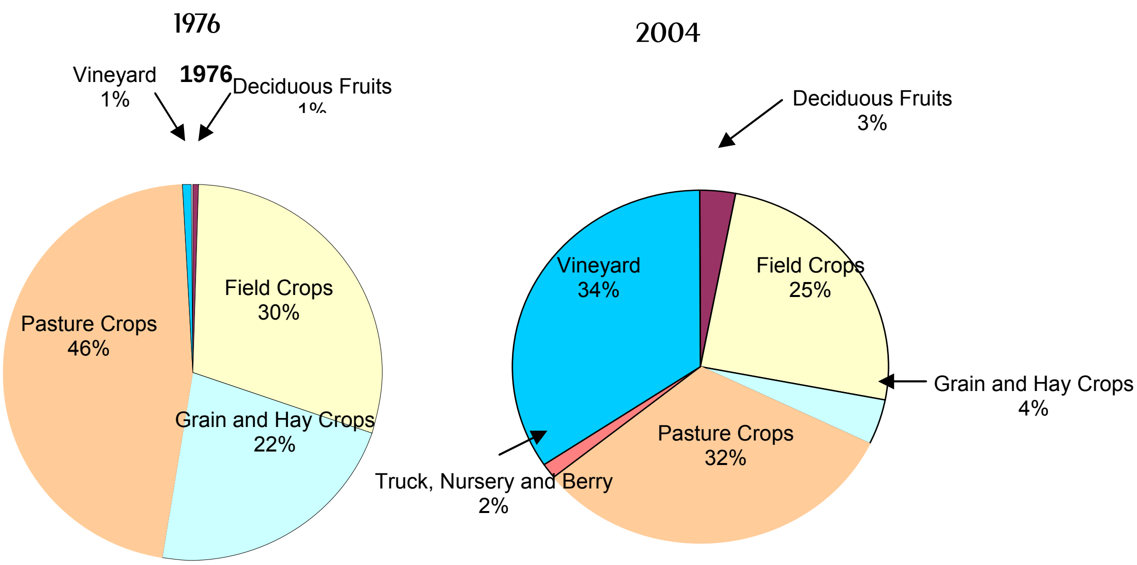


Figure 1-19. Irrigated agriculture land use classification crop mix in 1976 and 2004, South Basin Jurisdiction Area.

1.5 Basin Water Demand

Water demand estimates are based on updated 2004 land use data described in the previous section, DWR 2000 water use survey data for Sacramento County and the Sacramento County Integrated Groundwater and Surface water Model (SacIGSM).

Water demand estimates are calculated separately for Planning and Jurisdiction areas and are presented in two main groups.

- **Developed water: includes surface water or groundwater pumped or diverted for agricultural, semi-agricultural, or urban uses.**
- **Undeveloped water: includes the consumptive use of surface flow by vegetation in open space and riparian areas.**

A summary of the total water demand in the Planning and Jurisdiction areas is presented in **Table 1-9**. These demands are described in greater detail in the remainder of this section.

Table 1-9. Summary of total water demand for Planning and Jurisdiction areas of the South Basin, 2000–2004

Water Demand Category	Planning Area Water Demand (acre-feet per year)	Jurisdiction Area Water Demand (acre-feet per year)
Developed	156,000	122,200
Undeveloped	112,700	96,400
Total	268,700	218,600

1.5.1 Developed Water Demand

The total estimated annual developed water demand 156,000 and 122,200 acre-feet per year for the Planning and Jurisdiction areas, respectively. **Table 1-10** summarizes demands for these areas. The agricultural demand represents about 92 percent of the total water demand in the South Basin.

Table 1-10. Developed water demand for Planning and Jurisdiction areas of the South Basin, 2000–2004

Water demand Category	Planning Area Water Demand (acre-feet per year)	Jurisdiction Area Water Demand (acre-feet per year)
Irrigated Agricultural	132,100	102,000
Semi-Agriculture	11,700	10,500
Urban	12,200	9,700
Total	156,000	122,200

Irrigated Agricultural

No complete records of irrigated agricultural water demand in the South Basin exist. However, DWR estimates that existing agricultural demands (i.e., the total volume of water applied to a crop) using values for precipitation, crop acreage, evapotranspiration, and irrigation efficiency (**Appendix A**). In this study, these DWR values were used as an input to the SacIGSM. The model refined these DWR values through model calibration to achieve final estimates for irrigated agricultural water demand in South Basin.

Total annual irrigated agricultural water demand is estimated to be 132,100 and 102,000 acre-feet per year for the Planning and Jurisdiction areas, respectively (Table 1-10).

Semi-Agriculture

The average semi-agriculture water demand is about 11,700 and 10,500 acre-feet per year for the Planning and Jurisdiction areas, respectively. Dairies and fish farms are included in this land use classification. Actual water demand data, number of farms, and information on dairy and fish farm practices were used to develop a better estimate of water demand. This was done by interviewing farm owners in the basin. About 90 percent of the total water demand by semi-agriculture is used by fish farms in the Planning Area, or approximately 11,000 acre-feet. It is important to note that during the irrigation season, some fish farms make their tailwater available to adjacent agricultural users. This amount is approximately 20 percent of the total water pumped for the fish farm activity, or approximately 2,000 acre-feet per year that is available for re-use by agriculture.

Urban

According to 2004 census data, the total population in South Basin is 39,540. The City of Galt has a population of 22,965; Rancho Murieta has a population of 6,750, and about 9,800 people live in the ag-residential communities in the basin.

The average annual urban water demand for 2000–2004 in the South Basin was about 12,200 and 9,700 acre-feet per year for the Planning and Jurisdiction areas, respectively. On average, Galt uses about 4,900 acre-feet per year of groundwater, Rancho Murieta diverts about 2,000 acre-feet of Cosumnes River flow per year. The remainder of the urban water demand is consumed by ag-residential in the rural communities in the basin almost exclusively from groundwater.

Water demand records from the City of Galt (1990–2007), Rancho Murieta diversion record (2000–2007), and the 2000–2004 water data are used for this effort. No records are available for ag-residential water demands. A water duty of 0.5 acre-feet per acre was used in this study to develop the annual water demand for ag-residential areas in the South Basin. This value was based on estimates of water demand for ag-residential areas developed by WRIME in the Central Sacramento County Basin Groundwater Planning effort.

1.5.2 Undeveloped Water

Undeveloped water is the consumptive use of water by vegetation in grasslands and riparian areas. Grasslands are non-irrigated grassland, brush, and oak woodland where the consumptive use of water for plants is met from precipitation that infiltrates into the plant root zone. Much of the grassland in the basin is also grazed by cattle.

Water use by riparian vegetation includes the consumptive use of water by vegetation along streams and water courses and marsh lands. The source of water for the riparian vegetation is stream water that infiltrates into the plant root zone.

Table 1-11 summarizes the annual volume of water consumptively used by vegetation in grassland and riparian areas for the Planning and Jurisdiction areas. This consumptive water use is met from precipitation and river flow seepage that is stored in the root zone of plants.

Table 1-11. Grassland and riparian vegetation consumptive use for Planning and Jurisdiction areas of the South Basin, 2000–2004

Water Use Category	Planning Area Consumptive Use (acre-feet per year)	Jurisdiction Area Consumptive Use (acre-feet per year)
Grassland	109,000	93,300
Riparian Vegetation	3,700	3,100
Total	112,700	96,400

1.6 Basin Supply Sources

The water supply in the South Basin depends mainly on groundwater. Groundwater pumping supplies about 93 percent of the total agricultural and urban demand in the South Basin. Only 5 percent of total demand is met by surface water in the South Basin. Reclaimed water provides 2 percent of the area's total demand.

Apart from the City of Galt—whose public water system is supplied completely by groundwater—commercial agricultural, semi-agricultural operations, and residential homeowners are all self-supplied pumpers. Surface water supply in the basin is used by Rancho Murieta, some riparian diverters, SMUD, and a limited number of customers in Galt Irrigation District and Clay Water District. In addition, reclaimed water is supplied from fish farm discharges and the wastewater treatment plant for the City of Galt. Reclaimed water is supplied to a limited number of farmers in the basin. The following are the main water purveyors in the South Basin.

- City of Galt

The city public water system is supplied completely by groundwater. City of Galt pumps water from its municipal wells to meet an average annual demand of 4,900 acre-feet. The current water system is comprised of two three-million gallon storage tanks with pump stations, seven wells, 62 miles of water piping and valves, and 5,800 lateral connections.

- Galt Irrigation District

The Galt Irrigation District purchases surface water from SMUD, via the Rancho Seco power facility. This water is conveyed through Laguna Creek to local diversions. Away from the Laguna Creek corridor, agricultural water demands are met from groundwater. The Galt Irrigation District contains 34,000 acres.

- Clay Irrigation District

The Clay Irrigation District has historically purchased water from SMUD for delivery to irrigators along Laguna Creek. The District contains 6,500 acres.

- Omochumne-Hartnell Water District

Omochumne-Hartnell Water District has historically purchased and managed supplemental water from the Central Valley Project (CVP) for the benefit of District agricultural users adjacent to the Cosumnes River and Deer Creek. In recent years, however, the number of riparian diverters has decreased because of the unavailability of CVP water, declining flows in the Cosumnes River during the irrigation season, and the increasing use of drip irrigation for orchard and vineyards in the Cosumnes River and Deer Creek floodplain.

Typical drip irrigation operators prefer groundwater because it is a cleaner, more reliable source. **Table 1-12** shows the volume of water purchased by OHWD from 1959 to 1986. This surface water importation improved the groundwater levels in the district by reducing groundwater pumping.

Four flashboard dams that historically supported diversions are now maintained and operated by the District to increase the wetted perimeter of the river to affect greater groundwater recharge.

- Rancho Murieta Community Services District

Rancho Murieta Community Services District (RMCSD) relies on Cosumnes River water as its sole water supply source. RMCSD has appropriative water rights on the Cosumnes River for up to 6,368 acre-feet per year for municipal, agricultural, industrial, environmental, and recreational uses. Water is diverted from the Cosumnes River at Granlee's Dam and pumped into three off-stream lakes—Calero, Chesbro, and Clementia—from November 1 until May 31 of each year. The minimum flows in the Cosumnes River must be 76 cfs at Michigan Bar before water can be diverted.

RMCSD diverted on average about 2,000 acre-feet per year from 1992–2001 to meet its water demand (**Figure 1-20**). Surface water supplied by the Cosumnes River is counted for the Planning Area only and not the Jurisdiction Area because the Cosumnes River is outside the Jurisdiction Area.

- Sacramento Municipal Utilities District

SMUD imports CVP water from the American River, via the Folsom South Canal for use in the Rancho Seco facility. SMUD utilizes approximately 1,700 acre-feet per year either in the power facility or in Rancho Seco Lake.

Table 1-12. Volume of water purchased by OHWD from 1959 to 1986

	Year	Acre-Feet
Sly Park Reservoir released to the Cosumnes River	1959	2,610
	1960	3,150
	1961	3,474
	1962	0
	1963	1,116
	1964	2,027
	1965	0
	1966	5,300
	1967	0
	1968	4,000
	1969	0
	1970	3,271
	1971	0
	1972	4,006
	1973	2,737
	1974	790
Folsom South Canal releases to Deer Creek	1975	500
	1976	8,697
	1977	0
	1978	785
	1979	371
	1980	72
	1981	2,950
	1982	107
	1983	40
	1984	86
	1985	2,008
	1986	638
	1987	44
	Total	48,779
Average per year		1,680

SMUD also discharges approximately 800–1,000 acre-feet monthly into Hadselville Creek, a tributary of Laguna Creek, from Rancho Seco. During the irrigation season, water released to the creek is diverted by farmers in Galt Irrigation District and Clay Water District. This source of surface water provides about 4,000 acre-feet annually to meet a portion of the agricultural water demand in the Jurisdiction area and about 3,600 acre-feet recharge to the aquifer through the Laguna Creek streambed.

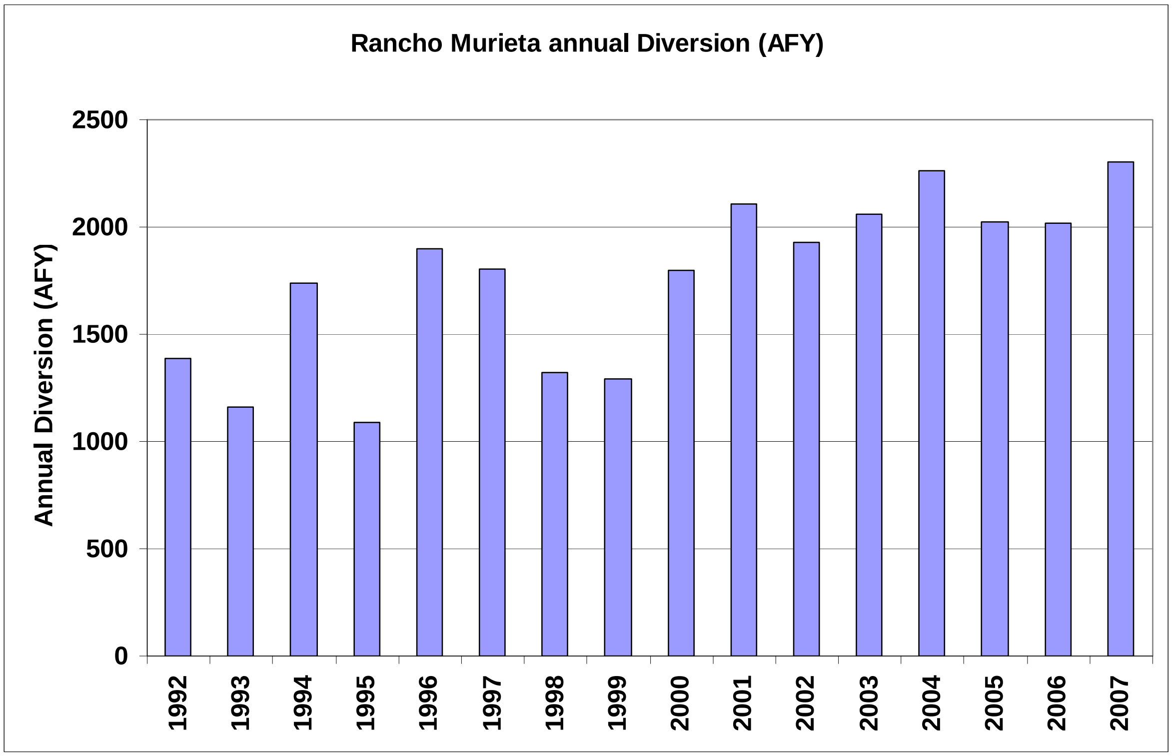


Figure 1-20. Rancho Murieta annual diversions from the Cosumnes River, 1992–2007.

The total estimated developed water demand is 156,000 and 122,200 acre-feet per year for Planning and Jurisdiction areas, respectively. **Table 1-13** summarizes the water supplies that meet this developed water use for 2000–2004. The details of these estimates are provided in the following discussion.

Table 1-13. Water supply for Planning and Jurisdiction areas of the South Basin, 2004		
Water Supply Source	Planning Area Water Supply (acre-feet per year)	Jurisdiction Area Water Supply (acre-feet per year)
Surface Water (Cosumnes River and SMUD)	7,700	5,400
Reclaimed Water (Galt WWTP & fish farm tailwater)	2,700	2,000
Groundwater	145,600	114,800
Total	156,000	122,200

1.6.1 Surface Water Sources

Surface water supplies a small portion—only 5 percent of the total water supply—of the South Basin's annual water demand. There are two sources of surface water in the area—the Cosumnes River and SMUD's imported water through the Folsom South Canal.

Due to the strong seasonality of Cosumnes River flows, only a smaller volume of water is available for use during the irrigation season. As discussed in Section 2, flows in the Cosumnes River typically cease in the lower reaches of the river from July through November.

Landowners along the Cosumnes River have riparian water rights and historically riparian users have received imported water from the Central Valley Project, purchased by Omochumne-Hartnell Water District (OHWD). Current riparian diversions within the Planning Area are estimated to be 100 acre-feet annually.

1.6.2 Reclaimed Water Sources

The City of Galt's wastewater treatment plant (WWTP) discharges effluent to Laguna Creek, a portion of which is used for irrigating fields adjacent to the WWTP (**Figure 1-21**). An average of 700 acre-feet per year of reclaimed water is used for agricultural irrigation. Effluent not used for irrigation is discharged to Laguna Creek during the winter when the WWTP is permitted release effluent to surface waters.

Fish farms in the Planning Area withdraw about 11,000 acre-feet of groundwater annually. These operations typically recycle water several times within the farm before it is discharged. During the irrigation season, agricultural farms adjacent to the fish farms use the discharge water for irrigation. The amount of tailwater utilized for irrigation is estimated to be about 2,000 acre-feet per year. Discharge water not used for irrigation, typically during the winter months, flows into local creeks.

The reclaimed water supply from the WWTP is available only in the Planning Area and not in the Jurisdiction Area because all the fields that receive reclaimed water from the WWTP are outside the Jurisdiction Area boundary.

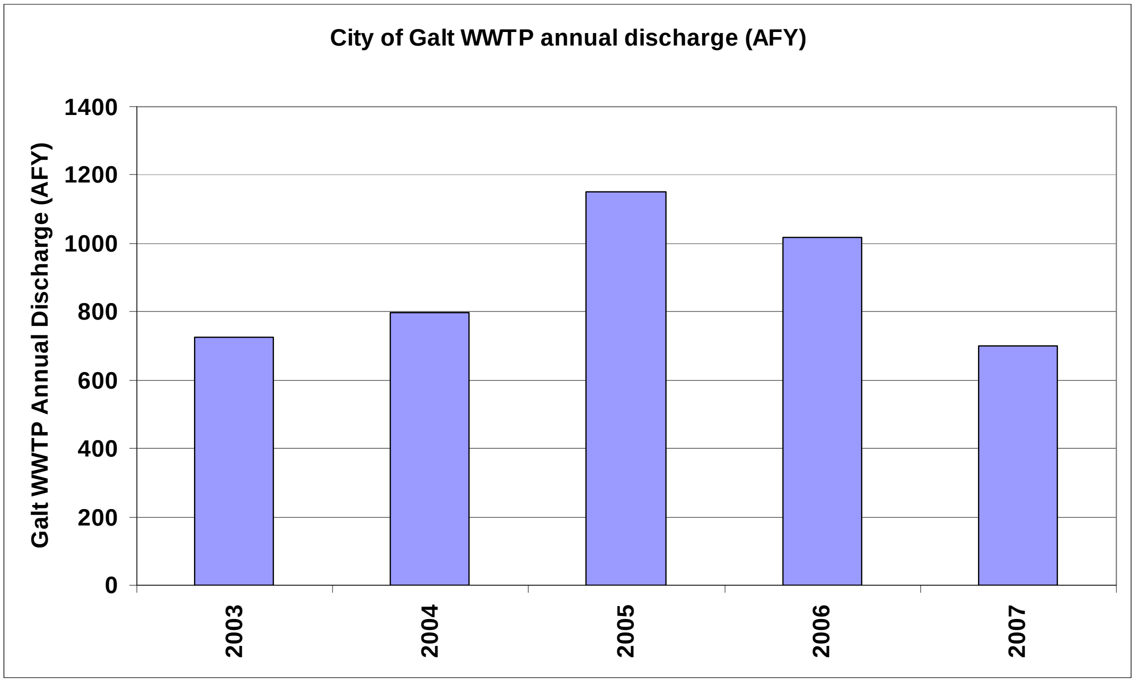


Figure 1-21. City of Galt WWTP discharges from 2003–2007.

1.6.3 Groundwater Sources

Groundwater supplies about 93 percent of the total agricultural and urban demand and 100 percent of the semi-agriculture demand in the South Basin. Water is extracted mainly from the shallow aquifer underlying the South Basin, with some wells penetrating the deeper confined aquifer. In 1990, there were an estimated 12 municipal wells, 200 agricultural wells, and 1,400 ag-residential wells in the South Basin (Sacramento County Water Agency 1990).

Studies concluded that there is a hydraulic disconnection between the regional aquifer and the streams in the South Basin (Fleckenstein et al., 2004) making the river a losing stream, meaning the river serves as a source of recharge to the underlying groundwater aquifer.

Recharge to the groundwater aquifer is derived from four major components:

- deep percolation of precipitation,
- deep percolation of the non-consumptive use portion of applied irrigation water,
- seepage from streams, and

- Subsurface inflow from surrounding areas.

No records exist for groundwater pumping in the South Basin except for the City of Galt, whose public water system is supplied completely by groundwater pumping from its municipal wells. However, groundwater pumping for agricultural and semi-agriculture operations and residential homeowners can be estimated using SacIGSM.[1] The model estimates that in the period 2000–2004, 145,600 was pumped from the aquifer underlying the Planning Area and 114,800 acre-feet from the Jurisdiction Area. Groundwater estimates for Jurisdiction area (114,800 acre-feet per year) concurs with the estimated sustainable yield (115,000 acre-feet per year) recommended in the Water Forum Agreement for the basin. The distribution of groundwater pumping among the different users in the South Basin is summarized in **Table 1-14**.

Table 1-14. Summary of groundwater pumping in the South Basin, 2000–2004.

Category	Groundwater Pumping acre-feet Planning Area	Groundwater Pumping acre-feet Jurisdiction Area
Irrigated Agriculture	125,300	96,000
Semi Agriculture	11,700	10,500
Galt	4,900	4,900
Rural Residential	3,700	3,200
Total	145,600	114,800

1.7 Basin Water Balance

In the preceding sections, water supplies and demands were discussed based on information collected from DWR, information provided by stakeholders, and SacIGSM results. The SacIGSM is used to refine annual water use estimates in the South Basin from 1970 to 2004. SacIGSM was developed in the early 1990s and has been used over the past 15 years by local and state agencies in numerous projects across Sacramento County.

[1] The IGSM is a finite element, quasi three-dimensional, multi-layered model that integrates surface water and groundwater on a monthly time step. The IGSM was developed for use as a regional planning tool for large areas influenced by both surface water and groundwater. The tool is well equipped to accommodate input and output of land use and water use data over large areas. Data input includes hydrogeologic parameters, land use, water demand, precipitation and other hydrologic parameters, boundary inflows, and historical water supply. For purposes of parameter definition and developing water budgets around physical and/or political boundaries, the SGSM divides Sacramento, Placer, Sutter, and San Joaquin counties into subregions. Each subregion is further divided into unique numbered elements varying from 200 to 800 acres in size. Overlying this grid is a coarse parametric grid utilized for specifying aquifer and other parameters (SCWA 2004).

For development of this Land and Water Resources settings section, updated land and water use data was entered into the SacIGSM to refine water use estimates for the Planning and Jurisdiction areas. The update and calibration of the SacIGSM model readies it for use in developing water balance components, baseline conditions, and analyzing alternative water management scenarios in the South Basin. The model calculates an overall water balance for the South Basin, which is reported in this resources setting section for the South Basin. Additional information about the SacIGSM model can be found in **Appendix B**. This information is now used to develop a water balance for the South Basin.

1.7.1 Water Supply Demand Balance

Water supplies for the South Basin come from groundwater, surface water, and reclaimed water. Groundwater supplies about 93 percent of the total agricultural and urban demand in the South Basin, making it the main source of water in the basin. Reclaimed water is used to meet 2 percent of the total demand. Although surface water supplies are abundant in the South Basin, only about 5 percent of that source is utilized in the South Basin (estimated total annual surface flow is 537,000 acre-feet per year). Stream flow patterns, lack of infrastructure, and other constraints make it difficult to utilize more surface water in the South Basin. Surface water supplies an estimated 7,700 and 5,400 acre-feet per year for the Planning and Jurisdiction areas, respectively. The average water supply demand balance for the Planning and Jurisdiction areas for 2000–2004 is detailed in **Tables 15 and 16**. The reason to select the period from 2000–2004 is because it represents the most recent land use, demand and supply in the basin.

Table 1-15. Planning Area water demand and supply balance, 2000–2004.

Total Area	158,000	acres
Total Water Demand	156,000	acre-feet
Supply Sources		
Groundwater pumping	145,600	acre-feet
Surface water	7,700	acre-feet
Reclaimed water	2,700	acre-feet
Total Supply	156,000	acre-feet

Table 1-16. Jurisdiction Area water demand and supply balance, 2000–2004.

Total Area	131,300	acres
Total Water Demand	122,200	acre-feet
Supply Sources		
Groundwater pumping	114,800	acre-feet
Surface water	5,400	acre-feet
Reclaimed water	2,000	acre-feet
Total Supply	122,200	acre-feet

1.7.2 Groundwater Balance

The groundwater balance is the quantification of all individual inflows, outflows, and changes in groundwater storage over a given time period. **Figure 1-22** depicts the main groundwater inflow and outflow components in the South Basin. The basic concept of water balance is:

CHANGE IN STORAGE = SYSTEM INFLOWS – SYSTEM OUTFLOWS

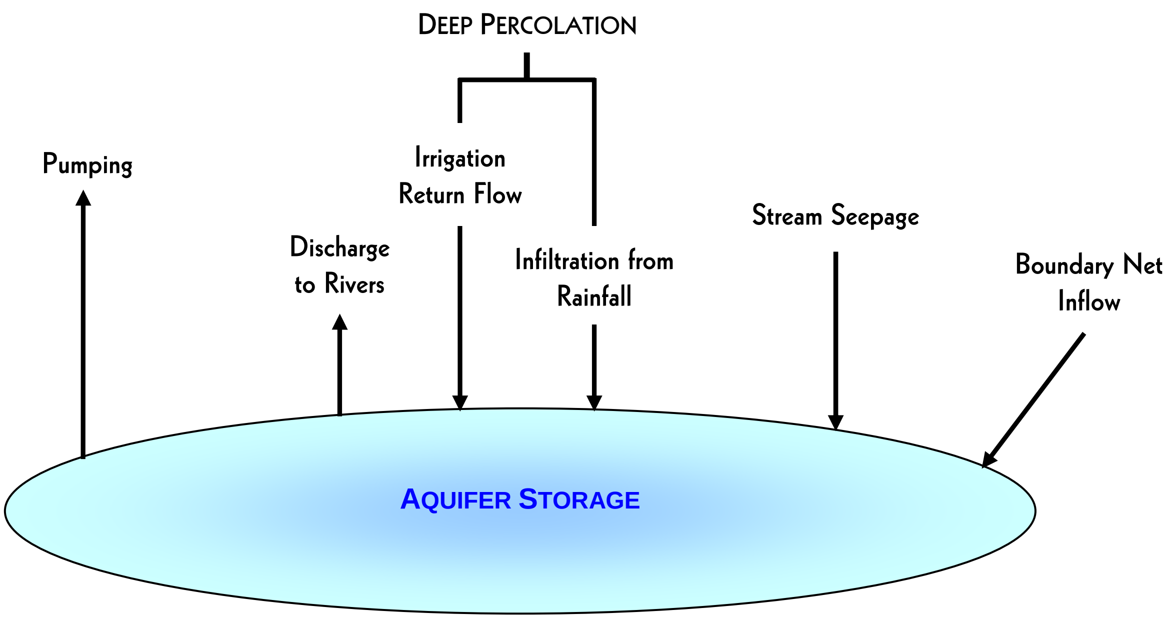


Figure 1-22. Groundwater balance components, South Basin.

Groundwater recharge (**inflow**) into South Basin includes the following components:

1. Deep Percolation consisting of:
   a. Irrigation return flow: from application of water to land including agriculture fields (seepage losses from unlined canals can be part of this component), semi-agriculture parcels and urban areas.

   b. Infiltration from rainfall that falls on the basin floor.

2. Stream Seepage: Seepage from surface water bodies, predominantly from Cosumnes River, Deer Creek, Dry Creek, and Badger creek.

3. Subsurface Boundary Inflow: Groundwater inflow to the South Basin along the eastern boundary with Amador County, northern and western boundaries with Central Basin, and southern boundaries with San Joaquin County.

Discharge (**outflow**) components from the groundwater basin include:

1. Groundwater pumping for agriculture, semi-agriculture and urban.

2. Discharge to rivers and creeks (base flow). Previous studies concluded that there is a hydraulic disconnection between the regional aquifer and the streams in the area; therefore, it is reasonable to assume that base flow from the aquifer to streams is zero.

Considering the various inflow and outflow components in the basin, the groundwater balance equation can be written as:

$$\Delta S = DP + S + IB - Tp - Se$$

Where,

DP = Deep percolation consists of infiltration from rainfall and return flow from agriculture, semi-Agriculture and urban.

S = seepage from rivers

IB = boundary inflow, eastern, northern, western and southern boundaries.

Tp = pumping from groundwater.

Se = Base flow to Rivers

ΔS = change in groundwater storage

The groundwater balance for the Planning Area for 2000–2004 and 1980–2004 can be expressed as:

Table 1-17. Groundwater balance in the South Basin Planning Area.

Inflow (acre-feet)		1980–2004		2000–2004	
DP	Deep Percolation (rainfall & irrigation)	+59,500		+48,400	
S	Seepage from rivers	+60,200		+52,300	
IB	Subsurface boundary inflows	+37,300		+33,000	
Subtotal			+157,000		+133,700
Outflow (acre-feet)					
Tp	Pumping from groundwater	-154,500		-145,600	
Se	Baseflow to rivers	0		0	
Subtotal			-154,500		-145,600
Change in groundwater storage			+2,500		-11,900

The groundwater balance for the Jurisdiction Area for 2000–2004 and 1980–2004 can be similarly expressed:

Table 1-18. Groundwater balance in the South Basin Jurisdiction Area.

Inflow (acre-feet)		1980–2004		2000–2004	
DP	Deep Percolation (rainfall & irrigation)	+45,000		+35,900	
S	Seepage from rivers	+19,400		+13,900	
IB	Subsurface boundary inflows	+50,400		+49,800	
Subtotal			+114,800		+99,600
Outflow (acre-feet)					
Tp	Pumping from groundwater	-118,300		-114,800	
Se	Baseflow to rivers	0		0	
Subtotal			-118,300		-114,800
Change in groundwater storage			-3,500		-15,200

1.7.3 Discussion

Updated and refined land and water use data for the South Basin was input to the SacIGSM and the model recalibrated to simulate surface water and groundwater interaction in Sacramento County. Water budgets resulting from the model calibration are used to develop the South Basin groundwater balance analysis (Sacramento County Integrated Ground and Surface water Model (SacIGSM) Model Refinement - Central and South Area, 2008).

In the Planning Area, the main source of recharge to the aquifer is stream seepage from the Cosumnes River and deep percolation from agriculture and precipitation, which provides 75 percent of the total recharge to the Planning Area (including the Jurisdiction Area). The remaining 25 percent is from subsurface boundary inflow, primarily along the eastern boundary of the Basin.

Within the Jurisdiction Area boundary, subsurface inflow and deep percolation are the main sources of recharge, contributing about 86 percent of the total recharge to the area. Seepage from streams in the Jurisdiction Area contributes only 14 percent of the total recharge since the Cosumnes River is not included in this area.

Model results show that every year for the 5-year period between 2000 and 2004, the aquifer storage was reduced by an average of 11,900 acre-feet in the Planning Area and 15,200 acre-feet in the Jurisdiction Area because groundwater outflow exceeds recharge in the basin. This rate of storage reduction in the Jurisdiction Area corresponds to groundwater levels declining by an average of 1.4 feet per year due to drought conditions during these years.

However, when we analyze the period from 1980–2004, which includes wet and dry years, the aquifer storage was increased by an average of 2,500 acre-feet in the Planning Area and reduced by an average of 3,500 acre-feet in the Jurisdiction Area. This long-term water balance shows that the overall aquifer status was stable and fluctuated following the hydrologic cycle.

Figure 1-23 shows the change of groundwater storage in the Planning Area for the period 1970 to 2004.

From 1970 to 1980—a relatively dry cycle—groundwater storage declined about 380,000 acre-feet, or approximately 35,000 acre-feet per year, and recovered slightly through 1986 due to wet hydrologic conditions While having approximately 24,000 acre-feet of surface water from Sly Park Reservoir and Folsom South Canal. During the 1987 through 1992 drought, groundwater storage once again declined and continues declining through 1994.

Due to wet conditions from 1995 through 2000, the Basin recovered to the same storage levels as in the mid-1980s. The groundwater storage declined again in recent years between 2000 and 2004. This graph confirms that the aquifer is in a state of equilibrium since the 1980s and groundwater storage fluctuates following the hydrologic cycle.

The model-calculated groundwater level declining rate is verified by comparing it to the observed groundwater levels in wells in the Jurisdiction area, which show a similar declining trend, as presented in previous sections. The observed groundwater levels in the basin declined at an average rate of 1.2 feet per year for the same period.

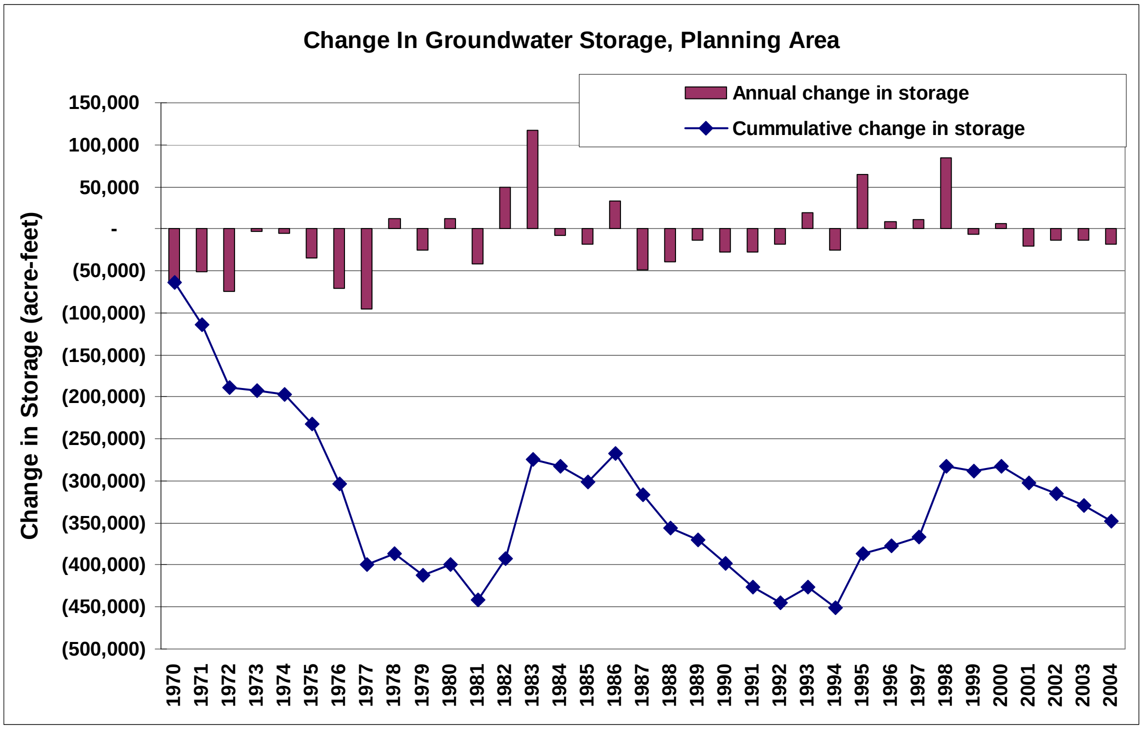


Figure 1-23. Change of groundwater storage in the Planning Area for the period 1970–2004.

1.8 Issues of Concern

This Land and Water Resources setting section is intended to provide stakeholders with a basic understanding of current groundwater conditions in south Sacramento County. This information was developed from the best available data. Additionally, several technical issues important to a comprehensive understanding of local groundwater conditions were identified. These issues are highlighted below.

1.8.1 Groundwater Recharge from Local Rivers and Streams

The rivers and stream that flow from the Sierra Nevada provide an important source of recharge water to groundwater aquifers of the Central Valley. As the development of groundwater resources increased to meet agricultural and municipal demands in the Central Valley, the interaction between rivers and underlying aquifers changed. In many cases, this interaction between river and aquifer is poorly understood—and the Cosumnes River is no exception. What is known is that the Cosumnes River and other local waterways are critical sources of recharge water to the aquifer underlying south Sacramento County and the northern San Joaquin County.

Increasing use of groundwater resources since the 1950s has lowered groundwater levels throughout south Sacramento County and levels are now 60 to 100 feet below the Cosumnes River channel. The result is a hydraulic disconnection between much of the river and the regional aquifer, causing the river to become a losing system—the river does not receive baseflow from the regional aquifer and generally contributes river flow to the aquifer through channel seepage. Investigations of river flow and groundwater interactions along the lower Cosumnes River (below Michigan Bar at river mile 36) show that the loss of baseflow contributions to the river, as a result of lowering groundwater levels, has at least partially decreased summer and fall flow in the lower reach of the river.

At this time, there is only a general understanding of surface water/groundwater interaction. Much of this information is based on research conducted by UC Davis. To develop a more comprehensive understanding of the groundwater basin, it is important that additional information be collected on the rate of groundwater recharge from the Cosumnes River and Dry Creek, as well as the lesser creeks.

There are efforts underway to collect such information along the Cosumnes River. UC Davis is currently conducting research along the river between Dillard Road and Twin Cities Road to identify river reaches with higher rates of recharge to the groundwater basin and to quantify those rates. This information will enhance our understanding of the Cosumnes' role in supplying water to the local aquifer.

1.8.2 Growth Projections

As the groundwater management planning efforts continue, stakeholders should prepare a projection of future water demands for the South Basin so that they can determine the long-term viability of groundwater resources. Future projections of water demands are typically based on projected growth in urban areas, as described in municipal and countywide land use plans. However, the South Basin is dominated by agricultural lands and the current Sacramento County General Plan (1993) does not project any changes to land use designation in the majority of the South Basin. The County's 1993 General Plan does report potential water demands for portions of South Basin for 2015, but the basis of these estimates is not completely understood and should be revisited prior to adopting these projections for this planning effort. The communities of Galt and Rancho Murieta are able to provide current growth projections, which was incorporated into this planning process. These available projects were included in the baseline scenario model run that is included in the Management Strategies section of this plan.

Because there are no comprehensive growth projections for the majority of the South Basin area, an alternative means of projecting growth in the area will need to be developed. Recently, the area has seen an increase in the subdivision of large agricultural parcels into ranchette-style parcels of 2–5 acres. It is important to capture the conversion of agricultural lands to ag-residential lands and the potential impacts to groundwater resources. Similarly, there has been a significant increase in the number of vineyards in the South Basin—replacing higher water using crops or converting previously non-irrigated lands to irrigated vineyards. A reasonable determination of whether this trend will continue in the future needs to made, as well as other potential crop type conversions, to facilitate an accurate estimate of future water demand in the South Basin.

Basin Management Objectives

2 Basin Management Objectives

This section discusses four goals and related Basin Management Objectives proposed for the South Basin based on feedback from basin stakeholders. The goals and objectives focus on managing and monitoring the basin to benefit all groundwater users in the Basin

2.1 Introduction

Groundwater and surface waters within the Cosumnes Groundwater Basin are a vitally important resource that provides the foundation for maintaining current and future water needs. Preservation of these resources is essential to maintaining the economic viability and prosperity of the Basin area.

The South Basin GMP provides a framework under which all users of the aquifer can move towards a commonly held set of goals and objectives concerning groundwater use and protection. Groundwater management goals express the desired state of the groundwater basin in qualitative terms. These groundwater basin management goals provide the foundation for the more specific Basin Management Objectives (BMOs)—specific criteria defining the desired state of the basin. These objectives provide a mechanism for determining whether groundwater management goals are being achieved.

Senate Bill (SB) 1938, created in 2002, requires that agencies:

"Prepare and implement a groundwater management plan that includes basin management objectives for the groundwater basin that is subject to the plan. The plan shall include components relating to the monitoring and management of groundwater levels within the groundwater basin, groundwater quality degradation, inelastic land surface subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping in the basin."

Local agencies that fail to adopt or participate in a plan fulfilling the requirements of SB 1938 shall not be eligible for State funding intended for groundwater projects.

The Stakeholders Plenary Group developed the following BMOs to meet the groundwater management plan goals listed below.

GOAL 1: MAINTAIN LONG-TERM RELIABLE GROUNDWATER SUPPLIES.

The purpose of this goal is to maintain or enhance groundwater elevations to meet the long-term needs of groundwater users within the Groundwater Management Area. The plenary group developed the following BMOs for the purpose of meeting this goal.

BMO 1.1 – Understand the groundwater dynamics of the basin.

The complexity of flow within aquifers requires extensive data and detailed modeling to answer development questions. Even with this, accurate analysis of the water balance is often complicated by inflows and losses that are difficult to identify, monitor or interpret. However, relatively simple data, such as specific water levels in a carefully designed network of monitoring wells, can be combined with estimates of groundwater inflows and outflows to provide key indications of groundwater dynamics.

The governing body will pursue the following water management actions under this BMO.

Actions

1. Develop and maintain a consistent long-term monitoring network of an adequate number of wells that represent overall groundwater conditions in the basin.
2. Identify current and future groundwater needs for different users in the basin: Domestic, Agricultural and Municipal based on information from users and other appropriate sources.
3. Identify areas that are contributing significant natural recharge in the basin.
4. Identify zones of critical groundwater conditions within the basin and evaluate interaction with surrounding areas.
5. Re-evaluate the Water Forum sustainable yield for the groundwater basin using data developed under this plan.

BMO 1.2 – Maintain or enhance groundwater elevations to meet the long-term needs of groundwater users within the Groundwater Management Area.

Long-term lowering groundwater levels can have adverse impacts on all groundwater users, ranging from increased energy costs and water quality degradation, to the need to deepen existing wells or even develop new wells. Therefore, it is important to maintain or enhance groundwater elevations in the basin so that groundwater will continue to be a reliable, safe, efficient, and cost-effective water supply.

Conjunctive use and recharge projects proved to be efficient means to achieve this objective in many parts of California. Conjunctive Use, as defined by the DWR 2003 Draft Bulletin 118, is:

"The coordinated and planned management of both surface and groundwater systems in order to maximize the efficient use of the resource; that is, the planned and managed operation of a groundwater basin and a surface water storage system combined through a coordinated conveyance infrastructure. Water is stored in the groundwater basin for later and planned use by intentionally recharging the basin during years of above-average water supply."

The governing body will pursue the following water management actions under this BMO.

Actions

1. Investigate and pursue conjunctive use opportunities within the South Basin area.
2. Seek and obtain permanent and/or temporary surface water supplies.
3. Identify recharge, and in-stream, and off-stream storage sites.

GOAL 2: MAINTAIN OR IMPROVE GROUNDWATER QUALITY.

Although groundwater within the Basin generally has good quality and historically no persistent water quality problems were reported, it is economically important to maintain or improve groundwater quality in the Basin to meet the long-term needs of groundwater users within the Groundwater Management Area. The plenary group developed the following BMOs for the purpose of meeting this goal.

BMO 2.1 – Protect against adverse impacts to groundwater quality from man-made contaminants.

The stakeholders recognize that the long-term sustainability of the underlying basin cannot be accomplished without adequate groundwater quality protection and contamination prevention programs. Other than the City of Galt public supply wells, and other public entities such as school supply wells, there is little historical groundwater quality data available within the basin. The governing body will pursue the following water management actions under this BMO.

Actions

1. Develop and maintain basin groundwater quality database utilizing existing monitoring network of wells to collect water quality samples in addition to water quality data available from other agencies.
2. Develop the basin water quality baseline criteria (constituents and thresholds).
3. Assess annually the adequacy of the groundwater quality monitoring well network.
4. At least annually, compare baseline and future monitoring results to historical data and water quality standards for agriculture and drinking water to determine existence of water quality problems.

BMO 2.2 – Protect against migration of contaminated groundwater.

Historically, there are no known areas of contamination within the South Basin as seen in neighboring basins. While the basin governance body does not have the authority or responsibility for remediation of contamination, it is committed to stay informed on the status and disposition of known contamination in neighboring basins or presence of any contaminants plumes in the South Basin. The governing body will pursue the following water management actions under this BMO.

Actions

1. Annually review data, regulations, and reports from regulatory agencies on contaminant plumes to provide warning of potential future problems.
2. If detections occur in monitoring wells within the basin or indicated in regulatory agencies reports, meet with the appropriate regulatory agencies and responsible parties to develop an action plan for warning water users and minimizing the further spread of contaminants.

BMO 2.3 – Monitor and control saline water intrusion.

Saline water intrusion from the Sacramento-San Joaquin Delta (Delta) is not currently a problem in the South Basin. Higher groundwater elevations associated with recharge from the American, Cosumnes and Sacramento rivers have maintained a historical positive gradient, preventing significant migration of any saline water from the Delta into Sacramento County. But salinity intrusion into the shallow aquifer of the South Basin is a possible scenario if pumping depressions in the basin reverse the groundwater gradient. The governing body will pursue the following water management actions under this BMO.

Actions

1. Periodically observe TDS concentrations in monitoring wells throughout the South Basin that are routinely sampled.
2. Establish a threshold salinity level for alert or action by locals.
3. Inform all stakeholders of the presence of the salinity interface and the approximate depth to the interface for their reference when locating potential wells.

BMO 2.4 – Facilitate implementation of policies and programs for wellhead protection, well abandonment and construction, by regulatory agencies.

Contaminants from the surface can enter an improperly designed or constructed well along the outside edge of the well casing or directly through openings in the well head. Therefore, proper well design, construction, and site grading are essential to any wellhead protection program to prevent intrusion of contaminants into the well from surface sources. Furthermore, because wells can be a direct conduit to the aquifer, they must be properly destroyed or abandoned because they could provide an unimpaired route for pollutants to enter the groundwater, particularly if pumping equipment is removed from the well and the casing is left uncapped.

The Sacramento County Environmental Management Department (EMD) administers the well construction permitting and abandonment programs for Sacramento County. Standards for well construction are identified in Sacramento County Code No. SCC-1217 (County Well Ordinance), as amended on April 9, 2002.

Identification of wellhead protection areas is an element of the Drinking Water Source Assessment and Protection (DWSAP) program administered by Department of Health Services (DHS). DHS set a goal for all water systems statewide to complete Drinking Water Source Assessments by mid-2003.

It is DHS's responsibility to maintain and enforce well-head standards; however, the governing body will pursue the following water management actions under this BMO.

Actions

1. Obtain vulnerability summaries from public water purveyor agencies within South Basin from the Drinking Water Source Assessment Program for SAWC governance body to use for guiding management decisions in the basin.
2. Coordinate with groundwater basin managers in other areas of the state to share technical advice, effective management practices regarding establishing Wellhead Protection Areas.
3. Working with California Department of Water Resources (DWR) and Sacramento County Environmental Management Department (EMD), to compile data regarding abandoned wells in the South Basin and create a Data Management System with the appropriate data.
4. Ensure that if requested, public and private agencies, and private groundwater users in the South Basin are provided a copy of the county well ordinance and understand the proper well construction and destruction procedures and support implementation of these procedures.

GOAL 3: MAINTAIN AND ENHANCE RELATED NATURAL RESOURCE FEATURES OF THE SOUTH BASIN.

The purpose of this goal is to minimize impacts resulting from continued groundwater pumping on related natural resources features such as surface water and land. The plenary group developed the following BMOs for the purpose of meeting this goal.

BMO 3.1 – Enhance the understanding of groundwater-surface water interaction along the Cosumnes River and creeks in the Basin to protect against adverse impacts to surface water resources.

The water agencies in South Basin and landowners understand the importance of preserving the fishery, wildlife, recreational, and aesthetic resources of the lower Cosumnes River. They also realize the significance to protect against adverse impacts to water quality resulting from interaction between groundwater in the basin and surface water flows in the Cosumnes River and other creeks in the Basin. The governing body will pursue the following water management actions under this BMO.

Actions

1. Work cooperatively with USGS, Sacramento County, TNC, GID, and OHWD to compile available information on stream flow, on tributary inflows, on surface water diversions from the Cosumnes River, and on groundwater pumping to quantify net groundwater recharge or discharge between gages along the waterways.
2. Coordinate with local, state, and federal agencies and develop partnerships to investigate cost-effective methods that could be applied to better understand surface water-groundwater interaction along the Cosumnes River.
3. Review results from studies and develop an action plan as appropriate.

BMO 3.2 – Protect against inelastic land surface subsidence.

Land subsidence can cause significant damage to essential infrastructure. There is no evidence of historical land surface subsidence within the South Basin and no known impacts to existing infrastructure. Given historical trends, the potential for land surface subsidence from groundwater extraction in the South Basin appears to be remote. The governing body will pursue the following water management actions under this BMO.

Actions

1. Cooperate with adjacent groundwater management agencies to monitor for potential land surface subsidence.
2. If inelastic subsidence is documented in conjunction with declining groundwater elevations, the basin governance body will investigate and take appropriate actions to avoid adverse impacts.

GOAL 4: MAINTAIN LOCAL CONTROL OF GROUNDWATER MANAGEMENT.

The water agencies and stakeholders in the basin intend to retain local active control of groundwater resources management by ensuring on-going stakeholder involvement in appropriate management decisions. The plenary group developed the following BMOs for the purpose of meeting this goal.

BMO 4.1 – Coordinate development and optimize operation of, or implement as appropriate future water management projects.

Various water agencies in the South Basin share intents for development and operation of recharge, storage, conservation, water recycling, and extraction projects. The role of the governing body is to promote cooperation and sharing of information between the agencies sponsoring water management projects and other local water agencies and stakeholders. To the extent feasible, the governing body also will support measures to coordinate development and optimize operation of facilities to improve Basin-wide effectiveness and efficiency of water management. The governing body will pursue the following water management actions under this BMO.

Actions

1. Share information on project planning, design, and operation among local land owners and stakeholders.
2. Promote a coordinated approach toward project development and operation to optimize water management efforts.
3. Seek funding for projects and programs for future water conservation, recycling, public outreach and education and groundwater recharge in the Basin.

BMO 4.2 – Actively develop and partner in conjunctive use projects of groundwater, surface water, and recycled water.

The region's assets of federal, state, and local water supplies, dewatered groundwater storage, and significant irrigation demand make it an ideal location to regulate surface supplies conjunctively. Some water agencies within south Sacramento County have existing/promised water rights and contracts that cannot be fully utilized for a variety of factors, including supply reliability and infrastructure limitations. It is very important for those agencies to maximize the utilization of existing/promised water rights.

The Basin should also be capable of absorbing wet-year water supplies in order to maintain a reliable and economical water supply. Wet-year water supplies, also known as flood-flows or unregulated flows, are defined as either releases made from upstream storage reservoirs to maintain adequate flood storage capacity or flows in excess of in-stream flow requirements. Developing cost-effective methods to capture and store flood water is a major challenge due to the intensity and infrequency of major storm/runoff events. Therefore, the local agencies intend to work cooperatively to increase the ability to absorb surface water when available. The governing body will pursue the following water management actions under this BMO.

Actions

1. Cooperate with other relevant agencies in projects that promote the area's conjunctive water management capabilities and enhance groundwater.
2. Investigate potential sources of water and funding opportunities for conjunctive use projects.

3. Identify potential recharge sites in South Basin; undertake and approve appropriate conjunctive use studies, plans and project proposals that benefit stakeholders and land owners in the basin.

BMO 4.3 – Examine public agency's land use plans to identify potential impact on groundwater.

Effective January 1, 2002, State Water Code Sections 10910-10915 (inclusive) (commonly known as SB 610) required that a water supplier take certain actions to confirm sufficiency of water supply as a condition to approval of new development projects. These actions require developing Water Supply Assessments and Written Verifications at the request of the land use authority. These documents provide an assurance that adequate water supplies are available before a project moves forward in gaining entitlements for development. The governing body will pursue the following water management actions under this BMO.

Actions

1. Undertake initial review of all proposed public agency's projects with potential to benefit or impact groundwater in the basin and provide comments as appropriate.
2. Coordinate with and exchange information with lead agencies regarding projects with the most significant risk to groundwater.
3. Submit formal comments on public agency's land use plans for the South Basin, when appropriate.
4. Coordinate with local planning agencies to develop land use strategies that protect groundwater recharge areas.

BMO 4.4 – Establish a procedure for sharing information with the public, appropriate resources management and regulatory agencies on local, state, and federal levels.

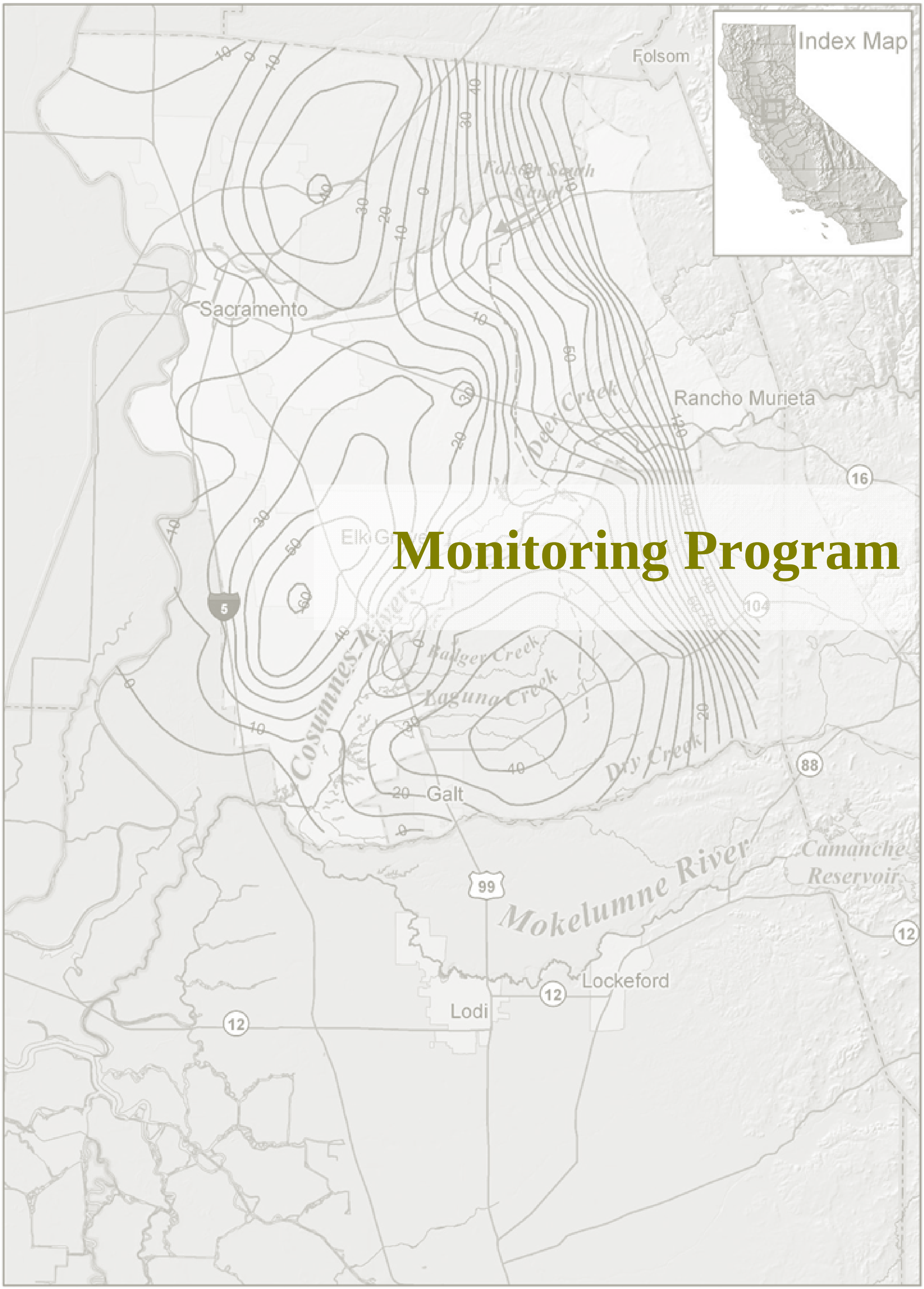
The governing body will continue coordination among its member agencies, local water agencies, land owners, and interested parties to manage the water supplies within the South Sacramento Basin. The governing body will also continue to cooperate and develop basinwide programs and projects to benefit the Basin's resources.

The governing body meetings will continue to be a forum where regional, state, and federal agencies can meet to discuss ongoing and future regulatory issues. The governing body will pursue the following water management actions under this BMO.

Actions

1. Develop working relationships with appropriate local, state, and federal regulatory agencies, and establish protocols for data exchange with these agencies.
2. Conduct periodic coordination meetings to ensure close collaboration.
3. Provide water efficiency measures to the public.

Monitoring Program



3 Monitoring Program

This section discusses the GMP groundwater monitoring program, which is designed to identify trends and changes in groundwater elevation and quality throughout the basin. The program includes monitoring groundwater elevation and quality, land subsidence, and groundwater-surface water interaction.

Groundwater level and quality monitoring protocols and programs are required components of Groundwater Management Plans prepared in response to Senate Bill (SB) 1938 (Amendments to Water Code section 10750). The monitoring program should include a map of monitoring sites, the type of monitoring at each site, the type of measurements and frequency of monitoring at each location.

This report section describes a monitoring program capable of assessing the current status of the basin, and predicting responses in the basin as a result of future management actions. The program includes monitoring groundwater elevations, monitoring groundwater quality, monitoring and assessing the potential for land surface subsidence resulting from groundwater extraction, leading to a better understanding of the relationship between surface water and groundwater along the Cosumnes River and other creeks in the basin. Also important is establishing monitoring protocols to ensure the accuracy and consistency of data collected. Finally, the monitoring program includes a tool (Data Management System) for assembling and assessing groundwater-related data.

3.1 Groundwater Elevation Monitoring

California Department of Water Resources (DWR) and Sacramento County Water Agency (SCWA) coordinate a program to collect semiannual (spring and fall) groundwater level data from more than 150 wells throughout Sacramento County. SCWA uses this data to generate semiannual groundwater contour maps for the county. However, comparison of a historical contour map with a recent levels map causes debate because wells have been added and dropped from the program over time. For this reason, the basin governance should plan to establish a standardized network of wells that combines those monitored by DWR, SCWA, member water purveyors, and other sources. It is the intent of the stakeholders that the wells comprising this program be maintained as a consistent long-term network that represents overall groundwater elevation conditions in the basin.

Figure 3-1 shows the wells currently proposed for this network. Well information, including well number, record length, well use, well depth and screened intervals is summarized in **Table 3-1**. The wells were selected to provide uniform geographic coverage of the entire South Basin.

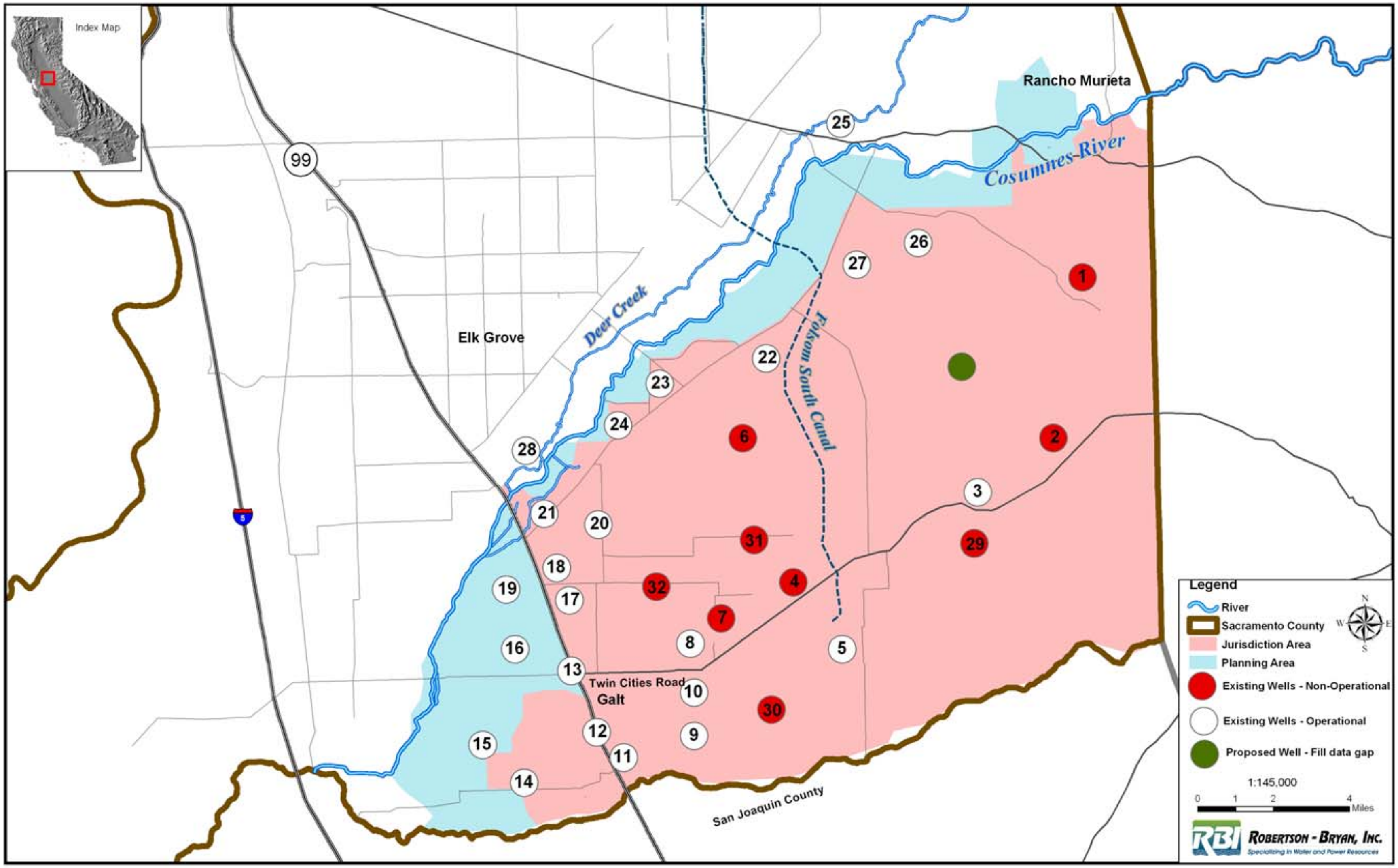


Figure 3-1. Wells currently proposed for the standardized monitoring network.

Table 3-1. Well network information.

Well No	State #	Data Range	Well Use	Well Depth (ft)	Screened Intervals (ft)	Notes
1	07N08E36B001M	1953–2009	Unused	15'	none	
2	06N08E15J001M	1954–2009	Domestic	150'	none	
3	06N08E21P003M	1972–2010	Domestic	305'	none	WWDR
4	06N07E34H001M	1966–2008	Unused	210'	none	
5	05N07E11R002M	1985–2010	Domestic	228'	none	WWDR
6	06N07E08R001M	1966–2008	Domestic	332'	none	
7	06N07E32P001M	1963–2008	Irrigation	545'	120'–124', 132'–136'	WWDR
8	05N06E12R001M	1990–2010	Irrigation	850'	none	
9	05N07E19N001M	1972–2010	Domestic	225'	none	WWDR
10	05N06E13R001M	1990–2010	Irrigation	240'	none	cased 0-170'
11	05N06E26K001M	1961–2010	Irrigation	310'	none	
12	05N06E26D001M	1963–2010	Irrigation	383'	263'to359'	WWDR
13	05N06E10P001M	1963–2010	Irrigation	384'	169'–193', 241'–265', 289'–361'	WWDR
14	05N06E33H001M	1990–2010	Irrigation	none	none	
15	05N06E30E001M	1991–2010	Irrigation	none	none	
16	05N06E08R001M	1972–2010	Irrigation	none	none	
17	06N06E34P001M	1990 -2010	Irrigation	375'	none	
18	06N06E33J002M	1966–2010	Irrigation	167'	none	
19	06N06E33L001M	1963–2010	Irrigation	226'	none	WWDR
20	06N06E23C001M	1990–2010	Irrigation	275'	none	
21	06N06E28C002M	1965–2010	Irrigation	none	none	
22	07N07E33G001M	1984–2010	Domestic	180'	none	WWDR
23	06N06E01G001M	1990–2010	Domestic/Irrigation	330'	none	cased 0-196'
24	06N06E11J003M	1990–2010	Domestic	215'	none	
25	07N07E02C001M	1990–2010	Irrigation	135'	none	
26	07N08E18F001M	1968–2010	Stock	none	none	
27	07N07E14R001M	1985–2010	Domestic	185'	none	WWDR
28	06N06E16E001M	1989–2010	Domestic	150'	none	
29	06N08E34E001M	1975–1994	Irrigation			
30	05N07E28A001M	1966–1994	Irrigation			
31	06N07E28E001M	1952- 1996	Domestic			
32	06N06E25Q001M	1990–1998	Domestic			

Individual wells were selected giving preference to wells currently in the DWR and SCWA monitoring program. These wells were selected because:

1. They have long records of historical groundwater level data and are useful in assessing trends within the groundwater basins, and
2. Uniform protocols were used in measuring and recording the water level data.

The monitoring network includes 23 currently operational monitored wells, 9 non-operational monitored wells and one proposed new well to fill a spatial gap in the network.

Additional actions by the basin governance body will include:

1. Construct new dedicated monitoring wells to eliminate influence of well operations on groundwater level data. Pursue state and other sources of funding to achieve this purpose.

2. Coordinate with DWR, SCWA and others to ensure that the selected wells are maintained as part of a long-term monitoring network and protected in the future from being dropped from the program.

3.2 Groundwater Quality Monitoring

Groundwater quality in the South Basin is generally acceptable for all potential uses and there are no known areas of contamination within the boundaries of the Planning or Jurisdiction areas. The City of Galt has monitored instances of arsenic in a few wells. A limited number of wells have available record of historical water quality data because few of the wells in the basin are used for public water supply. These wells are shown in **Figure 3-2** and they are:

- City of Galt Public Water System,
- Elk Grove Unified School District wells in Wilton, and
- Arcohe elementary School in Herald.

Water purveyors compile available water quality data for constituents monitored as required by DHS under CCR Title 22. As part of this monitoring plan, the governing body will seek additional resources to gather additional water quality data from existing monitoring programs by agricultural and domestic pumpers. The water quality monitoring well network may be expanded to include additional DWR, USGS, and privately owned domestic and agricultural wells based on the outcome of coordination effort with these agencies and interested land owners.

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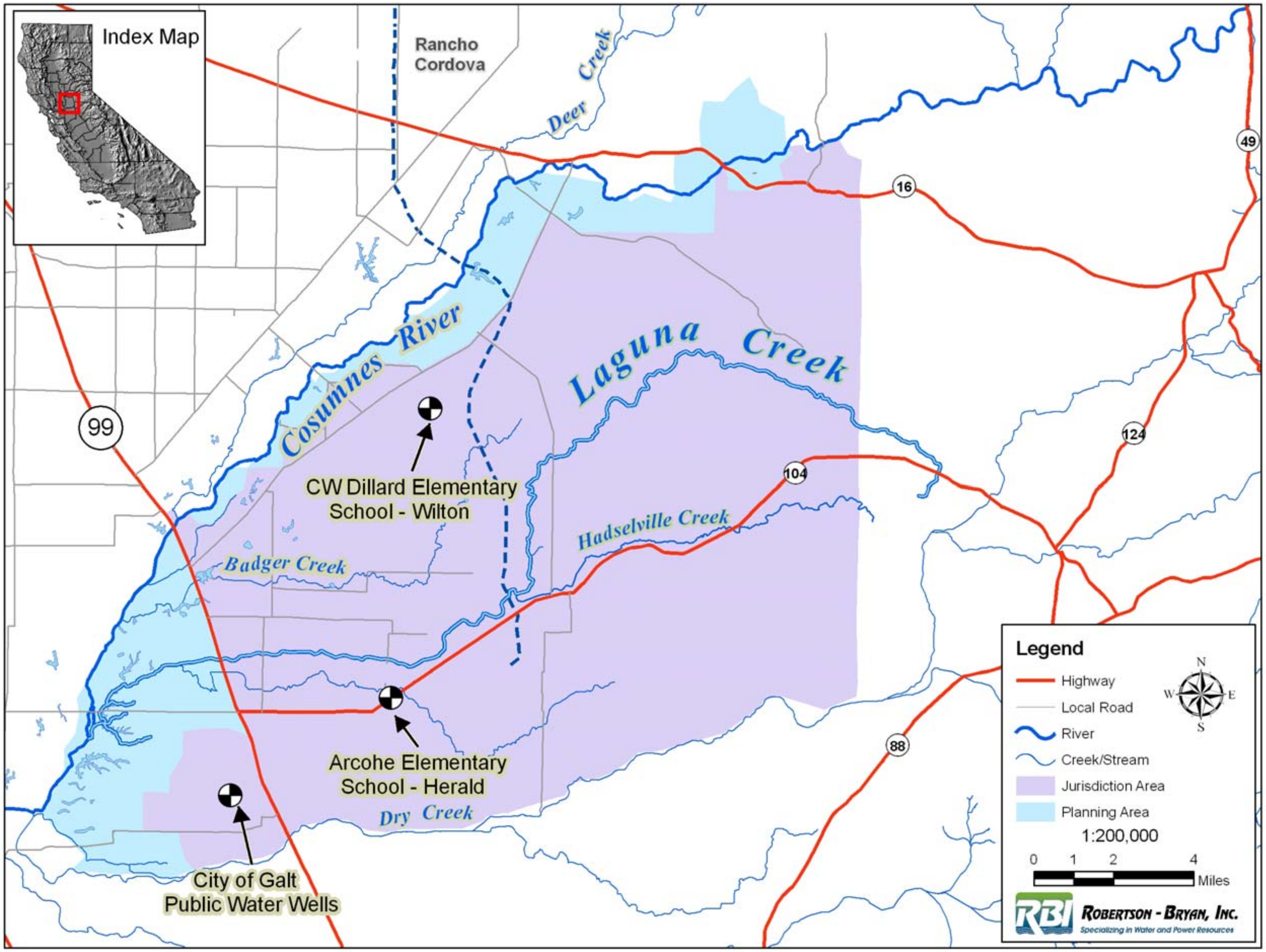


Figure 3-2. South Basin wells with historical water quality data records.

In Addition, the basin governance body will take the following actions:

1. Coordinate with cooperating agencies to verify that uniform protocols are used when collecting water quality data.

2. Assess periodically the adequacy of the groundwater quality monitoring well network

3.3 Land Subsidence Monitoring

While available data and reports indicate that surface subsidence is not occurring in Sacramento County, the basin governance body will review and evaluate DWR, Sacramento County, and National Geodetic Survey (NGS) land subsidence surveys data for Sacramento County. If subsidence is reported, the governing body will examine reports of land subsidence and discuss potential monitoring activities based on the results of the evaluation.

3.4 Groundwater-Surface Water Interaction Monitoring

The governance body will coordinate with agencies that currently maintain existing gauging stations for stream flow rates and water quality monitoring along the Cosumnes River and creeks in the basin (USGS, OHWD, SMUD, etc.) to ensure that the selected gauging stations are maintained as part of a long-term monitoring network and protected in the future from being dropped from the program. Surface water data will be assembled as part of the groundwater information database and will be reported in the annual monitoring report.

Three gauging stations are currently operational along the Cosumnes River for stream flow measurements:

1. One USGS gauge at Michigan Bar, and
2. Two OHWD gauges at Rooney Dam and Mahon Dam.

In addition, SMUD maintained two stream flow gauges along Hadselville Creek and Laguna Creek until 2010. The location of these gauges is shown in **Figure 3-3.**

Additional actions by the basin governance body will include:

1. Coordinate with TNC and UC Davis, to incorporate and analyze data obtained from monitoring wells near the Cosumnes River to better understand the relationship between groundwater basin and surface water flows at that location.
2. Obtain and incorporate available surface discharge monitoring data from the local water quality coalition.

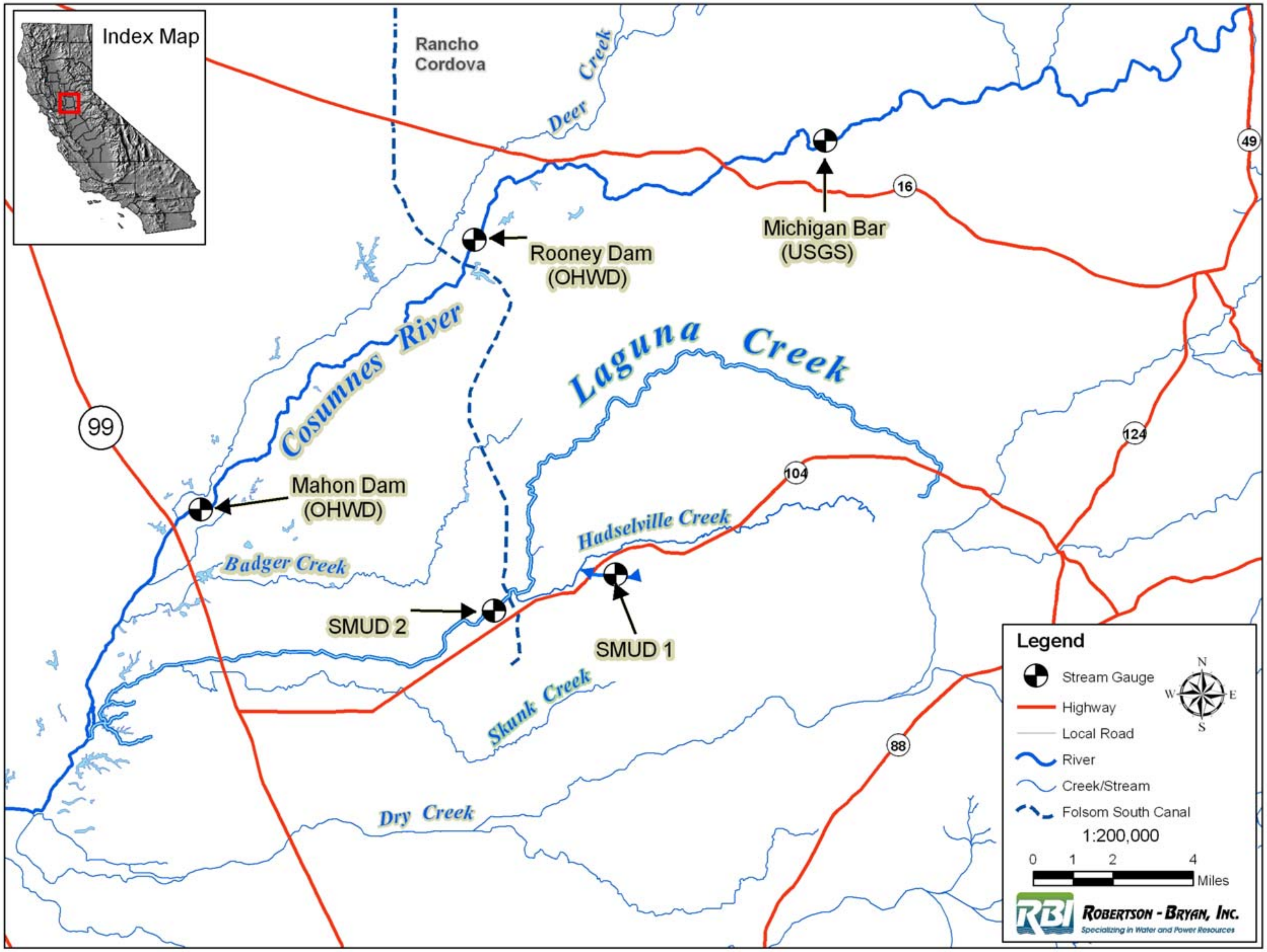


Figure 3-3. Location of stream flow gauges.

3.5 Protocols for Collection of Groundwater Data

The governance body will use DWR standard operating procedures (2010) for collection of water level data. The governance body will ensure that the procedure is consistent with protocols developed by other agencies involved in groundwater monitoring activities in the basin, such as SCWA, SMUD, USGS and USBR.

The governance body will also provide cooperating agencies with guidelines developed by DHS (DHS, 1995) or other agencies for the collection, pretreatment, storage, and transportation of water quality samples.

3.6 Data Management System

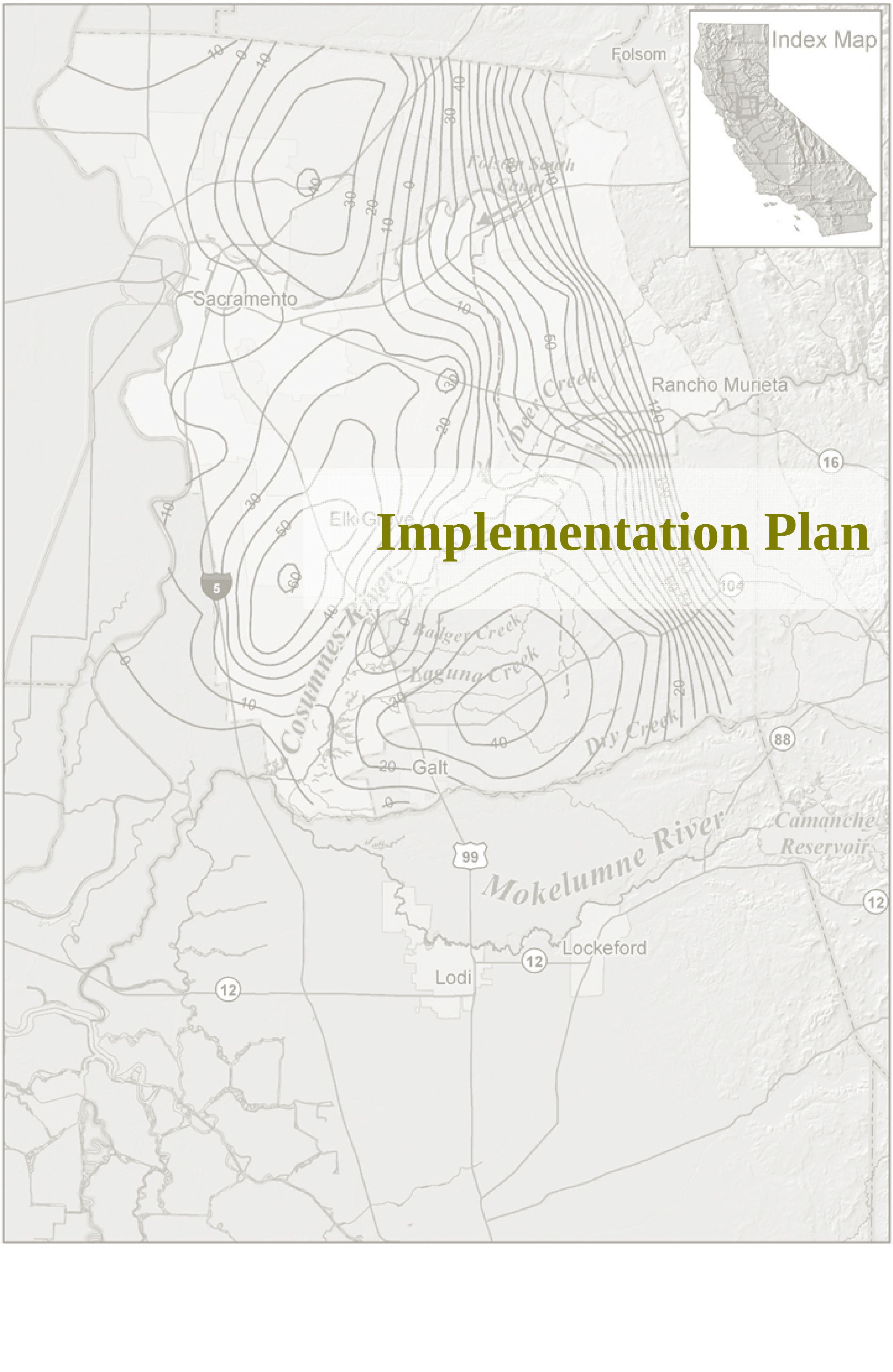
The Governance body will assemble and maintain a data management system (DMS) of groundwater information for the monitoring wells in the basin, establish a procedure to fill missing data and make data available to agencies, landowners, and stakeholders in the basin.

An annual groundwater report describing elevation and quality trends and basin development changes will be prepared.

The Basin governance body will take the following actions:

- Develop simple-to-use tools necessary to analyze groundwater data.
- Make groundwater information available to decision makers, agency staff, and the general public through the internet.
- Continue to update the DMS with current water purveyor data.
- Make recommendations to an assigned DMS developer to enhance the DMS to increase its functionality and ease of use.

Implementation Plan



4 Implementation Plan

This section describes the structure and the method for implementing the Groundwater Management Plan (GMP) after its adoption. The purposes of this implementation plan are to guide groundwater management efforts and carry out the proposed activities outlined in the basin management objectives (BMOs) section of this GMP. The overarching purpose of the BMOs and associated actions is to encourage a balance of surface water and groundwater use to protect the resources of the Basin and maximize the reliable supply of high quality water to meet the basin's current and future needs.

It is important to note that groundwater management requirements and responsibilities, as dictated by the California Code of Regulations, may change over time. Individual agencies, as well as the agency responsible for implementing this plan, will evaluate regulatory changes and determine how best to address those changes, when and if they occur. The recommendations and implementation priorities may change over time, to accommodate the changing regulatory framework.

4.1 Basinwide Management Actions

The following Basin-wide management actions are provided as suggested measures for facilitating the achievement of the BMOs described in Section 2:

1. Maintain the groundwater elevation and quality monitoring wells network as part of a consistent long-term monitoring network.
2. Implement GMP's monitoring program components by collection, analysis and assimilation of water levels and quality data and development and maintenance of a data base system. Data are needed to understand conditions within the Basin, evaluate trends, facilitate the implementation of management actions, and evaluate their effectiveness.
3. Investigate and pursue conjunctive use opportunities within the South Basin area. This entails Seeking and obtaining permanent and/or temporary surface water supplies and Identification of recharge, and in-stream and off-stream storage sites.
4. Promoting coordination and cooperation between water agencies (federal, state and local) within the basin and outside the basin. The Basin Governing body should continue to coordinate water management activities within the Basin and work cooperatively to implement the agreed-upon BMOs. The local water agencies also may work together to develop a coordinated outreach program to educate basin residents and groundwater users on groundwater management issues.

5. Annually review data, regulations and reports from regulatory agencies on contaminant plumes, vulnerability summaries and TDS concentrations to provide warning of potential future problems.
6. Seek funding for projects and programs for future water conservation, recycling, public outreach and education and groundwater recharge in the Basin.

4.2 Governing Structure

The plenary committee recommended that a new Implementation Authority, formed through a Joint Powers Authority (JPA), represent the following interests in the basin to carry out the implementation plan:

- City of Galt
- County of Sacramento
- Galt ID
- Clay WD
- Omochumnes Hartnel WD
- Commercial Irrigated Agriculture Interest Representative from within the Jurisdictional Boundaries of the Basin
- Commercial Aquaculture Interest Representative from within the Jurisdictional Boundaries of the Basin
- Rangeland/Grazing Agriculture Interest Representative from within the Jurisdictional Boundaries of the Basin
- Conservation Landowners Representative from within the Jurisdictional Boundaries of the Basin
- Ag- Residential Representative from within the Jurisdictional Boundaries of the Basin – Cosumnes CPAC
- Ag- Residential Representative from within the Jurisdictional Boundaries of the Basin – Herald CPAC
- Commercial/Industrial Interest from within the Jurisdictional Boundaries of the Basin
- Sloughhouse RCD
- RD 800
- Rancho Murieta CSD
- SMUD

The final structure of the governing body is still being negotiated by the stakeholders in the basin.

The primary roles of the implementation authority could include:

- Securing and providing funds for implementation of the GMP.
- Issuing and managing contracts necessary for implementation of the GMP.

- Overseeing the accuracy and quality of all reports associated with GMP implementation.
- Advancing and facilitating pursuit of the goals and objectives identified in this GMP in a timely manner.
- Directing future updates to the GMP every 5 years, or more frequently if needed, to reflect changes in state laws or in local conditions/programs.
- Act as liaison between GMP implementation activities and agencies, individuals, and agencies represented by the group members

The Implementation Authority will meet at least annually, unless the Authority decides it should meet more frequently, at which time it will:

1. Review, amend and adopt the annual report on the status of the basin.
2. Review the progress on meeting the GMPs goals and objectives.
3. Discuss and approve the work plan for the upcoming year.
4. Consider any amendments to the GMP.

4.3 Annual Review and Report (ARR)

The Implementation Authority would be responsible for reporting on the progress of implementing the Southeast Sacramento County Groundwater Management Plan (SSCGMP) in an annual State of the Basin report. The annual Review and State of the Basin report can be completed between April 1 and June 1 of each year and will cover conditions and activities completed through December 31 of the prior year. The reason for starting the review process in April is due to the time that data compilation process can take before it is ready for board members review. Prior to accepting the report, the Implementation Authority will consider comments from the general public.

The Annual Review and Report will include:

- Status of groundwater conditions within the Basin – levels and trends.
- Summary and analysis of monitoring effort.
- Summary and status of GMP elements implemented and proposed for implementation.
- Review annual work plan and BMOs, and assess achievement of BMOs.
- Contingency actions, if any BMO is violated or threatened.
- Prioritization of projects and programs to achieve BMOs, based on funding and other resources.

- A review of the political, institutional, social, or economic factors affecting groundwater management.
- Changes relative to the previous ARR
- Recommendations for revisions to BMOs or elements.

4.4 Financing Mechanisms

Operational funding for the Implementation Authority activities can be through annual member/participant contributions, county funding or state grants. Tasks to be performed under operational fund may include:

- GMP annual review and meetings
- Development of JPA and set up of Authority Board (first year)
- Public Outreach and development of relations with other agencies
- Set up of Data Management System
- Monitoring
- Reporting
- Grant application and funding opportunities

The projects, policies, and programs that encompass the many groundwater-related management activities, can be funded through a variety of sources, which include, but are not limited to:

1. Member/participant contributions – the ability to fund plan implementation locally will depend on available resources and is subject to an individual agency's budgetary process.
2. Funding from other interested entities.
3. In-kind services by other entities within the Basin.
4. State or Federal grants programs; such USBR WaterSmart grants, California DWR grants and NRCS grants.

It is important to note that state grant programs or other sources of outside funding often require local financial support or contributions; therefore, local contributions may aid in the acquisition of outside funding to implement the plan.

4.5 Implementation Schedule

The Implementation Authority must initiate certain activities within the first year to fulfill statutory requirements for its formation. These activities include:

- Establish an authority board, its strategies, and structure.
- Monitoring groundwater status.
- Develop a Data Management System (DMS).
- Prioritize activities that can be undertaken immediately, taking into consideration public inputs.
- Acquire funding for first year activities.

The schedule for implementing the GMP must remain flexible to account for many factors that influence the implementation. Flexibility of the implementation schedule should not be considered as grounds for delay.

Table 4-1 provides an estimate of annual cost of plan operation and additional costs associated with the start-up of the first year of plan implementation.

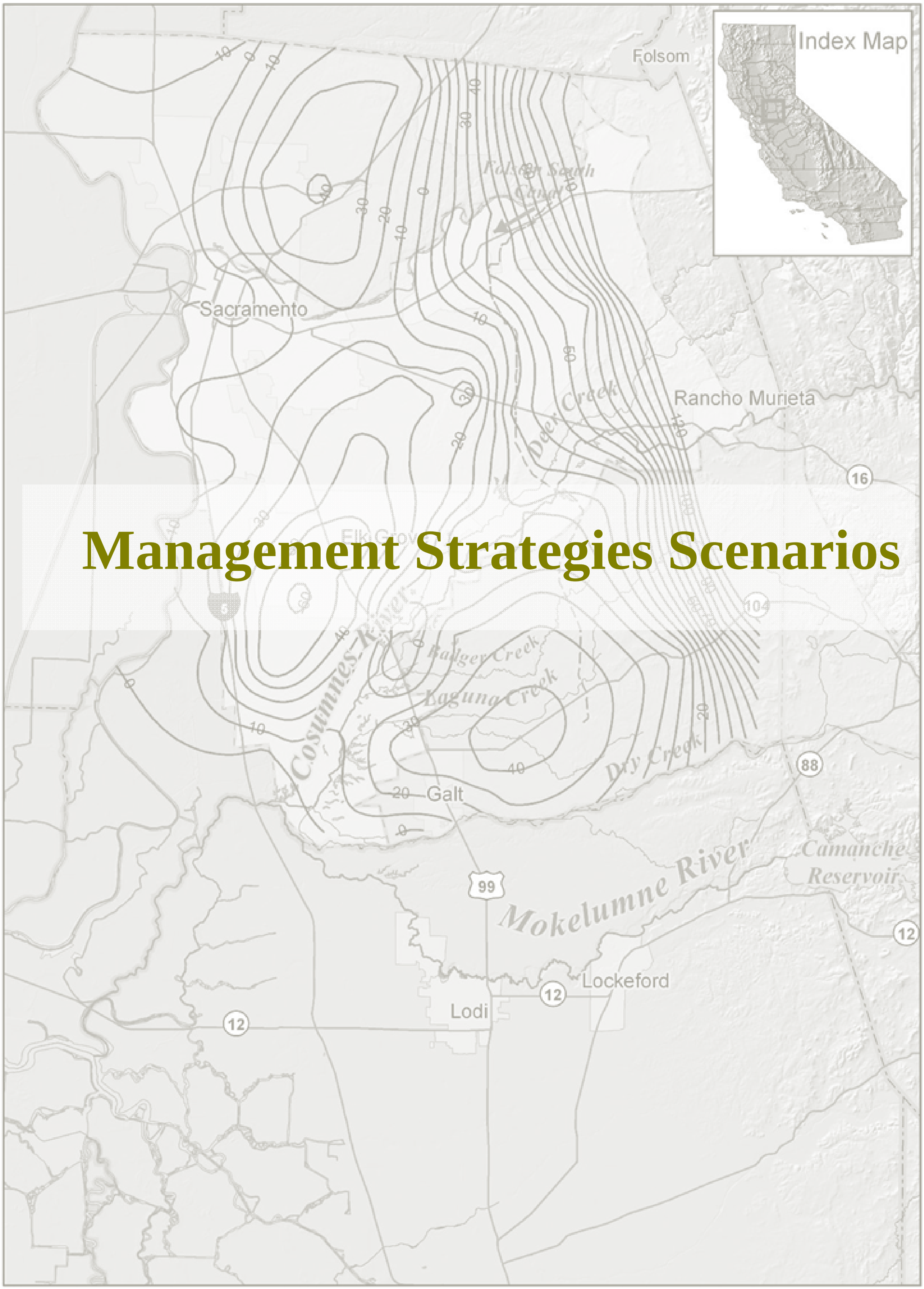
4.6 Future Re-evaluation of GMP

The GMP and documents developed as part of the implementation are part of an on-going and evolving groundwater management program. The GMP will be reviewed and updated based on new issues, changed conditions, and future technological advancements that will occur over time. Comprehensive review of the GMP will be scheduled every 5 years, unless the Authority decides it should be more frequently. This action will help maintain the GMP as a current and viable tool to guide continuing management of groundwater resources within the GMP management area.

Table 4-1. Estimated Cost of Implementation of GMP.

Budget for GMP Implementation					
1st Year					
Task	**Legal**	**Project Mgt**	**Technical**		**TOTAL**
GMP annual review and meetings	$ -	$ 10,000	$ 10,000		$ 20,000
Development of JPA and set up of Authority Board	$ 20,000	$ 30,000	$ -		$ 50,000
Public Outreach and development of relations with other agencies	$ -	$ 20,000	$ 10,000		$ 30,000
Set up Data Management System	$ -	$ 2,000	$ 13,000		$ 15,000
Monitoring	$ -	$ 2,000	$ 8,000		$ 10,000
Reporting	$ -	$ 3,000	$ 7,000		$ 10,000
Grant application and funding opportunities		$ 5,000	$ 10,000		$ 15,000
TOTAL	$ 20,000	$ 62,000	$ 48,000	$ -	$ 150,000
Annual Implementation Cost					
Task	**Legal**	**Project Mgt**	**Technical**		**TOTAL**
GMP annual review and meetings	$ -	$ 10,000	$ 10,000		$ 20,000
Public Outreach and development of relations with other agencies	$ -	$ 10,000	$ 10,000		$ 20,000
Monitoring	$ -	$ 2,000	$ 8,000		$ 10,000
Reporting	$ -	$ 3,000	$ 7,000		$ 10,000
Grant application and funding opportunities	$ -	$ 5,000	$ 10,000		$ 15,000
TOTAL	$ -	$ 30,000	$ 45,000	$ -	$ 75,000

Management Strategies Scenarios



5 Management Strategies Scenarios

In coordination and consultation with SSCAWA and stakeholders in the basin, RBI developed and evaluated alternatives for groundwater management that will facilitate achieving some of the BMOs, primarily conjunctive use and groundwater recharge. Alternatives are projects that could be reasonably implemented solely by the Authority or in conjunction with other stakeholders in the study area.

The SacIGSM Model simulated baseline and three alternative groundwater management strategies. The simulation results were evaluated in terms of groundwater elevation changes at several observation wells (**Figure 5-1**), groundwater contours changes, and changes to the groundwater budget. The focus of these simulations was a comparative analysis.

The results of the simulations were compared to each other, particularly the baseline case, in order to evaluate the potential benefits of pursuing a particular management strategy. The model simulated 35 years of hydrology (1970 to 2004) with initial conditions of fall 2004, which represents the model output at the end of the calibration period. The model delineated three aquifer layers based on DWR Bulletin 118-3, U.S. Geological Survey (USGS) reports, numerous well logs, and California Division of Oil and Gas geographical logs. The top two aquifer layers—Upper Aquifer (Model Layer 1) and Lower Aquifer (Model Layer 2)—are fresh-water bearing aquifers.

Four simulations covered a range of potential management scenarios or options:

- Continuation of existing conditions with no projects (baseline).
- Conjunctive use - utilize available surface water supplies in lieu of pumping.
- Direct Groundwater Recharge - spread available surface water supplies onto percolation basins and existing channels to directly recharge groundwater.
- Combination of In-lieu Recharge and Direct Recharge - utilize available surface water supplies in lieu of pumping groundwater and directly recharge groundwater.

Above Average Year
March–November unimpaired inflow to Folsom Reservoir is above 1,600

RBI and the plenary proposed these scenarios to meet the basin management objective to maintain or enhance groundwater elevations to meet the long-term needs of groundwater users within the Groundwater Management Area. The surface water supplies used in the scenarios employ the Water Forum specification that a maximum of 35,000 acre-feet per year of surface water will be available from the American River during **above average** and wet years (about 50 percent of the time) to the South Basin (SMUD Water for M&I use). This water is not available in dry years. Location of conjunctive use areas and direct recharge spreading ponds are shown in Figure 5-1.

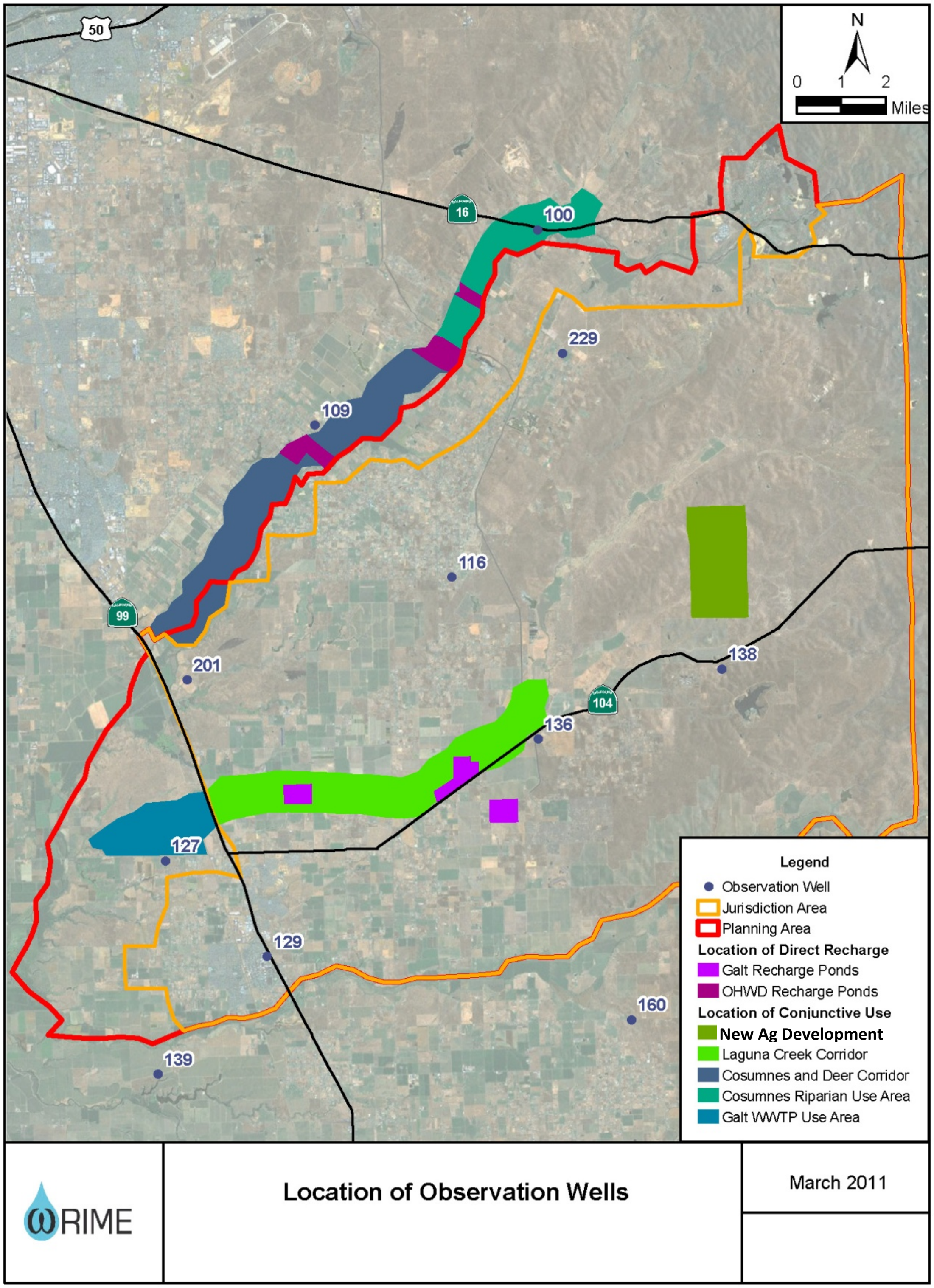


Figure 5-1. Location of Observation wells, Conjunctive Use and Direct Recharge.

5.1 Baseline

The key objective of simulating this baseline scenario is to assess the impact of maintaining existing conditions (pumping, land use) unchanged with no management project employed in the future.

5.1.1 Description of the Scenario

The assumptions used to develop the SacIGSM Model simulation for the Existing Conditions Baseline (EC Baseline) are presented below. The simulations for the Scenarios are based upon the EC Baseline.

Land Use – Land use is based on DWR Land Use Survey of 2000 for Sacramento County. Non-urban parcels that have been converted to urban land between 2000 and 2007 were urbanized for the model based on Sacramento county Assessor Parcel Number (APN) data. The area of the new agricultural development north of Highway 104 is set to 2,000 acres.

Rancho Murrieta Demand and Supply – Urban demand and surface water supply for Rancho Murrieta use 2004 data. RMCSD diverted on average about 2,000 acre-feet per year from 1992–2001 to meet its water demand.

City of Galt Demand and Supply – Urban demand and municipal groundwater production for City of Galt are based on well production data from the SGA and SCGA data management system. The City of Galt municipal pumping and demand were scaled up to 5,000 acre-feet per year to reflect current conditions.

Rural Residential Demand and Supply – Urban demand and supply for rural residential pumping is calculated based on land use using a water duty of 0.5 AF/acre.

Fish Farms – Fish farm operations use 2004 calibration data, which is approximately 11,000 acre-feet per year.

Agricultural Water Demand – The IGSM model calculates agricultural water demand based on land use and model parameters.

Tail Water Reuse – Agriculture surface supply and tail water reuse uses 2004 calibration data.

Agricultural Pumping – Agriculture pumping is the difference between demand and surface water supply.

SMUD Deliveries – SMUD deliveries and release uses 2004 calibration data. This source of surface water provides about 4,000 acre-feet annually to meet a portion of the agricultural water demand in the Jurisdiction area.

5.1.2 Results

Figure 5-2 shows well hydrographs for three wells in the basin that represent the different water elevations trends resulting from simulating existing conditions. For wells away from the Cosumnes River, the groundwater elevations trend is declining slightly, as shown in the well 138 hydrograph. Wells closer to the Cosumnes River exhibit a stable groundwater elevation trend, as shown in wells 229 and 201 hydrographs.

The water budget for the Existing Conditions Baseline is summarized in T**able 5-1**. Inclusion of 3,600 acre-feet per year direct recharge from SMUD releases in the model has slightly improved the overall annual groundwater storage to stay on the positive side by an average of 1,200 and 1,900 acre-feet in the jurisdiction and planning areas respectively.

Table 5-1. Groundwater Budget for Baseline.

Average Annual Groundwater Budget for Jurisdiction Area (ac-ft/year)						
	Net Inflow				Outflow	
Model Run	Deep Percolation	Seepage From Rivers	Subsurface Boundary Flow	Direct Recharge	Pumping	Change in Storage
Existing Conditions Baseline	37,700	21,300	52,200	3,600	113,600	1,200
Average Annual Groundwater Budget for Planning Area (ac-ft/year)						
	Net Inflow				Outflow	
Model Run	Deep Percolation	Seepage From Rivers	Subsurface Boundary Flow	Direct Recharge	Pumping	Change in Storage
Existing Conditions Baseline	48,800	58,100	36,300	3,600	145,000	1,900

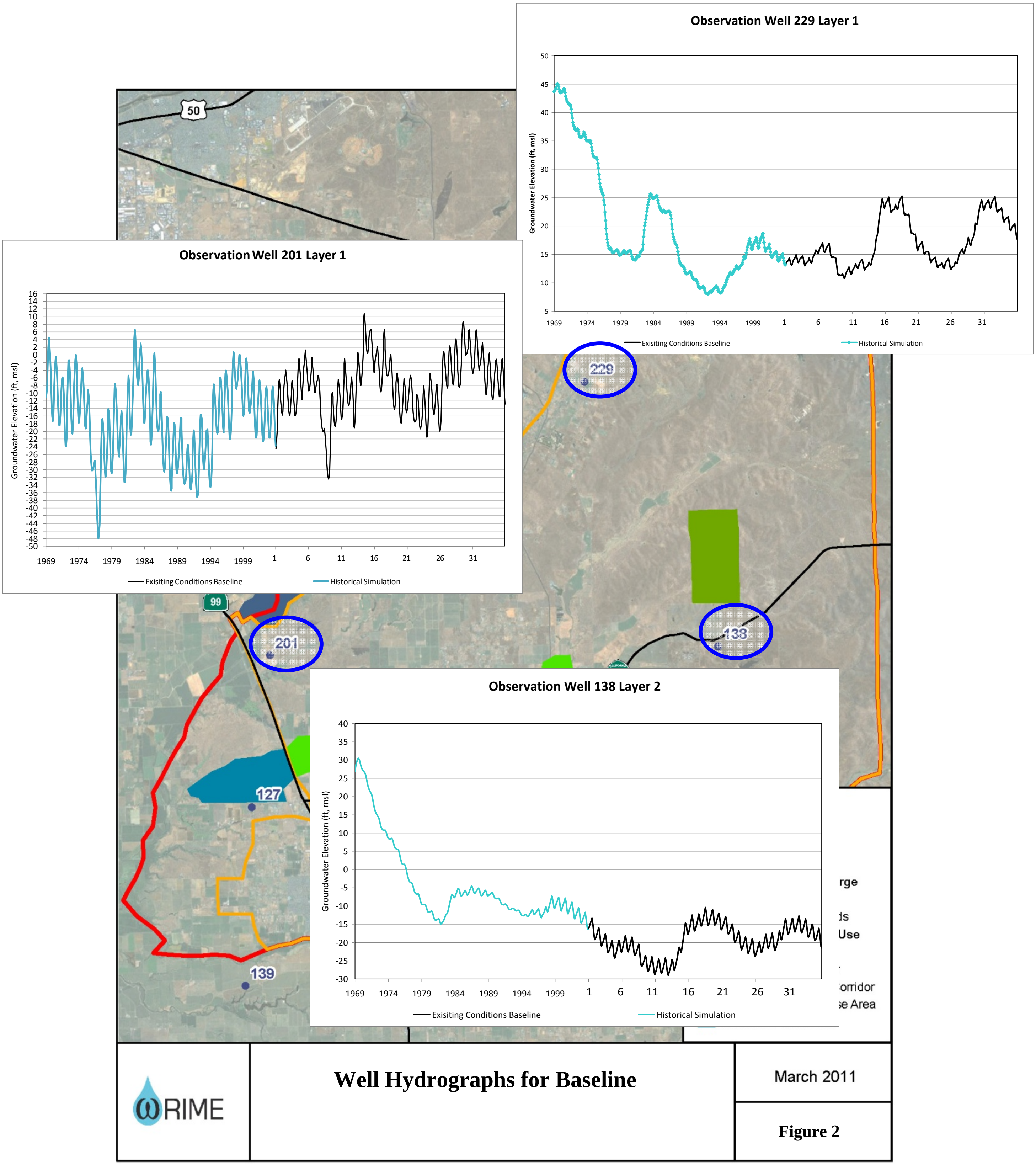

Observation Well 229 Layer 1
Groundwater Elevation (ft, msl)
Exisiting Conditions Baseline
Historical Simulation
Observation Well 201 Layer 1
Groundwater Elevation (ft, msl)
Exisiting Conditions Baseline
Historical Simulation
Observation Well 138 Layer 2
Groundwater Elevation (ft, msl)
Exisiting Conditions Baseline
Historical Simulation
50
99
229
201
138
127
139
RIME
Well Hydrographs for Baseline
March 2011
Figure 2

Figure 5-2. Well Hydrographs for Baseline.

5.2 Conjunctive Use: Surface Water Supplies in lieu of Pumping Groundwater

A key objective of simulating this scenario is to assess the impact of utilizing available surface water supplies in lieu of groundwater pumping.

5.2.1 Description of the Scenario

This scenario utilizes available surface water supplies from the American River in lieu of groundwater pumping in Laguna Creek Corridor, Cosumnes River and Dry Creek Corridor, New Agricultural development during above-normal years. The simulation used an average of 12,300 acre-feet per year of surface water at these locations. Additionally, the simulation also used 2,400 acre-feet per year of recycled water from the Galt Wastewater Treatment Plant for this Scenario.

This scenario employs the following assumptions:

- Potential sources of water supplies:
  - Water forum / SMUD water during above normal and wet years; no additional surface water in below normal years.
  - Galt Waste Water Treatment Plant discharge.
  - Riparian water rights: farmers with riparian rights will exercise these rights whenever water is available.
- Potential surface water users: New water delivered by GID, OHWD.
  - GID: In-lieu Irrigations demand – within about ¼ mi of Laguna Creeks.
  - OHWD: In-lieu Irrigations demand – within about ¼ mi of Cosumnes River.
- Conveyance: Folsom South Canal, Hadselville creek, Laguna Creek, Deer Creek, and Cosumnes River.

5.2.2 Results

Figures 5-3 and 5-4 present the change in groundwater elevation between the baseline and the conjunctive use scenario for fall of model simulation year 31 (2000 hydrology) in the two layers included in the model. Note that the change in groundwater elevation was calculated as difference between water elevation resulted from the conjunctive use scenario minus the baseline water elevation.

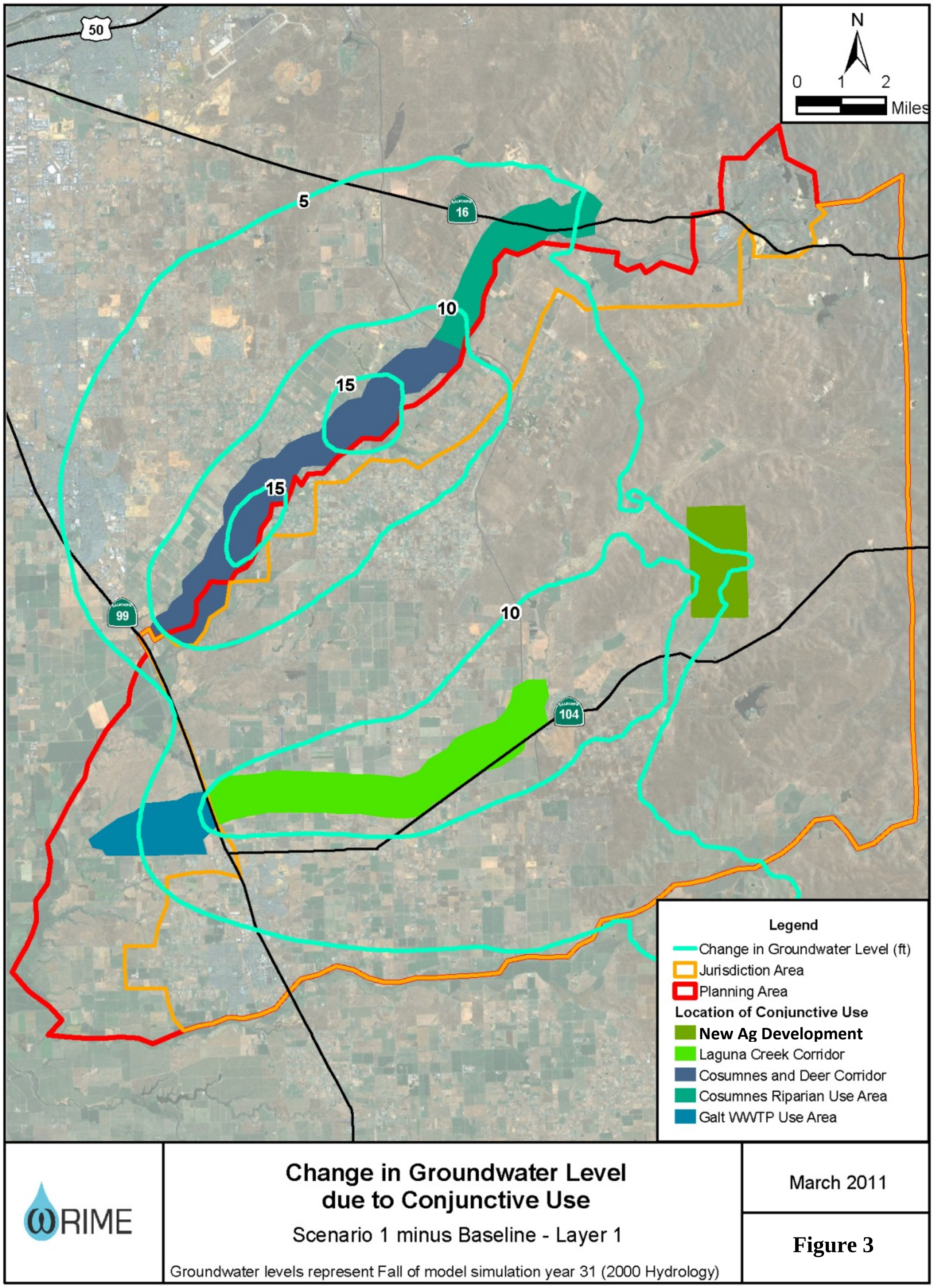


Figure 5-3. Change in groundwater level due to Conjunctive Use – Layer 1.

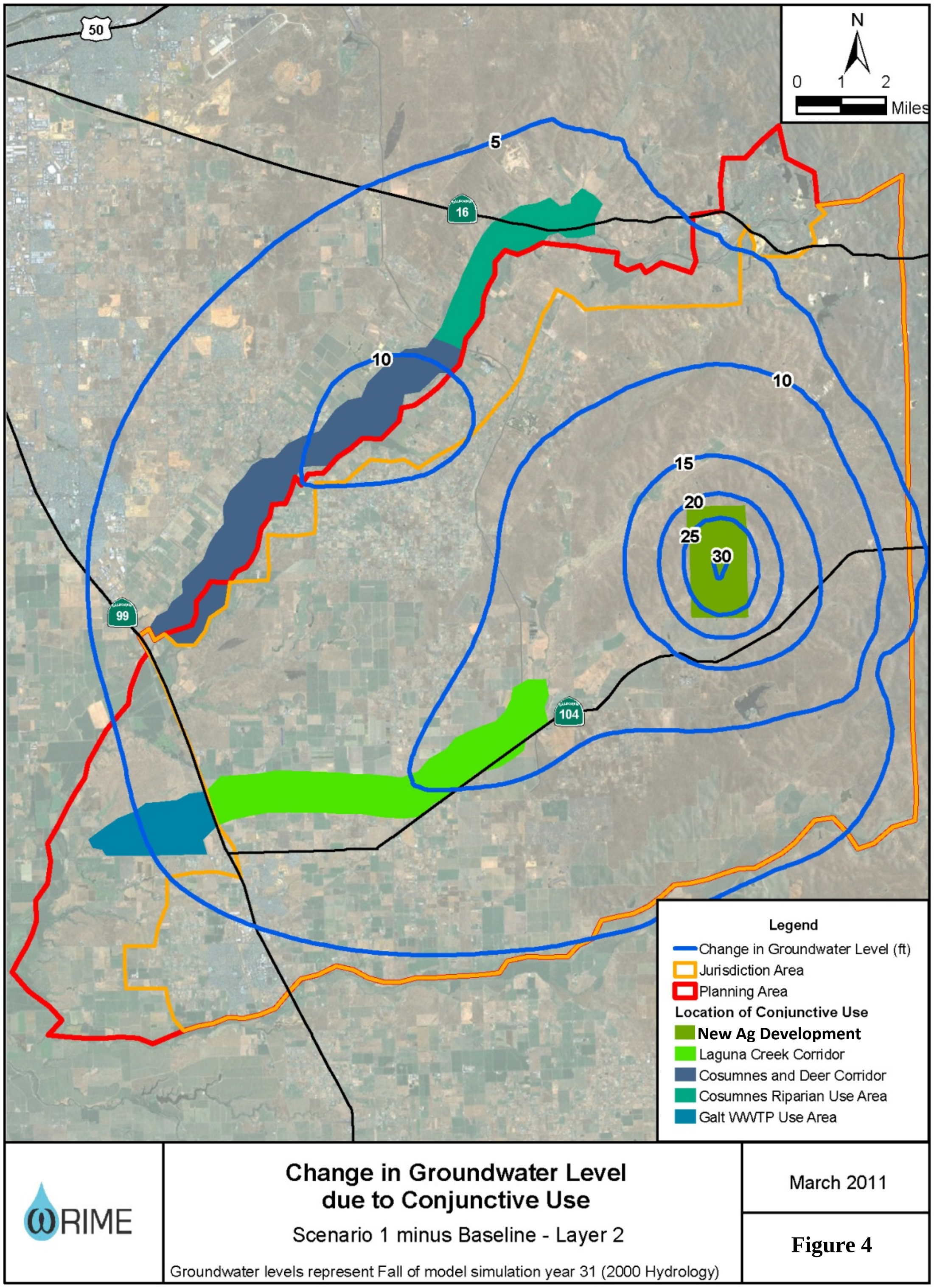


Figure 5-4. Change in groundwater level due to Conjunctive Use – Layer 2.

It can be seen that the groundwater elevation increased throughout the basin due to the conjunctive use in both model layers by 5 to 30 feet, depending on the proximity to the conjunctive use locations. Figure 5-2 showed higher water elevations in layer 2 of the model concentrated in the eastern side of the basin. This indicates that replacing pumping from the deeper wells with surface water in that area of the basin results in these higher water elevations.

These higher water elevation observations were confirmed by comparing well hydrographs resulted from the conjunctive use scenario and baseline in several wells in the area as seen in **Figure 5-5**.

The water budget for this scenario is summarized in **Table 5-2**. Groundwater pumping in this scenario is reduced in both jurisdiction and planning areas by an average of 6,600 and 8,500 acre-feet annually when compared to the baseline. Accordingly that resulted in increased aquifer storage by an average of 2,800 and 3,300 acre-feet per year in the jurisdiction and planning areas respectively. Note that the Cosumnes River in-lieu areas and the Galt WWTP recycled water use area are outside the Jurisdiction Area and a majority of the Cosumnes River in-lieu area are outside the Planning Area. The subsurface boundary flow decreased in this scenario compared to the baseline due to the higher water elevations.

Based on these results, the following can be concluded regarding the conjunctive use scenario:

- Water elevation increased throughout the basin due to the conjunctive use in both aquifer by 5 to 30 feet.
- Groundwater storage increases by an average of 2,800 and 3,300 acre-feet per year in the jurisdiction and planning areas respectively.
- Neighboring areas and jurisdictions would benefit as a result of this scenario's implementation by 3,900 and 5,200 acre-feet per year.

Table 5-2. Water Budget Summary for Scenario 1, Conjunctive Use

Average Annual Groundwater Budget for Jurisdiction Area (ac-ft/year)						
	Net Inflow				Outflow	
Model Run	Deep Percolation	Seepage From Rivers	Subsurface Boundary Flow	Direct Recharge	Pumping	Change in Storage
Existing Conditions Baseline	37,700	21,300	52,200	3,600	113,600	1,200
Scenario 1	37,800	21,300	48,300	3,600	107,000	4,000
Difference Scenario 1 - Baseline	100	0	-3,900	0	-6,600	2,800

*Note: The Cosumnes River direct recharge and in-lieu areas and the Galt WWTP recycled water use area are outside the Jurisdiction Area

Average Annual Groundwater Budget for Planning Area (ac-ft/year)						
	Net Inflow				Outflow	
Model Run	Deep Percolation	Seepage From Rivers	Subsurface Boundary Flow	Direct Recharge	Pumping	Change in Storage
Existing Conditions Baseline	48,800	58,100	36,300	3,600	145,000	1,900
Scenario 1	48,900	58,000	31,100	3,600	136,500	5,200
Difference Scenario 1 - Baseline	100	-100	-5,200	0	-8,500	3,300

*Note: The Cosumnes River direct recharge area and a majority of the Cosumnes River in-lieu area are outside the Planning Area

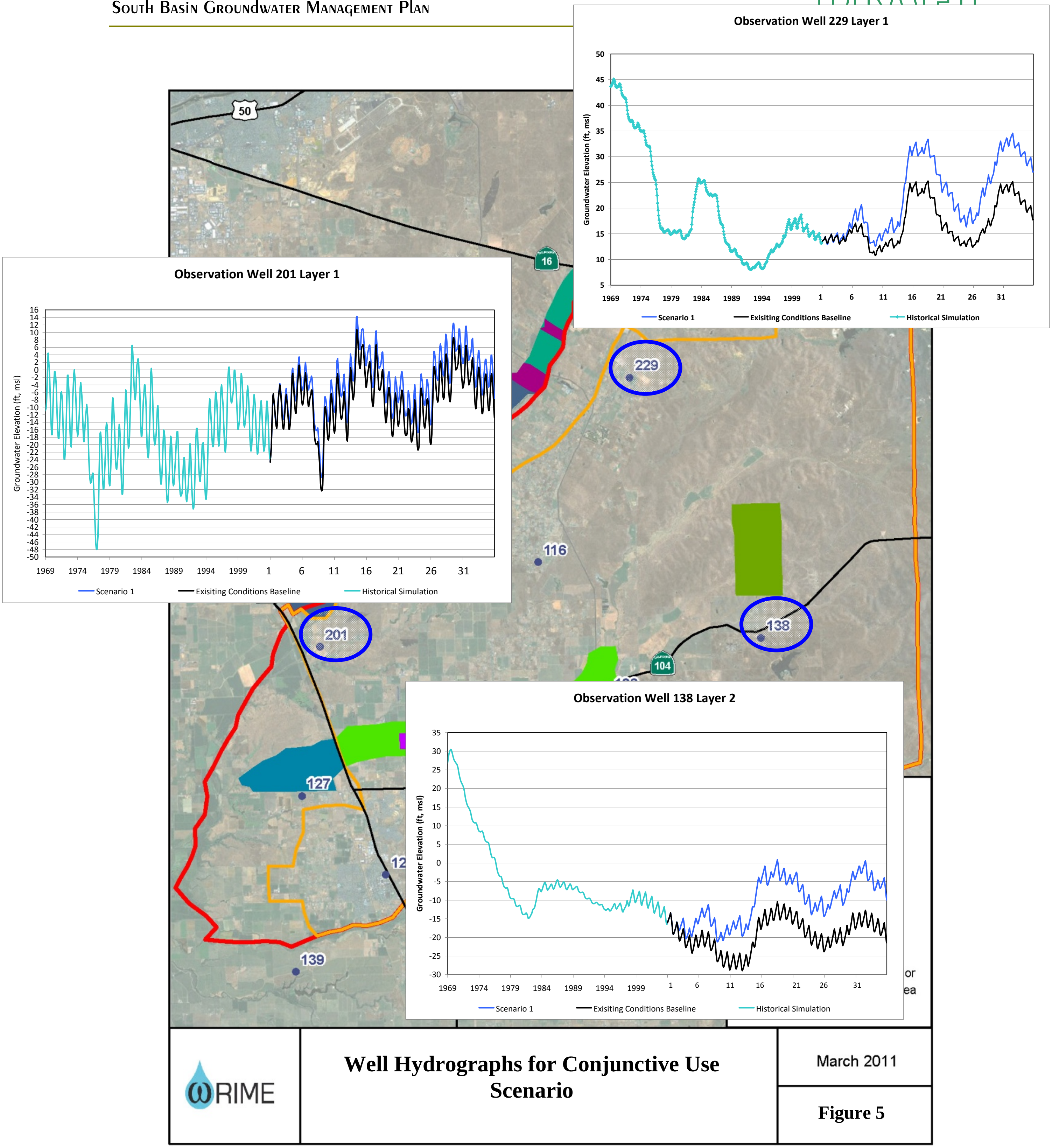


Figure 5-5. Well hydrographs for Conjunctive Use Scenario.

5.3 Direct Groundwater Recharge: Spread Surface Water Supplies onto Percolation Basins

A key objective of simulating this scenario is to assess the impact of spreading available surface water supplies onto percolation basins to directly recharge groundwater.

5.3.1 Description of the Scenario

The scenario presumes that surface water spreading onto percolation basins at Galt Irrigation District (GID) at 8,500 AF/year and Omochumne-Hartnell Water District (OHWD) at 10,500 AF/year. The presumed basins are close to the main surface water conveyance channels in the basin.

The scenario employs the following assumptions:

- Potential sources of water supply is Water Forum/SMUD water during above average and wet years; no water will be available during below normal years.
- Potential locations for percolation basins.
- Conveyance: Folsom South Canal, Hadselville creek, Laguna Creek, Laguna Creek, Deer Creek, and Cosumnes River.

5.3.2 Results

Figures 5-6 and 5-7 present the change in groundwater elevation between the baseline and the direct recharge scenario for fall of model simulation year 31 (2000 hydrology) in the two layers included in the model. Note that the change in groundwater elevation was calculated as difference between water elevation resulted from the direct recharge scenario minus the baseline water elevation.

The water elevation increased throughout the basin due to the direct recharge in both model layers by 10 to 30 feet depending on the proximity to the direct recharge locations. The figures also show that higher water elevations in layer 1 of the model, the shallow aquifer, uniformly concentrated around the recharge areas with higher elevations directly near the spreading basins (30 feet). In layer 2, the water elevations rose by about 15 feet near the recharge basins and about 5 to 10 feet elsewhere in the basin. This observation demonstrates that the water percolating from direct recharge spreading basins will have a greater impact in the shallow aquifer more than in the deeper aquifer.

These higher water elevation observations were verified by comparing well hydrographs resulted from the direct recharge scenario and baseline in several wells in the area as seen in **Figure 5-8**.

T**able 5-3** summarizes the water budget for this scenario. Groundwater pumping in this scenario was the same as Baseline in both jurisdiction and planning areas. The project surface water spread onto percolation basins in GID (8,500 acre-feet per year) and in OHWD (10,500 acre-feet per year) resulted in increased aquifer storage by an average of 3,300 and 4,000 acre-feet per year in the jurisdiction and planning areas respectively. Note that the OHWD direct recharge areas are outside the Jurisdiction Area and the Planning Area. The subsurface boundary flow decreased in this scenario compared to the baseline and scenario 1 due to the higher water elevations.

The following conclusions derive from the direct recharge scenario:

- Water elevation increased throughout the basin due to the direct recharge in both aquifers by 10 to 30 feet.
- Groundwater storage increases by an average of 3,300 and 4,000 acre-feet per year in the jurisdiction and planning areas respectively.
- Neighboring areas would benefit by 5,000 and 4,300 acre-feet per year under this scenario.

Table 5-3. Water Budget Summary for Scenario 2, Direct Recharge

Average Annual Groundwater Budget for Jurisdiction Area (ac-ft/year)

Model Run	Net Inflow				Outflow	Change in Storage
	Deep Percolation	Seepage From Rivers	Subsurface Boundary Flow	Direct Recharge	Pumping	
Existing Conditions Baseline	37,700	21,300	52,200	3,600	113,600	1,200
Scenario 2	37,800	21,300	47,100	11,900	113,600	4,500
Difference Scenario 2 - Baseline	100	0	-5,100	8,300	0	3,300

*Note: The Cosumnes River direct recharge and in-lieu areas and the Galt WWTP recycled water use area are outside the Jurisdiction Area

Average Annual Groundwater Budget for Planning Area (ac-ft/year)

Model Run	Net Inflow				Outflow	Change in Storage
	Deep Percolation	Seepage From Rivers	Subsurface Boundary Flow	Direct Recharge	Pumping	
Existing Conditions Baseline	48,800	58,100	36,300	3,600	145,000	1,900
Scenario 2	48,900	58,000	32,000	11,900	145,000	5,800
Difference Scenario 2 - Baseline	100	-100	-4,300	8,300	0	4,000

*Note: The Cosumnes River direct recharge area and a majority of the Cosumnes River in-lieu area are outside the Planning Area

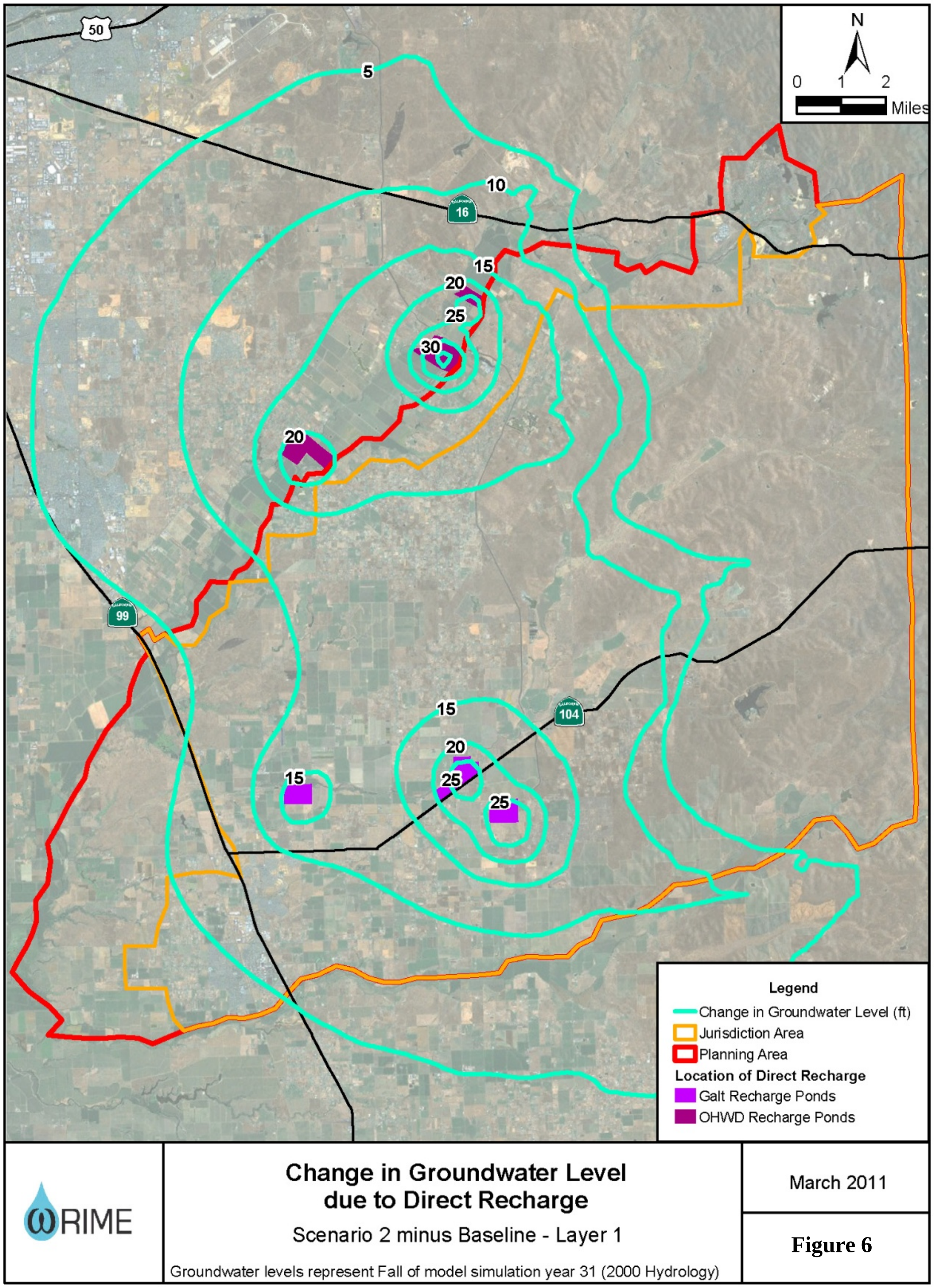


Figure 5-6. Change in groundwater level due to Direct Recharge – Layer 1.

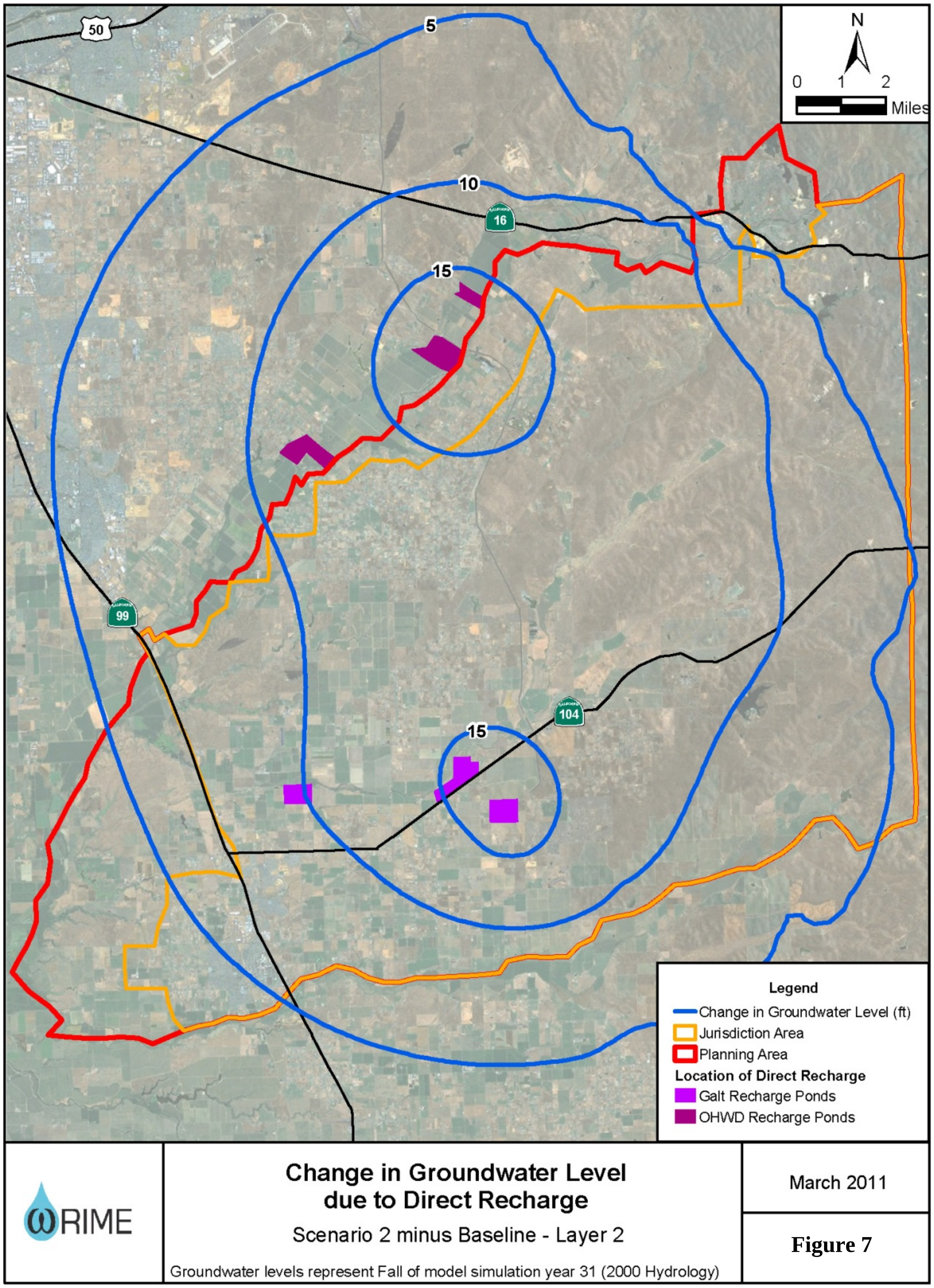


Figure 5-7. Change in groundwater level due to Direct Recharge – Layer 2.

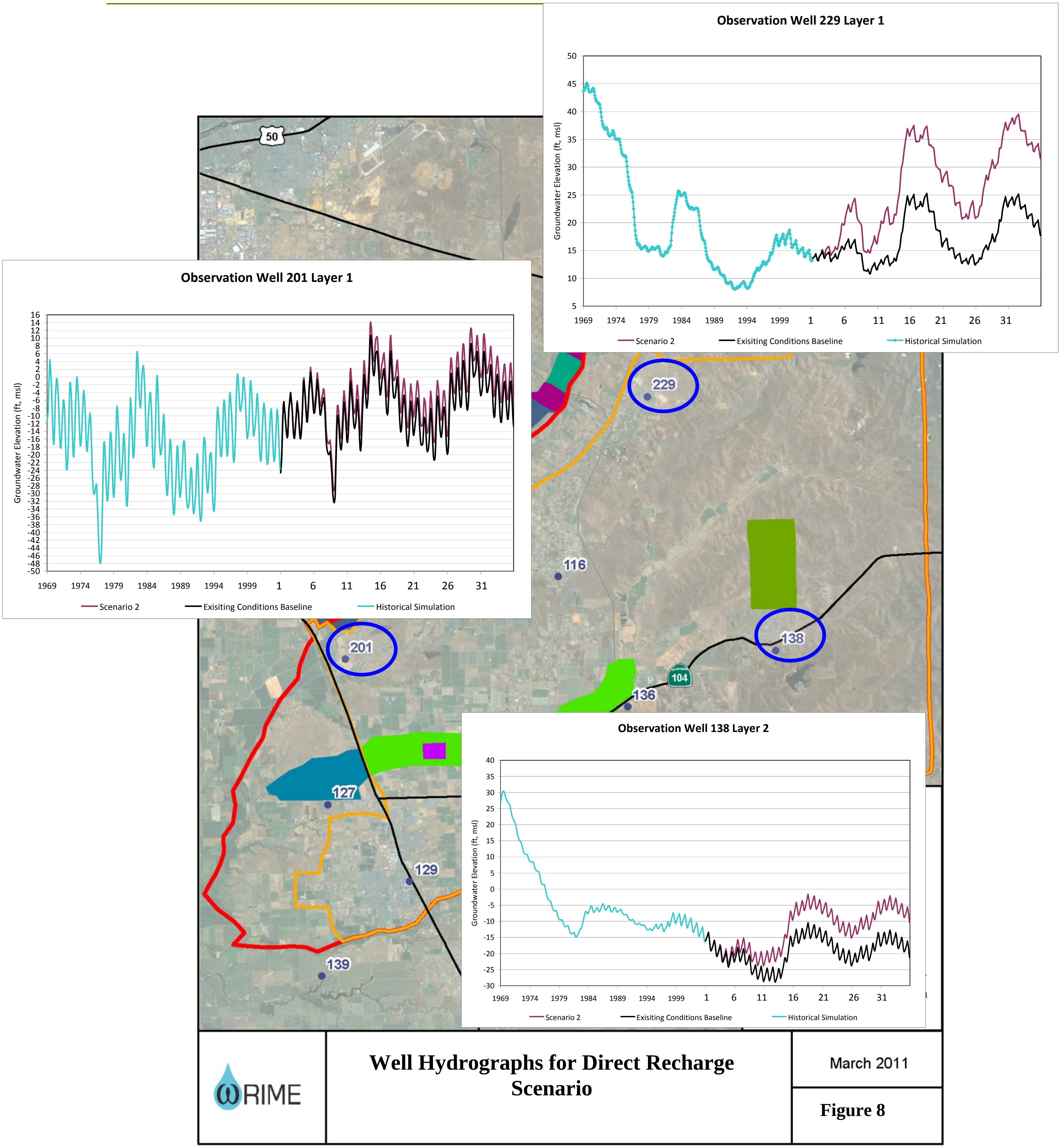


Figure 5-8. Well hydrographs for Direct Recharge Scenario.

5.4 Combination of In-lieu Recharge and Direct Recharge: Utilize Available Surface Water Supplies In lieu of Pumping Groundwater and to Directly Recharge Groundwater

The objective of simulating this scenario is to assess the impact of combining utilization of available surface water supplies in lieu of groundwater pumping and spreading available surface water supplies onto percolation basins to directly recharge groundwater.

5.4.1 Description of the Scenario

Scenario 3 utilizes the available surface water for a combination of in-lieu recharge and direct recharge projects. The available surface water is used for in-lieu recharge projects and the remaining surface water is recharge at the Galt recharge ponds first. The reason for such priority in water distribution is that Galt recharge ponds are the only ones within the Planning and Jurisdiction boundaries, and they are close to the cone of depression in the basin. A reduced recharge rate is used for direct recharge at Galt ID ponds.

- Potential sources of water supplies:
  - Water forum/SMUD water during above normal and wet years; no water will be available during below normal years.
  - Galt WWTP Discharge.
  - Riparian water rights.
- Potential surface water users: GID and OHWD
  - GID: In-lieu Irrigations demand – within about ¼ mi of Creeks
  - OHWD: In-lieu Irrigations demand – within about ¼ mi of River
- Conveyance: Folsom South Canal, Hadselville creek, Laguna Creek, Deer Creek, and Cosumnes River.

5.4.2 Results

Figures 5-9 and 5-10 present the change in groundwater elevation between the baseline and this scenario for fall of model simulation year 31 (2000 hydrology) in the two layers included in the model. Note that the change in groundwater elevation is calculated as difference between water elevation resulted from the direct recharge scenario minus the baseline water elevation.

The water elevation increased throughout the basin due to the combination of conjunctive use and direct recharge in both model layers by 15 to 30 feet, depending on the proximity to the direct recharge locations. The figures also show that higher water elevations in layer 1 of the model, shallow aquifer, uniformly concentrated around the in lieu recharge areas with even higher elevations directly near the percolation basins (30 feet). In layer 2, the water elevations increased by about 20 feet near the percolation basins, 30 feet near the conjunctive use locations to the east of GID and about 5 to 10 feet elsewhere in the basin.

These higher water elevation observations were verified by comparing well hydrographs resulted from the direct recharge scenario and baseline in several wells in the area as seen in **Figure 5-11**.

Table 5-4 summarizes the water budget for this scenario. Groundwater pumping in this scenario is reduced in both jurisdiction and planning areas by an average of 6,600 and 8,500 acre-feet annually when compared to the baseline. Portion of surface water was spread onto percolation basins at GID at 6,500 acre-feet per year and no water left to be spread onto the recharge ponds in OHWD. Accordingly that resulted in increased aquifer storage by an average of 4,200 and 4,900 acre-feet per year in the jurisdiction and planning areas respectively. Note that the OHWD direct recharge areas are outside the Jurisdiction Area and the Planning Area. The subsurface boundary flow decreased in this scenario compared to the baseline and both scenario 1 and 2 due to the higher water elevations.

Based on these results, the following can be concluded regarding the direct recharge scenario:

- Water elevation increased throughout the basin due to the direct recharge in both aquifers by 15 to 30 feet.
- Groundwater storage increases by an average of 4,200 and 4,900 acre-feet per year in the jurisdiction and planning areas respectively.
- This combination of conjunctive use and direct recharge has the significant impact on the aquifer regarding both groundwater storage and the spatial distribution of the rise in water elevations.
- Neighboring areas would respectively benefit by 9,100 and 10,100 acre-feet per year with this scenario.

Table 5-4. Water Budget Summary for Scenario 3, Combination of Conjunctive Use and Direct Recharge

Average Annual Groundwater Budget for Jurisdiction Area (ac-ft/year)

Model Run	Net Inflow				Outflow	Change in Storage
	Deep Percolation	Seepage From Rivers	Subsurface Boundary Flow	Direct Recharge	Pumping	
Existing Conditions Baseline	37,700	21,300	52,200	3,600	113,600	1,200
Scenario 3	37,900	21,300	43,100	10,100	107,000	5,400
Difference Scenario 3 - Baseline	200	0	-9,100	6,500	-6,600	4,200

*Note: The Cosumnes River direct recharge and in-lieu areas and the Galt WWTP recycled water use area are outside the Jurisdiction Area

Average Annual Groundwater Budget for Planning Area (ac-ft/year)

Model Run	Net Inflow				Outflow	Change in Storage
	Deep Percolation	Seepage From Rivers	Subsurface Boundary Flow	Direct Recharge	Pumping	
Existing Conditions Baseline	48,800	58,100	36,300	3,600	145,000	1,800
Scenario 3	49,000	57,900	26,200	10,100	136,500	6,700
Difference Scenario 3 - Baseline	200	-200	-10,100	6,500	-8,500	4,900

*Note: The Cosumnes River direct recharge area and a majority of the Cosumnes River in-lieu area are outside the Planning Area

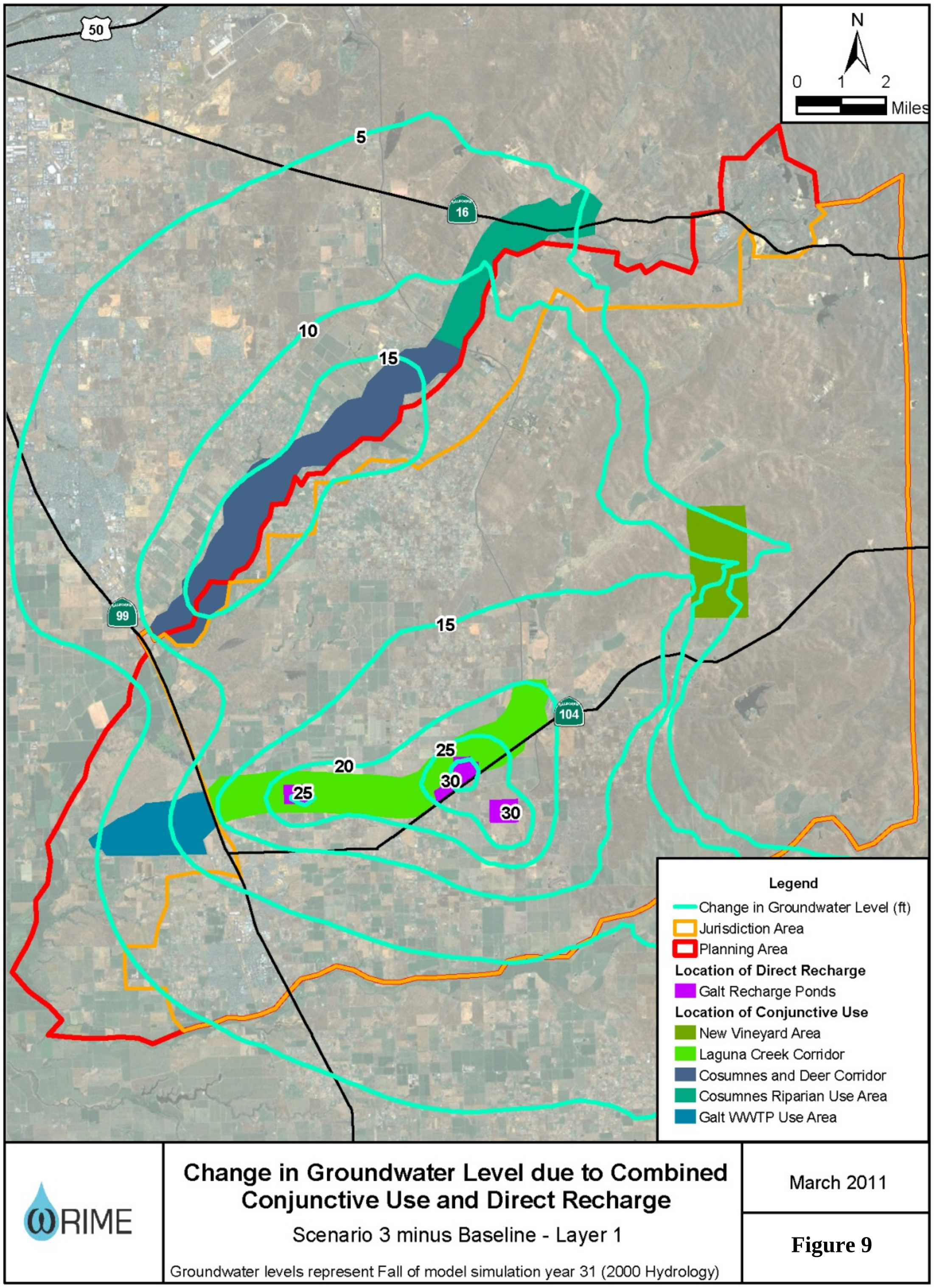


Figure 5-9. Change in groundwater level due to Combined Conjunctive Use and Direct Recharge – Layer 1.

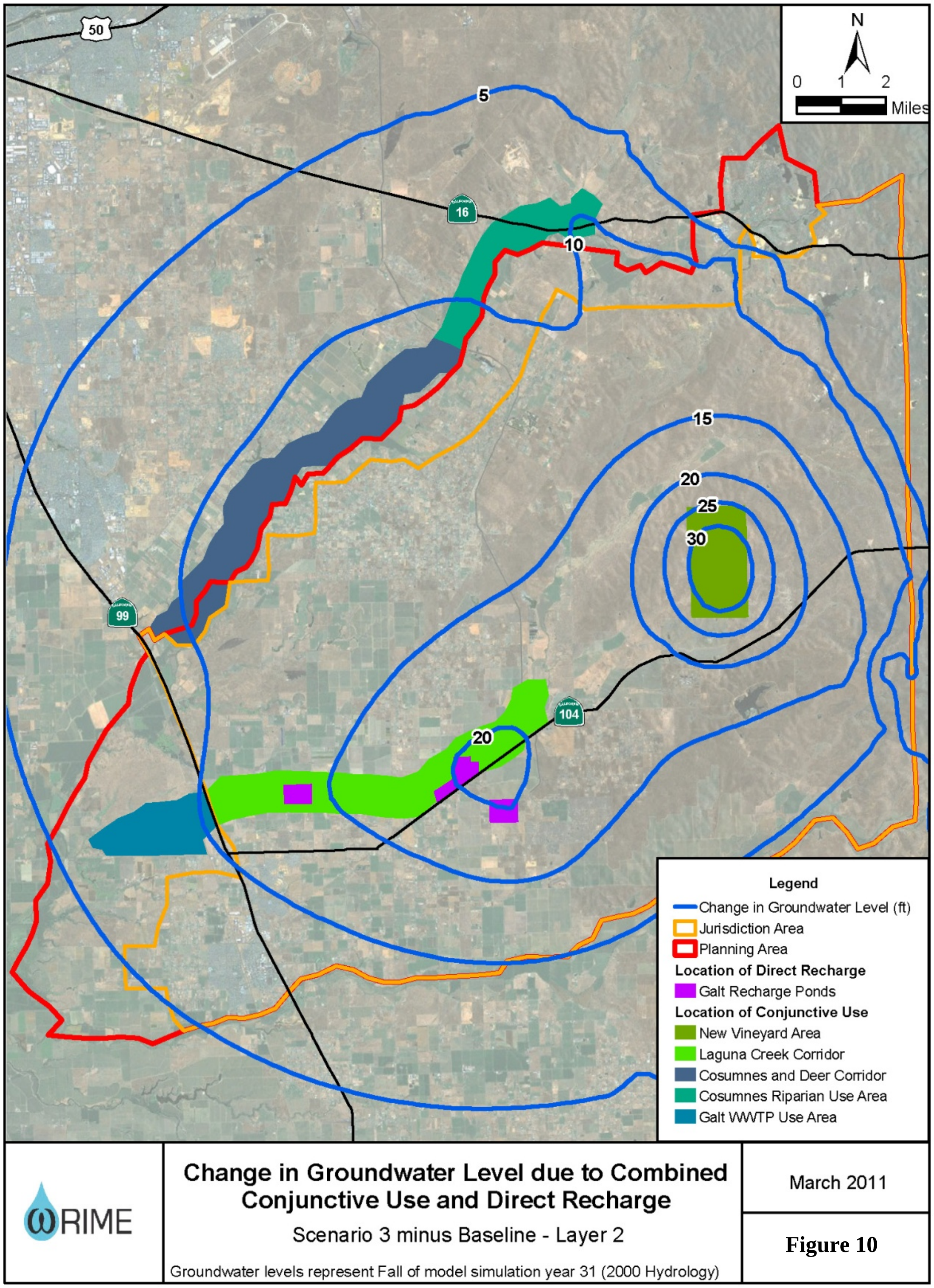


Figure 5-10.Change in groundwater level due to Combined Conjunctive Use and Direct Recharge – Layer 2.

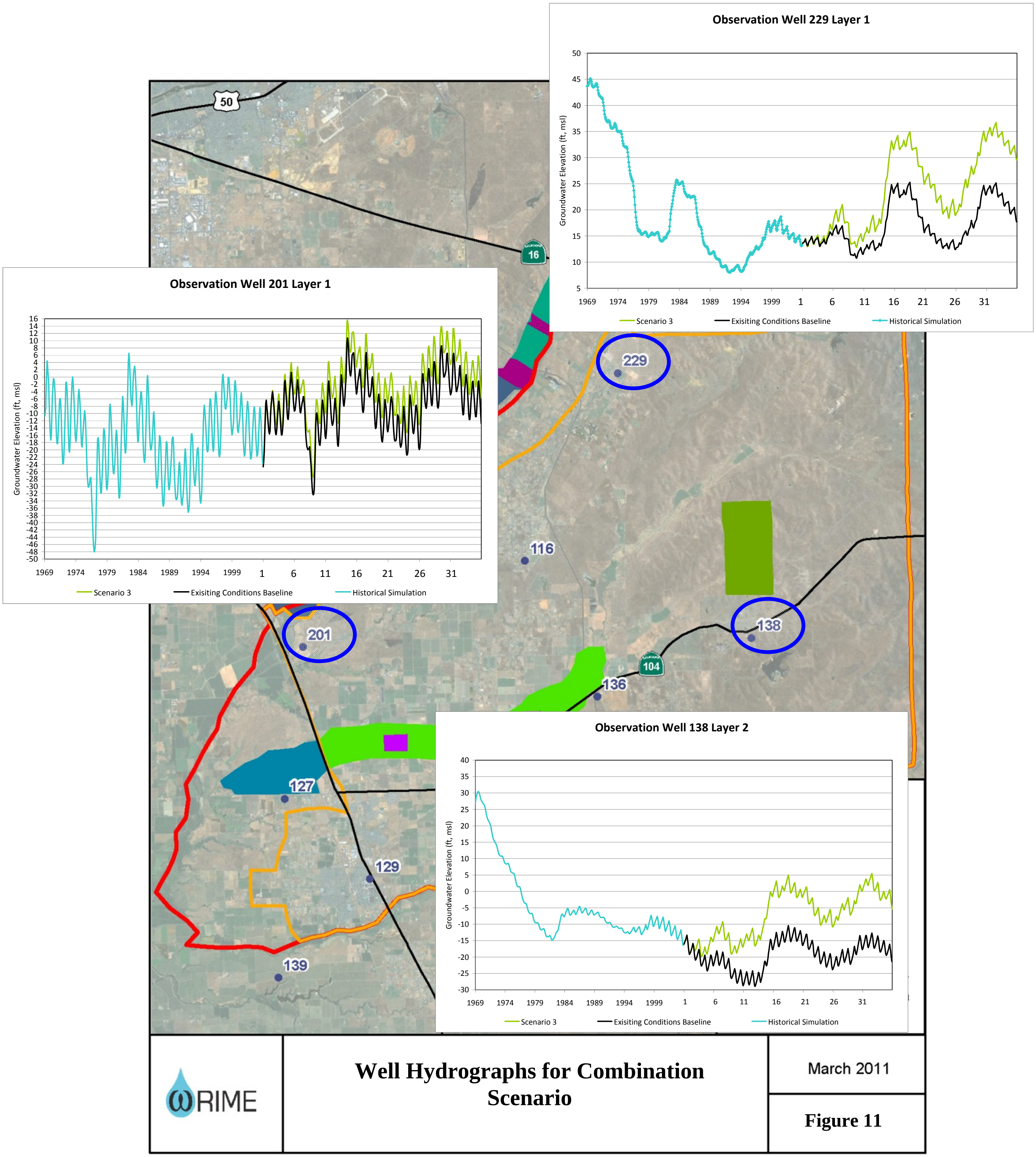


Figure 5-11. Well hydrographs for Combination Scenario.

5.5 CONCLUSION

- The results of the three scenarios showed higher groundwater elevations and increased average annual groundwater storage when compared to the baseline scenario.
- The combination of conjunctive use and direct recharge has the significant impact on the aquifer regarding both groundwater storage and the spatial distribution of the rise in water elevations when compared to the other management scenarios.
- The baseline conditions show somewhat stable, if not slightly increasing, water levels.
- Each of the alternatives would benefit neighboring areas almost equally as it benefits the targeted Planning and Jurisdictional areas by reducing the long-term subsurface boundary flow.

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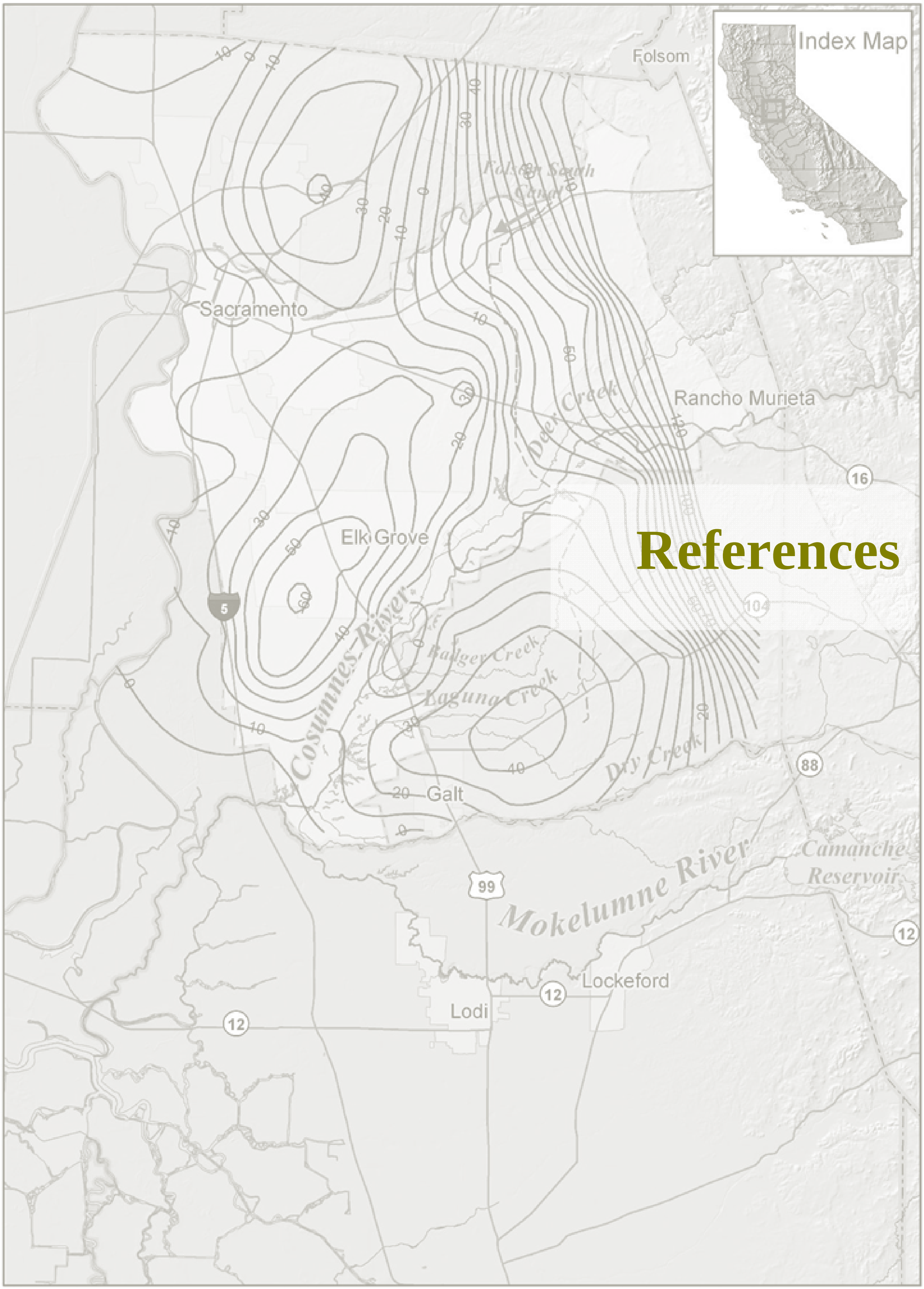
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Folsom
Folsom South Canal
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Elk Grove
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Badger Creek
Laguna Creek
Dry Creek
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Appendix A

DWR Methodology to Determine Applied Water and Return Flow in Sacramento County

Appendix B

SacIGSM Model Refinement Executive Summary