Report

Anderson-Cottonwood Irrigation District Groundwater Management Plan

Prepared for

Anderson-Cottonwood Irrigation District

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CH2MHILL
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Contents

Contents, Continued

Acronyms and Abbreviations

1995 WQCP	water quality control plan
AB 3030	Assembly Bill 3030
ACID	Anderson-Cottonwood Irrigation District
Bay-Delta	San Francisco Bay/Sacramento-San Joaquin Estuary
bgs	below ground surface
Delta	Sacramento-San Joaquin River Delta
District	Anderson-Cottonwood Irrigation District
DWR	California Department of Water Resources
GMP	groundwater management plan
M&I	municipal and industrial
Management Plan	Redding Basin Water Resources Management Plan
MO	management objectives
MOU	Memorandum of Understanding
msl	mean sea level
Plan	Shasta County AB 3030 Groundwater Management Plan
Program	Conjunctive Water Management Program
RAWC	Redding Area Water Council
RBGM	Redding Basin Groundwater Model
SB 1938	Senate Bill 1938
Shasta County AB 3030 Plan	Shasta County AB 3030 Groundwater Management Plan
SVWMP	Sacramento Valley Water Management Program
Water Code	California Water Code

SECTION 1

Introduction

1.1 Plan Authority

Adoption procedures for and substantive components of a groundwater management plan (GMP) are outlined in Section 10750 et seq. of the California Water Code (Water Code), also known as Assembly Bill 3030 (AB 3030). In 2002, Senate Bill 1938 (SB 1938) amended this section of the Water Code, making formalized and effective groundwater management a requirement for any agency seeking state funding. Anderson-Cottonwood Irrigation District (ACID or District) is a signatory to the Shasta County AB 3030 Groundwater Management Plan (Shasta County AB 3030 Plan). As a water purveyor with the intentions of developing a responsible groundwater supply, the ACID Board of Directors has authorized the development of a supplemental GMP specific to the District's potential and future groundwater management operations through the ACID Conjunctive Water Management Program (Program).

1.2 Plan Objectives

ACID recognizes the need for improved management of water supplies to leverage existing resources, respond to increased regulatory pressures while maintaining District viability, and protect both the quantity and quality of supply. The following District GMP objectives have evolved over the last few years through local and regional planning efforts and as ACID has developed plans for the Program:

- ***Regulatory Compliance –*** ACID, through the Shasta County AB 3030 Plan, has worked to meet the Water Code requirements to be AB 3030 and SB 1938 compliant. However, as development of its own groundwater program continued, ACID decided to develop a program-specific GMP that is linked with the Shasta County AB 3030 Plan, which seemed appropriate to meet the spirit of the Water Code. Furthermore, ACID continues to coordinate local groundwater monitoring with the California Department of Water Resources (DWR) and local partners as appropriate and as funding allows. Eligibility for funding that is necessary to develop and monitor groundwater resources requires that the GMP comply with SB 1938.
- ***Water Supply Reliability –*** The District must increase long-term water supply reliability and availability. Inherent in this objective is the need to improve critical-period water supply reliability, alleviate localized water shortages, and control the cost of water supply for its users. Analyses of water demands and supplies for 2030 indicate that localized water shortages are likely to occur, especially during the critical years. The District must ensure that an adequate water supply is available to meet its future water needs.
- ***District Long-term Viability –*** This objective is directly tied to the need for the District to have a reliable water supply. However, District viability may also require the ability

to make water available for in-basin and out-of-basin transfers that will improve state-wide water supply reliability, while ensuring ACID sustainability.

- ***Groundwater Resource Sustainability –*** This objective directly relates to groundwater management as defined in DWR Bulletin 118-2003, *California's Groundwater* (Appendix C): "planned and coordinated monitoring, operation, and administration of a groundwater basin or portion of a groundwater basin with the goal of long-term sustainability of the resource" (2003b). ACID hopes to leverage this planning effort to help meet the following Program goals:
  - Protect groundwater quality
  - Minimize long-term drawdown of groundwater levels
  - Develop groundwater supplies, which will add flexibility in water management decisions and improve the timing of flow and availability of water supplies
  - Expand knowledge of local aquifer characteristics through extensive and continued groundwater monitoring, evaluation of aquifer properties and water flow, and groundwater flow modeling analyses checked against measured hydrologic data
  - Increase groundwater pumping to increase recharge rates and induce greater natural recharge in the Program area
- ***Encouragement of Regional Cooperation while Maintaining Autonomy***—Groundwater use should be controlled at a local level, with regional cooperation.

1.3 Plan Components

DWR generally recommends the inclusion of 14 components to formulate an effective and comprehensive GMP. These components are described in the DWR's Bulletin 118-2003 (2003b), and in DWR's brochure, *Water Facts, No. 10: Components of a Groundwater Management Plan*. However, the Water Code and Chapter 3 of DWR's Bulletin 118-2003 specifically classify GMP components into two categories: required and recommended. DWR criteria for an SB 1938-compliant GMP are summarized in Table 1-1.

The ACID GMP is not intended to be a stand-alone document at this time. It tiers off the Shasta County AB 3030 Plan (Appendix A). The ACID GMP is a District- and Program-specific plan that can be updated and modified as the ACID Program develops. Table 1-1 summarizes the GMP components included in the ACID GMP.

1.4 Plan Adoption

Adoption of the ACID GMP complies with requirements of the California Water Code. The following process was followed:

- Publish a Notice of Public Hearing in local newspapers.
- Conduct a public hearing to discuss ACID's intention to develop a plan.
- Adopt a Resolution of Intent (Appendix B).

- Prepare a GMP with interested parties.
- Publish a second Notice of Public Hearing in same local newspapers that published the first notice.
- Conduct a second public hearing to discuss ACID's adoption of the GMP.
- Given no majority opposition, pass a Resolution to Adopt the GMP (Appendix C).

TABLE 1-1
Assembly Bill 3030 Groundwater Management Plan Components
Anderson-Cottonwood Irrigation District Groundwater Management Plan

Plan Component Description	Plan Section
California Water Code Section 10750 et seq. Required Components	
Requirement **–** Provide documentation that a written statement was provided to the public (Water Code Section 10753.4 [b]). ***ACID Action*** **–** Notices were posted in advance of public hearings and a resolution of intent was passed at the first public hearing on March 10, 2005, after public comments. The Resolution of Intent is provided in Appendix B.	Table 1-1 and Appendix B
Requirement **–** Establish management objectives (MO) for the groundwater basin that is subject to the plan (Water Code Section 10753.7 [a] [1]). ***ACID Action*** **–** Establish foundational MOs that can be built upon as the Program develops for the District and reference Shasta County's MOs.	Section 3.3 and the Shasta County AB 3030 Plan
Requirement **–** Monitoring Plan: Include components relating to monitoring and managing groundwater levels, groundwater quality, 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 (Water Code Section 10753.7 [a] [1]). ***ACID Action*** **–** Refer to existing monitoring activities in ACID and regional program monitoring plans (e.g., Sacramento Valley Water Management Plan [SVWMP] and Redding Basin), and defer to the Shasta County AB 3030 Plan.	Section 2.1.1.2 (Groundwater Infrastructure), Section 3.1.1, and Appendix A
Requirement **–** Include a plan by the managing entity to "involve other agencies that enable the local agency to work cooperatively with other public entities whose service area or boundary overlies the groundwater basin" (Water Code Section 10753.7 [a] [2]). ***ACID Action*** **–** ACID is an active member of the Redding Area Water Council (RAWC) with other basin water purveyors.	Sections 1.4, 1.5, and 3.2
Requirement **–** Adopt monitoring protocols. ***ACID Action*** **–** ACID has a monitoring network in place and coordinates monitoring activities with DWR, and also references the Shasta County AB 3030 Plan where appropriate.	Sections 2.1.1.2 (Groundwater Infrastructure) and 3.1.1, and Appendix A
Requirement **–** Provide a map of the groundwater basin as defined by Bulletin 118 (Water Code Section 10753.7 [a] [3]). ***ACID Action*** **–** A map is provided in the GMP.	Section 2.1
Requirement **–** Use appropriate geologic and hydrogeologic principles. ***ACID Action*** **–** The ACID GMP was reviewed by professional geologists who are familiar with local geology and hydrogeology. Furthermore, generally agreed-upon regional principles for groundwater management were included within the ACID GMP.	Section 3.1
California Water Code Section 10750 et seq. Voluntary Components	
Voluntary Component **–** Administer a well abandonment and well destruction program. ***ACID Action*** **–** Defer to the Shasta County AB 3030 Plan.	Refer to the Shasta County AB 3030 Plan

TABLE 1-1
Assembly Bill 3030 Groundwater Management Plan Components
Anderson-Cottonwood Irrigation District Groundwater Management Plan

Plan Component Description	Plan Section
Voluntary Component **–** Mitigate conditions of overdraft. ***ACID Action*** **–** The Redding Groundwater Basin has significant natural recharge, with estimates of groundwater storage far exceeding potential ACID Program capacities. The Redding Groundwater Basin is not in overdraft.	Refer to the Shasta County AB 3030 Plan
Voluntary Component **–** Monitor groundwater levels and storage. ***ACID Action*** **–** Refer to the existing monitoring program in ACID and other regional (DWR) and local (Shasta County) monitoring efforts.	Sections 2.1.1.2 (Groundwater Infrastructure) and 3.1.1, and Appendix A.
Voluntary Component **–** Facilitate conjunctive use operations. ***ACID Action*** **–** To be developed under the operating plans for regional programs (e.g., SVWMP) and ACID's Program.	Section 3.1.6
Voluntary Component **–** Identify well construction policies. ***ACID Action*** **–** A preliminary design for ACID's future groundwater production wells is available at the District, and defers to Shasta County standards when appropriate.	Refer to Shasta County AB 3030 Plan and Section 3.1.5
Voluntary Component **–** Develop relationships with state and federal regulatory agencies. ***ACID Action*** **–** ACID is an active participant in regional programs working in partnership with numerous state and federal regulatory agencies, including DWR and the U.S. Bureau of Reclamation (USBR).	Section 3.2
DWR Bulletin 118-2003 Recommended Components	
DWR Recommendation **–** Describe area to be managed under the GMP. ***ACID Action*** **–** The program area is described in text and presented graphically in the ACID GMP.	Section 2
DWR Recommendation **–** Describe ACID's monitoring program. ***ACID Action*** **–** The monitoring program is described in the ACID GMP.	Sections 2.1.1 and 3.1
DWR Recommendation **–** Describe integrated water management planning efforts. ***ACID Action*** **–** ACID participation in integrated management activities on a local basin level and a statewide level is described in the GMP.	Sections 1.5 and 3.2
DWR Recommendation **–** Report on implementation of the GMP. ***ACID Action*** **–** ACID's reporting method is presented in the GMP.	Section 3.4
DWR Recommendation **–** Periodically re-evaluate the GMP by the managing entity. ***ACID Action*** **–** ACID's intentions for periodic re-evaluations are presented in the GMP.	Section 3.4

1.5 Existing Groundwater Plans and Planning Efforts

1.5.1 Local and County Planning

The RAWC, made up of 12 municipalities and/or water districts, including ACID, adopted the Shasta County AB 3030 Plan for the Redding Groundwater Basin in November 1998. This plan was designed to preserve, protect, and manage the groundwater resources in Shasta County to the benefit of its residents. Further, a Redding Basin Water Resources Management Plan (Management Plan) has continually been developed and revised to meet current basin conditions. The Management Plan identified five core solution elements that are essential to the Redding Groundwater Basin's future water needs, of which additional groundwater pumping and conjunctive management of surface water and groundwater sources were two (CH2M HILL, 2001). Shasta County is currently updating its AB 3030 Plan to comply with SB 1938.

1.5.1.1 Local Water Resources Planning

ACID has been an active partner in Redding Groundwater Basin planning, participating in the phased development of the Management Plan since the mid-1990s. The phases are as follows, with short annotated bibliographies:

- **Phase 1 Report: Current and Future Water Needs (CH2M HILL et al., 1997)**. This document outlines the initial program for regional planning to meet the current and future needs for water users in and outside the Redding Groundwater Basin. Water purveyors (including ACID), industries, and private interests joined together to identify current and long-term water supply needs throughout Shasta County. The study provided the basic information upon which subsequent work was premised, namely a formal GMP. This information included current and projected land use and water supply needs, supplies, and shortages in the Redding Groundwater Basin through 2030. Although agricultural needs are expected to remain relatively stable, population growth will cause an increase in the water demand for urban, industrial, and recreational needs by more than 90,000 acre-feet per year by 2030. The study concluded that existing water supplies must be augmented, integrated, and made more dependable to maintain a vital and healthy economy in Shasta County.
- **Memorandum of Understanding and GMP Development (Phase 2A).** Phase 2A of the basinwide planning effort was initiated in October 1998. Initial elements of Phase 2A included forming committees to guide the study efforts, identifying water supply problems and opportunities for each purveyor, setting preliminary goals, listing environmental and institutional concerns, establishing an approach for developing an integrated groundwater/surface water model of the Redding Groundwater Basin, developing a Memorandum of Understanding (MOU) among the participants, developing a GMP, and developing a work plan for future activities. A public information component was also developed to inform and obtain input from affected agencies and the public.
- **Redding Basin Water Resources Management Plan Phase 2B Report (CH2M HILL, 2001).** This report concluded the second step in a long-term water supply planning effort for the RAWC, which helped initiate a long-term water resources planning effort for the Redding Groundwater Basin. This report presents the findings and recommendations for the development and adoption of a Shasta County AB 3030 Plan, development of a detailed regional groundwater model of the Redding Groundwater Basin, evaluation of existing water supply reliability, and a screening evaluation of short- and long-term actions to improve regional water supplies. The report builds on the information from the Shasta County Water Resources Master Plan Phase 1 Report: Current and Future Water Needs (CH2M HILL et al., 1997).
- **Redding Basin Water Resources Management Plan Phase 2C Report (CH2M HILL, 2003b).** This report concluded the third step in a long-term water supply

planning effort for the RAWC, which helped initiate a long-term water resources planning effort for the Redding Groundwater Basin, and will serve as the basis for coordinated use and development of water resources through 2030. This report presents the final development of recommended combined actions and modeling results. The report assessed the effects of the combined actions; cost-benefit analyses for each purveyor's recommended actions; development of a public information program; impact analyses; and development of a detailed implementation plan, including institutional framework and financial planning. This work was funded by two AB 303 grants through Shasta County Water Agency (SCWA) and helped to develop components of ACID's GMP.

1.5.1.2 County Ordinance

The Shasta County ordinance that deals with groundwater use is described as follows:

> **Shasta County Ordinance No. SCC 98-1, 1998** This county ordinance requires permits prior to the extraction of groundwater for direct or indirect use. Except in certain outlined circumstances, this ordinance includes all groundwater that could be substituted for surface water and exported from the county. Permit applicants must fund the necessary environmental reviews. The public is notified of the permit filing, and notices are sent to all interested parties and to the owners of overlying or adjacent lands. A commission, consisting of nine appointed representatives of Shasta County, decides whether to approve the permit if the environmental review determines that the Proposed Action/Proposed Project Alternative would not result in any significant adverse impacts (DWR, 2003a).

1.5.2 Regional Planning

ACID has long recognized institutional and legal impediments that limit water management flexibility. As such, the District has participated in regional planning efforts that reach beyond the Redding Groundwater Basin. Although water transfers provide some relief, additional flexibility in moving water among regional users could assist in meeting demands. Improved coordination of these supplies at the regional level is needed to improve overall water management and to aid in establishing operational improvements. ACID believes in working regionally, when appropriate and feasible, to improve management while maintaining autonomy.

The following subsections describe the regional efforts in which ACID participates.

1.5.2.1 Sacramento River Basinwide Water Management Plan and Regional Water Management Plan

The first step in regional planning was taken in the mid-1990s, when the Sacramento River Settlement Contractors initiated discussions with USBR for Central Valley Project contract renewals. This process resulted in the Sacramento River Settlement Contractors, in cooperation with USBR and DWR, preparing the Sacramento River Basinwide Water Management Plan. Finalized in 2004, the Basinwide Water Management Plan identified potential water management improvements, including subbasin-level management actions, system improvements, and water use efficiency projects. This planning process resulted in a high level of regional cooperation in working toward common goals among the Sacramento River Settlement Contractors, other Central Valley Project contractors, government agencies, and stakeholders. It was also the basis for the Regional Water Management Plan currently being prepared in cooperation with USBR.

1.5.2.2 Sacramento Valley Water Management Agreement and Water Management Program

In 1995, the State Water Resources Control Board adopted a water quality control plan (1995 WQCP) for the San Francisco Bay/Sacramento-San Joaquin Estuary (Bay-Delta). In July 1998, the State Water Resources Control Board began water rights hearings to consider how to implement the 1995 WQCP, which is an administrative action to allocate responsibility for achieving the 1995 WQCP objectives to water rights holders affecting the beneficial uses of the Bay-Delta. Phase 8 of the hearings was to address the responsibility of water right holders in the Sacramento Valley to meet the 1995 WQCP requirements.

Phase 8 was expected to entail 10 years of litigation and judicial review. This extended process would have resulted in adverse impacts to the environment and undermined the progress of other statewide water management initiatives. As an alternative, more than 40 water suppliers in the Sacramento Valley, including ACID, negotiated and executed the Sacramento Valley Water Management Agreement with USBR, DWR, the U.S. Fish and Wildlife Service, the California Department of Fish and Game, and the State Water Contractors. Signed in 2002, the Sacramento Valley Water Management Agreement assured that Sacramento-San Joaquin River Delta (Delta) water quality standards would be met. It also outlined a cooperative regional approach to improve local, regional, and statewide water supply reliability and quality, while providing supplies to help meet water quality standards in the Delta. This led to the SVWMP.

The SVWMP is the result of a collaborative grassroots effort to formulate a successful and viable alternative to traditional water management in a state with increasing constraints on its water resources. ***ACID's water management project is a critical component of the SVWMP, helping to meet its water supply, environmental, and water quality goals***. The SVWMP seeks to remedy the water resources challenges in the state while maintaining consistency with CALFED goals and objectives.

1.5.2.3 Sacramento Valley Framework for Integrated Regional Water Management Plan

In December 2000, the Northern California Water Association and Sacramento Valley Water Leaders prepared a paper titled *An Integrated Water Supply Management and Water Development Program for the Sacramento Valley*. This paper described a framework for a possible partnership between Sacramento-region interests and federal and state agencies. The paper noted that "the goal of the program is…to achieve 100 percent of existing and future municipal and industrial and agricultural demand within Northern California" while ensuring sustainable groundwater supplies.

SECTION 2

Water Resource Setting

2.1 Background

The ACID GMP area is shown on Figure 2-1, including the groundwater basin and the overlying District boundaries.

2.1.1 Anderson-Cottonwood Irrigation District

2.1.1.1 History and Size

ACID was formed under Division 11 of the Water Code and is the oldest such district in the Sacramento Valley. On November 24, 1914, McCoy Fitzgerald posted a "Notice of Appropriation of Water" on the west bank of the Sacramento River in Redding. In December of that same year, title to this appropriation was deeded to ACID. The State Division of Water Rights issued a certificate in June 1918 prescribing the time to complete application of water to the proposed place of use. ACID subsequently made beneficial use of the water and established a pre-1914 water right. In June 1967, ACID entered into a negotiated agreement with USBR quantifying the amount of water ACID could divert from the Sacramento River. The resulting negotiated agreement recognized ACID's annual entitlement as a "Base Supply" of 165,000 acre-feet per year of flows from the Sacramento River and its tributaries, and also provided for a 10,000-acre-foot allocation of "Project Water," resulting in a total contract entitlement of 175,000 acre-feet per year. This agreement was renegotiated and, as of 2006, the new ACID entitlements are a Base Supply of 121,000 acre-feet per year and a Project Water allocation of 4,000 acre-feet per year.

ACID is a surface water purveyor with two diversion points on the Sacramento River. The main supply for ACID is diverted from the Sacramento River at Caldwell Park in Redding, California, via gravity feed enabled by a diversion dam across the river. There is also a supplemental supply from a small pumping plant on the river at the south edge of Redding. Groundwater usage by ACID customers has historically been very low. Sole public-entity groundwater users in the Redding Groundwater Basin include the City of Anderson and the Town of Cottonwood, while others might occasionally use groundwater as a supplemental or emergency supply.

ACID's service area (Figure 2-1) encompasses approximately 32,000 acres and directly serves approximately 7,000 acres. The District extends south from the City of Redding, in Shasta County, to northern Tehama County, encompassing the City of Anderson and the Town of Cottonwood. Although ACID overlaps the service area boundaries of these water purveyors, the District does not currently provide water for municipal and industrial uses in these communities. Approximately 90 percent of ACID's customers irrigate pasture for haying or livestock; however, some orchard and other food crops are also grown. In total, ACID's service area accounts for about two-thirds of irrigated pasture in the Redding Groundwater Basin and serves approximately 900 customers. Parcel sizes in the area range from small parcels to large ranches.

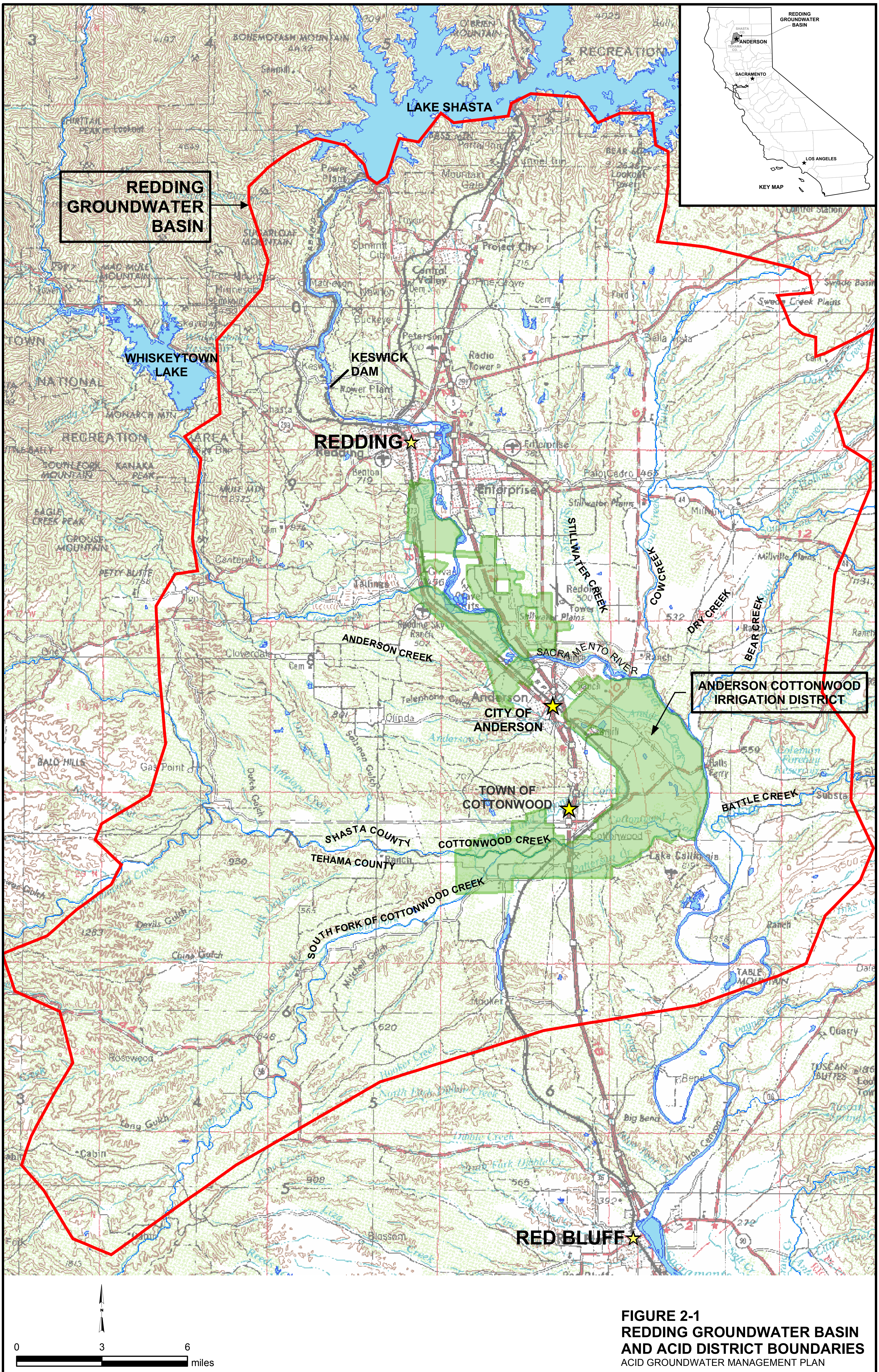

FIGURE 2-1
REDDING GROUNDWATER BASIN AND ACID DISTRICT BOUNDARIES
ACID GROUNDWATER MANAGEMENT PLAN

CH2MHILL

RDD \\ODIN\PROJ\ACID\324340_PHASE1B_TO-3\GWMP\FIGURES\FIGURE2-1.MXD 4/6/2006 16:36:50

2.1.1.2 Facilities

Groundwater Infrastructure. The District does not currently own any groundwater production wells. However, ACID does own 13 groundwater monitoring wells (Figure 2-2) and 2 Sacramento River stage gages. ACID is seeking funding to expand the monitoring network. For further discussion on the monitoring efforts and monitoring network, see Section 3.

Table 2-1 summarizes information contained in DWR records for wells in the Redding Groundwater Basin. These data, coupled with estimates of groundwater use (CH2M HILL, 2003b) suggest that the approximate 50,000 acre-feet of groundwater production from the Redding Groundwater Basin occur from a combination of about 170 irrigation and municipal wells and approximately 6,000 domestic wells. Most municipal and irrigation wells are screened deeper within the aquifer (180 to 310 feet below ground surface [bgs]) and deeper than most domestic wells in the basin.

TABLE 2-1
Typical Well Construction in the Redding Groundwater Basin
Anderson-Cottonwood Irrigation District Groundwater Management Plan

Subbasin	Number of Domestic Wells	Average Depth (ft bgs)[a]	Number of Municipal and Irrigation Wells	Average Depth (ft bgs)[a]
Anderson	2,239	140	48	302
Bowman	804	257	27	312
Enterprise	1,970	139	65	180
Millville	487	156	8	265
Rosewood	447	181	15	311
South Battle Creek	18	189	5	227
Totals	5,965		168	

[a]Based on well completion reports (DWR, 2003b)

Diversion Facilities. ACID's primary water source is surface water from the Sacramento River and its tributaries. Water pools behind the District's seasonal dam, which create Lake Redding and flow by gravity through an intake screen, a tunnel, and ultimately into the Main Canal. In 1999, ACID completed improvements to the fish ladder and screen facilities as part of a CALFED-funded effort to enhance the Sacramento River anadromous fishery. ACID also has one pump station diversion on the Sacramento River, which is used to supply water to its Churn Creek Lateral. Table 2-2 summarizes ACID's surface water supply facilities.

Conveyance System. ACID's distribution system includes approximately 30 miles of unlined canals and main laterals. Approximately 5 miles of the Main Canal are concrete lined. The Main Canal flows through several inverted siphons for conveying the canal flows under cross-drainage channels, such as Clear Creek. The District has an ongoing program for replacement of open-channel farm laterals with pipeline laterals. Several wasteways exist along the canal route at creek crossings and natural drains. These wasteways return water to the river or local streams when flow exceeds the capacity of the canal, which typically occurs in the winter months during storm runoff. Table 2-3 summarizes ACID's Main Canal and irrigation lateral features. See Figure 2-2 for a map of ACID's major conveyance facilities.

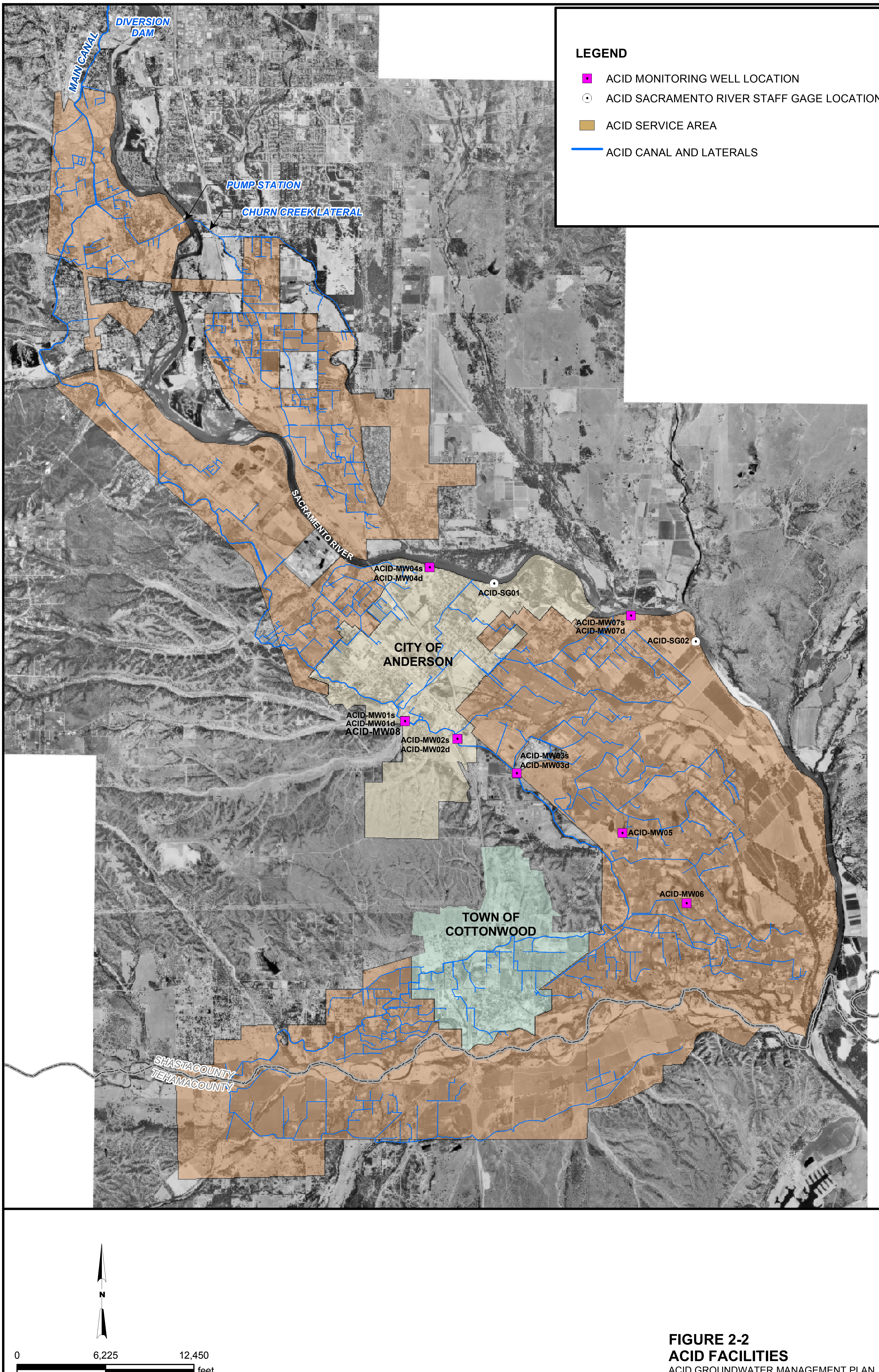

FIGURE 2-2
ACID FACILITIES
ACID GROUNDWATER MANAGEMENT PLAN

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RDD \\ODIN\PROJ\ACID\324340_PHASE1B_TO-3\GWMP\FIGURES\FIGURE2-2.MXD 4/6/2006 11:19:55

TABLE 2-2
Anderson-Cottonwood Irrigation District Surface Water Supply Facilities
Anderson-Cottonwood Irrigation District Groundwater Management Plan

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (acre-feet per year)
ACID Diversion Dam	Sacramento River	Gravity	450	114,700[a]
Churn Creek Lateral Pump Station	Sacramento River	Pump	75	19,400[a]

[a]Estimated proportion of total diversions based on pump station capacity

Note:
cfs = cubic feet per second

TABLE 2-3
Anderson-Cottonwood Irrigation District Canals and Laterals
Anderson-Cottonwood Irrigation District Groundwater Management Plan

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location
ACID Main Canal	ACID Diversion Dam	450	Partial (5 miles)	Cottonwood Creek
Churn Creek Lateral Canal	Churn Creek Pump Station	75	No	None

2.1.1.3 Spill Recovery

ACID uses a network of unlined drainage ditches to convey irrigation return flows. The drains generally empty into the Sacramento River or one of the local tributary creeks. Most of the soils in the District's service area are well drained; therefore, the field-applied water generally percolates directly to the underlying groundwater basin, which minimizes the need for extensive drainage facilities. Drainage flows out of the District by gravity. The District operates five drain pump stations for recapture of drain flows. Table 2-4 summarizes these drain recapture facilities.

TABLE 2-4
Anderson-Cottonwood Irrigation District Drain Pump Stations
Anderson-Cottonwood Irrigation District Groundwater Management Plan

Pump Station Name	Source	Discharges To	Capacity (cfs)	Average Historical Pumping Total (acre-feet per year)
Simpson	Anderson Creek	Lateral	10	1,400
Jesson	Anderson Creek	Lateral	5	700
Supan	Anderson Creek	Lateral	10	1,400
Perry's Pond	Perry's Pond	Lateral	5	700
Dymesich's Pond	Dymesich's Pond	Lateral	5	700

2.1.1.4 District Operations

The District tends to provide water to their users based on a 14-day schedule, starting in April and ending in October. The irrigation water demand in April, September, and October is significantly lower than during the summer months. The District is required to maintain a constant water elevation in the canal for users that may require a constant flow through their turnouts, even during times of lower overall irrigation demand. With no existing control structures other than for the radial gate near the upstream end, the only way to hold these elevations is to continue delivering very high rates of flow, far in excess of actual demands. As a result, during these low-flow periods, significant amounts of water are ultimately spilled to adjacent waterways or temporarily lost to seepage.

Following are the main water management constraints to District operations:

- Control is limited to managing the head gate near the river, with surpluses spilling at waterways.
- The District has little room for additional head losses in the Main Canal. Some bridge decks, siphons, and culverts also limit allowances for head losses. Some cross-drainage structures are limited in storm drainage capacity, such as at Crowley Gulch and Olney Creek.
- The canal system contains flow measurement capability at only one Main Canal location. The District does not use instruments to accurately quantify flows at any other location in the Main Canal or any of its laterals. Water measurements are currently estimated using gate head-flow tables, or where applicable, by estimating power consumption (drain pumps).

Canal seepage is significant in sections near natural drainages, where soils are fast draining. The canal contributes directly to the underlying groundwater basin in these areas.

2.1.1.5 ACID Operating Rules and Regulations

The following excerpt is from the *Rules and Regulations of the Anderson-Cottonwood Irrigation District* (ACID, 2004):

> The Anderson-Cottonwood Irrigation District is [the] government agency acting under and by virtue of Division 11 of the California Water Code. It is governed by a Board of Directors that is elected by the voters of the District. The District operates for the sole benefit of the lands and the people situated within the District boundaries. The benefits people within the District derive from the District will be measured by the extent to which the people within the District and the District's employees and Board of Directors cooperate to make the District a success.
>
> The rules and regulations are adopted pursuant to California Water Code Section 22257 to effect an orderly and equitable distribution of water within the District, and a procedure for operation, maintenance, repair and replacement of District facilities.

The following applies to water rotation, apportionment, and shortage allocation (ACID, 2004):

> Water will be furnished in rotation to each irrigator. Ditchtenders will endeavor to give advance notice, personally or through others, to irrigators of

> the approximate time their rotation will start. Any irrigator not taking water when his turn arrives may forfeit his right during that rotation. In the event of shortages, the District will endeavor to equitably apportion the available water supply.

The following applies to the use of drainage waters (ACID, 2004):

> All water introduced into the District by the District facilities remains District water and is subject to re-diversion and reuse by the District for the benefit of its customers. All such water, whether drainage or seepage water, intercepted and put to beneficial use will be charged for at the rates established by the District.

2.1.1.6 Water Measurement

ACID's main river diversions (Lake Redding, at Caldwell Park, and Churn Creek) have meters installed and operated by USBR that provide both flow rate and total volume of flow. At major lateral headgates, the District measures flow rates manually using weir or gate head-flow tables. Flows at field turnouts are measured using canal headgate-position tables. Drain-pump flows are not metered, but the total volume pumped is estimated using power consumption and pump efficiency history. ACID does not currently meter individual customer turnouts. Estimates of flow rate are made based on canal headgate position relationships.

2.1.2 Conjunctive Water Management Program Development

ACID has adopted a phased project approach to conjunctive water management. The phases, as identified to date, are as follows:

- Phase 1 – Groundwater Monitoring: Collect appropriate hydrologic data to better understand the interaction between groundwater and surface water elevation changes due to variations in local groundwater pumping and weather.
  - Phase 1a – CALFED Funded: ACID developed a groundwater monitoring plan, installed 12 monitoring wells and 2 stage gages in the Sacramento River, and implemented the plan in June 2003, with assistance of DWR, Northern District, staff.
  - Phase 1b – DWR Funded (AB 303 funding from the general fund, current contract): ACID installed a thirteenth monitoring well, developed a GMP specific to ACID, tiered off the Shasta County AB 3030 Plan, and completed a design development report for Phase 2.
  - Phase 1c – Not funded (applied for grant funding under AB 303 in fall 2004): In an attempt to expand the monitoring network and get the first extensometer readings in the Redding Groundwater Basin for DWR, ACID identified Phase 1c for installation of an extensometer, should funding be made available.
- Phase 2 – Implement Production Element (Seeking funding from DWR under Proposition 50 Integrated Regional Water Management Program, Implementation): Phase 2 will be implemented in phases as funding is available. Up to 12 groundwater

production wells with up to 20,000 acre-feet per year of combined capacity have initially been identified as part of Phase 2.

2.2 Physical Setting

This section can be cross-referenced with Section 2 of the Shasta County AB 3030 Plan, which also provides geologic cross sections and maps of the groundwater basin.

2.2.1 Geology

The Redding Groundwater Basin is predominantly filled with permeable alluvial deposits of the Tertiary Tuscan and Tehama Formations, which overlie the Chico Formation. Simultaneous deposition of material from the Coast Range and the Cascade Range resulted in two interbedded formations, which together comprise the principal freshwater-bearing aquifer in the basin. The Tuscan formation's pyroclastic and sedimentary rocks, located in the eastern portion of the Redding Groundwater Basin, consist of reworked volcanic sandstones, mudflows, and breccias. The Tehama formation's sediments consist of sand, gravel, and clay, which were deposited by the ancestral Sacramento River and its tributary streams on the western side of the basin. The Tuscan-Tehama Formation is 2,000 feet thick or more near the Town of Cottonwood and the confluence of the Sacramento River and Cottonwood Creek. Both the Tuscan and Tehama Formations are moderately to highly permeable (Pierce, 1983).

Above the Tuscan-Tehama Formation lies the discontinuous Quaternary Red Bluff Formation, which consists of coarse gravel, commonly with large boulders, in a red sandy-clay matrix. The Red Bluff Formation is of low to moderate permeability and, at a local scale, can contain perched water (Pierce, 1983).

Overlying the Red Bluff and/or the Tuscan-Tehama Formation are Quaternary terrace and alluvial deposits located in the Sacramento River floodplain and its tributaries. These materials are moderately to highly permeable (Pierce, 1983).

2.2.2 Hydrogeology

Based on the hydrogeologic setting, the groundwater system in the Redding Groundwater Basin can be thought of as a single unconfined to a semiconfined aquifer system with groundwater levels in the heart of the basin typically within 100 feet bgs.

Groundwater elevations typically range from greater than 460 feet above mean sea level (msl) around the fringes of the Redding Groundwater Basin, to less than 390 feet msl near the confluence of Cottonwood Creek and the Sacramento River. Historically, groundwater levels have generally remained stable, with no long-term trends in groundwater levels. However, groundwater levels are affected by changes in precipitation, temporarily declining during droughts and rising when normal or above-normal precipitation occurs. For example, some short-term declines were noticeable during the droughts of 1976 through 1977 and in 1987 through 1992. These declines were followed by recovery to pre-drought levels after one or more successive normal or above-normal precipitation events occurred.

Throughout the ACID service area, groundwater movement is generally to the east/southeast, toward the Sacramento River. The majority of the groundwater discharge to surface water in the basin occurs to the Sacramento River in the lower portions of the basin. Groundwater level changes range from 3.5 to 9 feet in the shallow, unconfined groundwater system (20 to 115 feet bgs) and from approximately 7.5 to 10 feet in the deeper, semiconfined groundwater system (100 to 200 feet bgs). During the Phase 1 monitoring period, groundwater elevations ranged from 380 to 404 feet msl. This corresponds to water level depths of 4 to 80 feet bgs, with the shallowest groundwater levels occurring near the Sacramento River (CH2M HILL, 2004a).

2.2.2.1 Water Quality

The general quality of groundwater in the Redding Groundwater Basin is considered good to excellent (total dissolved solids between 95 and 424 milligrams per liter) for most uses, except for water from shallow depths along the margin of the basin where pre-Tertiary formations may be tapped. Some wells in those areas yield water with constituents that are above limits for drinking (primarily metals, total dissolved solids, chloride, and sulfate). This water is likely derived from the Chico Formation (Pierce, 1983). There are no known historical groundwater quality problems in ACID. City of Anderson municipal well groundwater quality data show that the groundwater in the ACID area meets or exceeds state and federal drinking water standards (City of Anderson Water Quality Consumer Confidence Reports, 1995 through 2001). Each future ACID production well will be installed to a depth of at least 500 feet bgs. Water Quality will be monitored.

2.2.2.2 Land Subsidence

Land subsidence is not currently measured in the Redding Groundwater Basin. It has not been a parameter of concern because of minimal groundwater pumping in the basin, estimates of adequate natural recharge, and local lithology. However, ACID has been working with DWR to get funding for the installation of an extensometer in the basin. Funding has not been made available to date.

2.2.2.3 Groundwater Storage

Groundwater storage is the volume of water that would drain by gravity from a given saturated thickness of the aquifer deposits underlying a designated geographic area. Groundwater storage in the Redding Groundwater Basin is about 5.5 million acre-feet (Pierce, 1983). However, not all of this groundwater storage is available for groundwater use on an annual basis. Overuse of the groundwater resource could result in adverse impacts to groundwater quality, yields of nearby production wells, local streamflow, and/or the environment. Careful management and use of the groundwater resource is a key element of ACID’s GMP.

2.2.2.4 Typical Well Yields

Typical well yields from irrigation, industrial, and municipal wells located near and in ACID are 500 to more than 4,000 gallons per minute (Pierce, 1983). City of Anderson wells typically produce from 500 to 900 gallons per minute. These wells were constructed to achieve specific yields based on specific budgets. It is anticipated that larger-diameter production wells installed to depths of at least 500 feet bgs will provide higher groundwater yields.

2.2.3 Hydrology

The water budget of the Redding Groundwater Basin is dominated by a large annual influx of water falling as precipitation on the surrounding mountains and on the valley floor. A large portion of recharge to the Redding Groundwater Basin is from precipitation and snowmelt from higher elevations. Average annual precipitation in the Redding Groundwater Basin ranges from 22 to as much as 40 inches in the higher elevations (California Spatial Information Library/Department Statewide isohyet map; http://www.gis.ca.gov). As is typical throughout the Central Valley, 80 to 90 percent of the area's precipitation occurs from November to April. In the surrounding mountain ranges, precipitation ranges from 40 to 75 inches, much of it in the form of snow. A portion of this water is consumed by evapotranspiration by native vegetation, and the remainder occurs as runoff and groundwater recharge.

It has been estimated that the Redding Groundwater Basin yields an average of 850,000 acre-feet of annual runoff (CH2M HILL, 2003a). Much of this water is potentially available to recharge the Redding Groundwater Basin and replenish groundwater levels that have been temporarily depressed because of groundwater pumping. Applied water totals approximately 270,000 acre-feet in the Redding Groundwater Basin (CH2M HILL et al., 1997).

The Sacramento River is the main drain for the Redding Groundwater Basin (DWR, 2003a). The other principal surface water features in the Redding Groundwater Basin are tributaries of the Sacramento River: Battle, Cow, Little Cow, Clear, Dry, and Cottonwood Creeks. Surface water and groundwater interact along most of these surface water features.

2.2.4 Topography and Soils

The District's topography generally consists of gently sloping terrain in the 350 to 450 feet msl elevation range; as such, the impact of the area's terrain on ACID's water management practices is negligible.

Complete descriptions of the soil associations and the corresponding acreage of each association in the District are provided in the Natural Resources Conservation Service's soil surveys for Shasta and Tehama Counties (Appendix D). The following soil associations are found in the District:

- Newtown-Red Bluff: Nearly level to steep, well-drained and moderately well-drained clays and clay loams formed in old alluvium on high terraces.
- Churn Perkins-Tehama: Nearly level to moderately steep, well-drained and moderately well-drained clay loams and silty clay loams formed in recent alluvium on low terraces.
- Tuscan-Igo: Nearly level to gently sloping, well-drained cobbly clay loams and gravelly loams that contain a hardpan and were formed in old basic alluvium on high terraces.
- Reiff Cobbly Alluvial Land Association: Nearly level to gently sloping, moderately well-drained to excessively drained loamy fine sands to loams and frequently flooded cobbly land on valley bottoms and floodplains.

- Maywood-Tehama: Very deep to moderately deep silt loam, nearly level to very gently sloping soils on floodplains and terraces along tributaries of the Sacramento River.
- Corning-Redding: Nearly level to sloping, gravelly, medium-textured soils that are moderately deep to shallow to claypan or hardpan on terraces west of the Sacramento River and along its tributaries.
- Newville-Dibble: Shallow to deep, gravelly loam and silt loam, moderately steep or steep, medium- to fine-textured soils, underlain by soft sedimentary rock.

2.2.5 Climate

The climate of the area is described in Section 2 of the Shasta County AB 3030 Plan.

2.2.6 Economy

The general economy of the area is described in Section 2 of the Shasta County AB 3030 Plan.

2.3 Water Use

Land use in ACID's service area is primarily pasture, in addition to alfalfa and some deciduous orchard crops. Pasture use is typically in the range of 75 percent of the total crop mix served by the District (CH2M HILL, 2004b). Water requirements are typically highest during the summer months (June, July, and August) because of the area's hot, dry climate. Annual cropping patterns have not varied a great deal since the mid-1970s. Associated on-field crop water requirement needs and diversions, therefore, have been more a function of water-year type and climate than changes in cropping.

The exact quantity of groundwater that is pumped from the basin is not known; however, it has been estimated that approximately 50,000 acre-feet of water are pumped annually from municipal, industrial, and agricultural production wells (CH2M HILL, 2003a). This magnitude of pumping represents approximately 6 percent of the average annual runoff into the basin.

It is anticipated that future irrigated cropping patterns and associated water requirements will remain relatively stable. However, the District anticipates an overall decrease in irrigated acreage as a result of continued urban encroachment.

2.3.1 Urban

ACID's service area overlays several municipal water purveyors, but the District currently does not serve any major municipal and industrial users. Many of these users are projecting increased demands in 2020. DWR estimates that growth in the municipal and industrial sector in the vicinity of ACID will result in an increased annual water requirement of approximately 30,000 acre feet by 2020, which would represent an increase of about 75 percent (CH2M HILL, 2004b). It is assumed that most of the increased demand will be met by surface water taken from the Sacramento River. The District is currently exploring programs that would increase supply and supply reliability to local and other purveyors. Examples of programs being considered include direct supply to water treatment facilities, direct supply for municipal irrigation, provision of water for cooling buildings and industrial developments, and water marketing.

2.3.2 Environmental

No managed, designated environmental or wetland areas exist in the District. Approximately 3,000 acres of riparian vegetation are estimated to be incidentally supplied by irrigation associated with delivery laterals or adjacent lands (CH2M HILL et al., 1997). The application of water to pasture lands (historically ranging from 10,000 to 12,000 acres) and associated vegetation provides habitat to common and special-status terrestrial and avian species that use such habitat. Additionally, pasture provides habitat for a number of species of small mammals, ground-dwelling birds, reptiles, and amphibians, all of which provide a prey base for predatory birds. Dryland pasture in the region often supports a vernal pool ecosystem that is occupied by a number of special-status plant and animal species.

2.3.3 Groundwater

Currently, groundwater use across the District is minimal; the small portion used is limited primarily to deciduous crops. Groundwater use is expected to increase with development of the ACID Program. Groundwater will contribute to overall District supply through direct linkage of groundwater infrastructure to the District's surface water conveyance system.

SECTION 3

Implementation

ACID will continue development of its groundwater management activities as its Program develops. Presented in this section are basic principles that the District intends to follow as its Program evolves. These principles are shared with the SVWMP and will continue to be refined over time as they specifically relate to ACID's Program.

The goals of the overall Program are as follows:

- Meet the water supply and reliability needs of agricultural water users in the ACID service area while practicing optimization principles of responsible groundwater management (e.g., protecting groundwater quality and minimizing long-term drawdown of groundwater levels; see Section 3.3).
- Maintain records of groundwater-level and river-stage monitoring.
- Meet objectives set forth by the Basinwide Management Plan and the SVWMP while adhering to the Shasta County AB 3030 Plan and ACID's GMP.
- Develop a responsible and flexible groundwater supply.

To reach these goals, ACID has been working to determine seasonal baseline groundwater conditions in the area and forecast the potential impacts of providing a supplemental water supply though conjunctive management. ACID is striving to develop the means to evaluate and monitor groundwater basin conditions for proper management of the resource, resulting in protection of the Redding Groundwater Basin, third-party users, and surface water flows. A phased project approach has been adopted for Program development. The District has developed initial monitoring infrastructure and continues to pursue funding to expand this monitoring network, update modeling, and develop groundwater production infrastructure.

ACID's Program is in its infancy and groundwater production in the basin is considerably underused, creating both opportunities and challenges in developing a GMP. This section addresses principles of GMP implementation to help achieve the following intents of this document: (1) meet the minimum requirements of SB 1938 compliance, (2) create a foundation on which the District's groundwater management activities can be based, and (3) allow for adaptive management as the Program develops.

3.1 Technical Principles of Groundwater Management and Program Development

3.1.1 Groundwater Monitoring

A reporting framework is essential as a guide to develop project-specific monitoring and reporting programs. ACID, with DWR's assistance, has been monitoring the area identified as the location for the potential groundwater production element of the Program since 2003. Input from DWR and local county staff in the continued development of the system is welcomed. Potential adverse impacts to the Redding Groundwater Basin will be evaluated through continued and increased individual monitoring and reporting. As the programmatic groundwater monitoring and reporting framework develops, it is anticipated that the following components will be included:

- Groundwater levels in selected production and monitoring wells in a participating district should be measured and documented prior to initial pumping. Groundwater levels should be evaluated and documented monthly from the termination of the pumping period until water levels have recovered to the pre-pumping level or have otherwise stabilized.
- Flow-meter readings should be recorded at least every month for each production well through the pumping period. The total quantity of water pumped between successive readings should be calculated and documented.
- Electrical conductivity should be measured at selected production wells at the initiation of pumping, 2 months after initial electrical conductivity measurements, and at the termination of pumping.
- For selected monitoring wells, to be identified by ACID, drawdown analyses (distance and time) should be performed. These analyses would be conducted at a regional level, with individual proponents providing information to support the regional analysis.
- Monitoring at selected locations and analysis of the potential for impact to local streams should be made to the extent possible.
- If agreed upon through assistance of DWR staff and/or through regional programs like the SVWMP, monitoring data should be summarized and reported annually. The annual report may include groundwater-level contour maps for the basin showing water levels before, during, and after the period of extraction. Under the SVWMP, ACID would contribute data as appropriate to develop regional-level reporting and support regional analysis.

3.1.1.1 Existing Monitoring Activities

ACID has been working to improve the understanding of the groundwater and surface-water interactions in the Redding Groundwater Basin and response to changes in seasons, pumping, and irrigation practices. This, in turn, is leading to better predictive abilities for impacts from potential Program activities and a better understanding of the Redding Groundwater Basin as a whole.

The first step in developing the Program was collecting appropriate hydrologic data to better understand the interaction between groundwater and surface-water elevation changes due to variations in local groundwater pumping and weather. Semiannual to quarterly groundwater-level monitoring data collected in the area by DWR were found to be insufficient for this task because the responses of the groundwater and surface water systems to local pumping and weather conditions occur throughout the year. Monitoring with the objective of understanding the real-time responses of the groundwater and surface water systems resulting from seasonal pumping requires more frequent monitoring events.

Phase 1 of the Program was completed through a CALFED grant whereby 12 new monitoring wells (5 pairs of shallow/deep wells and 2 additional shallow wells) and 2 Sacramento River stage gages were installed (summer 2003) and monitored at hourly intervals beginning in June 2003. A thirteenth well, installed to a depth of 530 feet bgs, was added to the network in February 2005. The monitoring locations are depicted on Figure 2-2. In addition, pump on/off information for selected City of Anderson municipal supply wells and selected industrial water supply and domestic wells were also monitored during a portion of this phase.

Tasks that supported these Phase 1 efforts included the following:

- Completion and ACID's adoption of Shasta County's AB 3030 Plan
- Development of an integrated groundwater/surface water flow model of the Redding Groundwater Basin in 2001
- Completion of the ACID Monitoring Field Plan in 2003
- Installation of 12 new monitoring wells and 2 Sacramento River stage gages in the ACID area in summer 2003
- Installation of one additional monitoring well in February 2005
- Hourly monitoring of groundwater and surface water levels at the monitoring locations
- Development of a Design Development Report, which outlines the basis of a preliminary design for the future groundwater production element of the Program
- Development of an ACID-specific GMP

ACID is working with DWR to continue data collection in the existing groundwater monitoring network. Further, the District is working with local, state, and federal resource agencies to identify additional funding to expand the existing monitoring network to meet the needs of its developing Program. As ACID develops groundwater production capability, specific groundwater monitoring plans (and, if appropriate, additional groundwater monitoring infrastructure) will be developed to meet the needs of the basin and the District, consistent with local (e.g., county) and regional (e.g., SVWMP) monitoring requirements.

3.1.2 Groundwater Modeling

3.1.2.1 Existing Groundwater Model

A numerical groundwater flow model developed for the Redding Area Water Council (CH2M HILL, 2001 and 2003b) was used to examine potential impacts of an ACID groundwater program to the Basin. The Redding Basin Groundwater Model (RBGM) includes details on the distribution of groundwater recharge from a variety of sources, so a more detailed description of the Program's impacts can be developed.

The boundary of the RBGM generally coincides with the boundary of the Redding Groundwater Basin as depicted by Pierce (1983). The RBGM boundary was extended slightly beyond the boundary depicted by Pierce (1983) in the following areas:

- North of the Redding Groundwater Basin boundary and south of Shasta Reservoir
- West of the Redding Groundwater Basin boundary and east of Clear Creek below Whiskeytown Reservoir

The RBGM boundaries were extended in these areas to fully encompass local water purveyor service areas for future simulations involving potential water transfers and impacts. The total aquifer thickness in the RBGM was estimated by subtracting the depth to bedrock (i.e., Chico Formation) (DWR, 1968) from average groundwater levels. The total aquifer thickness was subdivided into four model layers based on typical screened intervals of wells in the Redding Groundwater Basin. A no-flow boundary was used along the margins of the model domain to simulate the lateral extent of freshwater-bearing sediments in the basin. A head-dependent boundary condition was used to simulate 31 individual streams throughout the model domain. The distribution of aquifer properties that resulted from the calibration process, such as transmissivity, were originally derived from specific capacity data obtained from municipal, industrial, and where available, domestic water supply wells. An additional head-dependent boundary was applied to the surface of the RBGM to simulate the loss of shallow groundwater to evapotranspiration.

Output from the RBGM provides estimates of impacts on surrounding groundwater levels and changes in streamflow due to project pumping.

3.1.2.2 Program Analysis

Two variations of a possible ACID Program have been analyzed with the groundwater model to date. One version of the Program included 12 proposed project production wells with a Program capacity of up to 20,000 acre-feet per year. Simulations were performed to evaluate potential impacts, resulting from the following:

- Monthly groundwater extraction, projected during the June through October (153-day) pumping period.
- Monthly reduction of streamflows resulting from implementation of two system improvement projects in the Redding Groundwater Basin. The two projects include reduction of ACID canal seepage through lining three discrete portions of the main canal and reduction of seepage through conveyance of water through a newly constructed pipeline in the Churn Creek Bottom area in the Redding Groundwater Basin. Impacts resulting from these system improvements were projected during the irrigation season using the RBGM.

The RBGM has been used to simulate only limited versions of potential ACID groundwater programs for environmental documentation purposes. The two groundwater analyses that have been performed to date can be found in the SVWMP Environmental Impact Statement/Environmental Impact Report and the Redding Basin Environmental Assessment/Environmental Impact Report. It should not be assumed that ACID has determined the capacity or design of a future groundwater production system. The existing groundwater model is one of many aids in determining ACID groundwater production capacity and configuration.

3.1.3 Groundwater in Storage

Quantifying the relative contributions of recharge for a basin is challenging. Accurately quantifying the changes of the various recharge rates due to an extraction project is even more challenging. Only with a combination of monitoring over time, evaluating aquifer properties and water flow, and comparing modeling analyses with measured data can these relative effects be understood. The approach has been developed since 2002 by ACID to establish the beginnings of the implementation of its Program. Using sound technical judgment and then monitoring and measuring the effects of the Program over time will help ACID to develop and make reasonable operational decisions through time and in conjunction with local (e.g., GMPs), county (e.g., ordinances), and regional (e.g., SVWMP/DWR Groundwater Subcommittee plans) groundwater management and management objectives. This monitoring and measurement will also provide the ability to understand the basic characteristics of the basin and to monitor changes in basin conditions that might cause adverse impacts to other groundwater users.

A discussion of the current estimate of groundwater in storage can be found in Section 2.2.2. The Redding Groundwater Basin is not in a state of groundwater overdraft.

The Redding Groundwater Basin has been estimated to contain up to 2.5 to 5.5 million acre-feet of groundwater in storage (DWR Bulletin 118, 1975, and Pierce, 1983). Groundwater levels in wells in the basin are depressed seasonally, but fully recover over the winter months in all but the driest rainfall years. However, further study is necessary to determine the effects of a prolonged, severe drought on regional groundwater levels.

3.1.4 Land Subsidence

Land subsidence is currently monitored in the Redding Groundwater Basin. The basin has historically been full and generally considered underused. As such, the infrastructure for monitoring for land subsidence was never developed. ACID defers to Shasta County and DWR for this monitoring effort, but if opportunities for funding arise, the District will assist as appropriate to develop a monitoring network that may include extensometers.

3.1.5 Groundwater Well Construction and Installation

3.1.5.1 Groundwater Monitoring Wells

Should funding permit, additional monitoring wells will likely be installed to meet the monitoring well standards that have developed in the Sacramento Valley through DWR, Northern District, activities. New monitoring wells will be multi-completion and will generally follow the DWR design (as appropriate to the local geology and hydrogeology) presented on Figure 3-1.

3.1.5.2 Groundwater Production Wells

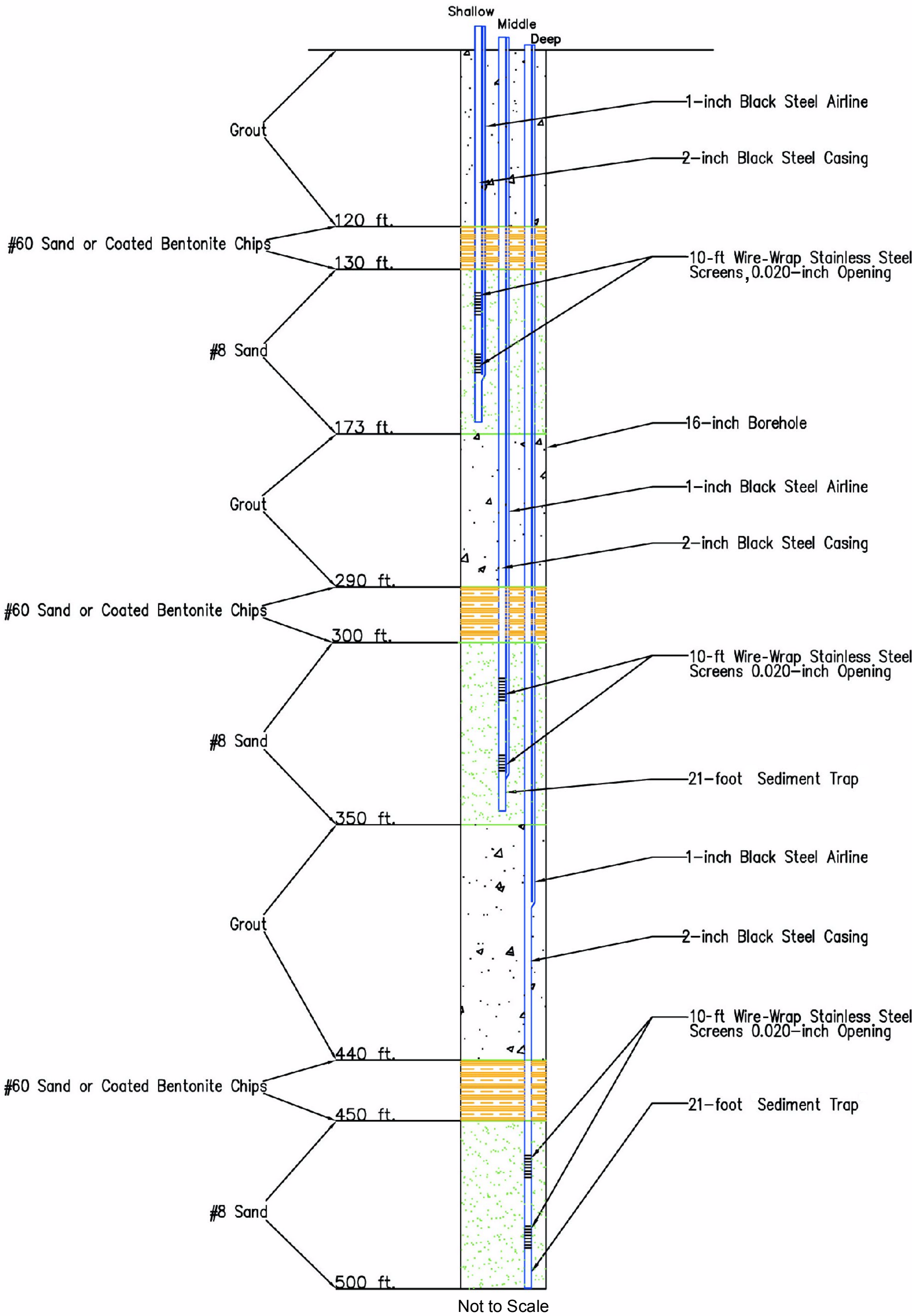
Future groundwater production wells will likely have the following characteristics:

- Drilling Techniques: Mud-rotary and/or reverse drilling techniques

- Materials and Procedure:
  - Blank well casing will likely range in diameter from nominal 18-inch to 24-inch steel of appropriate alloy, to minimize significant corrosion over the desired lifespan of the well.
  - Screen materials will likely range in diameter from 18- to 24-inch steel of appropriate alloy, to minimize significant corrosion over the desired lifespan of the well.
  - Gravel pack will extend a safe distance above the top of the well screen and be topped with a finer-grained transition sand.
  - Gravel pack material will depend on lithology encountered during drilling, the geophysical log (e-log), and the selected well screen aperture size.
  - Cement/bentonite grout will be used above the transition sand to the land surface as the seal.
  - Wells will be developed using some combination of airlift, surge, swab, and pump techniques until turbidity is less than 10 Nephelometric Turbidity Units and field parameters are stabilized (e.g., pH, electrical conductivity, and temperature).
  - After a production well is installed and developed, a vertical turbine pump with an electrical motor ranging from 25 to 200 horsepower will be installed to extract the groundwater through welded steel pipe (and appurtenances like butterfly valves and flow meters) ranging in diameter from 8 to 16 inches.
  - High-density polyethylene pipe will convey water from the welded steel pipe to the open-channel conveyance systems of the individual irrigation districts and water companies.
  - Hydraulic testing will be performed at each production well after well development to aid in the evaluation of well efficiency and local aquifer properties.

3.1.5.3 Quality Assurance and Quality Control

An inspection team will be staffed by the design team, ACID, or (potentially) DWR for the purposes of quality assurance and control of well installation and development. The inspection team will likely consist of one to two resident inspectors during surface infrastructure installation, well installation, and well development. Inspectors will record observations in inspection diaries, which will be collected and archived for project records. One geologist will provide drilling oversight for construction of the wells. The onsite geologist will verify that well installation materials meet specifications and that the drilling and well



NOTES:

1. Information shown on this drawing should be considered general design guidelines and does not reflect a final well design. Each well is designed based on actual local conditions found at the time of construction.

2. Design drawing provided by DWR, Division of Local Assistance (Northern District). Dated 01/15/2002.

Not for Construction

FIGURE 3-1
DWR MULTI-COMPLETION GROUNDWATER MONITORING WELL DESIGN, TYPICAL
ACID GROUNDWATER MANAGEMENT PLAN

installation/development procedures are carried out correctly. The onsite geologist will also document the cuttings in a soil boring log (Unified Soil Classification System soil type encountered with depth), fill out daily progress logs, and keep the owner and/or project manager informed of billing progress.

Inspection documentation will include, but not be limited to, routine construction meeting agendas and notes, correspondence notes from the contractor, review of construction submittals, requests for information, possible change orders, and progress reports to ACID and DWR. A health and safety plan will be prepared for the inspection team; a similar plan will be expected from the contractor. As appropriate, registered professional geologists and engineers will review and stamp any contract documents that go out for bid.

3.1.6 Facilitating Conjunctive Water Management Operations

Annual operating plans for the regional participation in groundwater programs will be developed as appropriate. For instance, participation in the SVWMP requires participating its annual operating plan. As ACID develops facilities for conjunctive management (specifically groundwater production infrastructure), operational guidelines will be developed.

3.2 Cooperation in Groundwater Management

ACID, in cooperation with the SVWMP and in support of RAWC efforts, has been developing a Program that would responsibly and efficiently use the resources of a full groundwater basin that receives extensive natural recharge. The Program will result in water supply, water quality, and environmental benefits to the mainstem of the river from the Redding Groundwater Basin to the Bay-Delta. This Program is one component of a single regional- and state-supported package designed to help meet the Bay-Delta water quality objectives. As one component of the SVWMP and the Management Plan, the ACID Program will provide benefits to both local and downstream users ***while maintaining District autonomy***.

3.2.1 Local Cooperation

ACID is a member of the RAWC, an association of water purveyors in the Redding Groundwater Basin. RAWC members executed an MOU, dated August 1998, to authorize the entities to jointly prepare, adopt, and implement an AB 3030 Plan for the Redding Groundwater Basin. The following entities have participated in Redding Groundwater Basin planning efforts to date:

- ACID
- City of Anderson
- City of Redding
- SCWA
- Centerville Community Services District
- Clear Creek Community Services District
- Cottonwood Water District
- Shasta Community Services District

- City of Shasta Lake
- Bella Vista Water District
- Mountain Gate Community Services District
- Keswick County Service Area
- Jones Valley County Service Area

The SCWA is an authorized groundwater management agency as defined in Water Code Section 10753 (b). SCWA was authorized by the MOU to serve as the lead agency in preparing, adopting, and implementing the Shasta County AB 3030 Plan. The MOU also designated the RAWC to serve in a policymaking oversight capacity for this planning effort. Accordingly, this AB 3030 Plan was undertaken by agreement of the public and private entities comprising the RAWC, as permitted by Water Code Sections 10750.7, 10753, and 10755.2.

ACID has been an active participant in the Redding Groundwater Basin planning activities. Various phases of the Management Plan are described in Section 1.

3.2.2 Regional (State and Federal) Cooperation

Conjunctive management opportunities are among the promising actions investigated by DWR in its regional water resources management plan. DWR, as a cooperating entity in the SVWMP, has shown its support of the Program and its corresponding projects. ACID is an active member of the SVWMP, which has a Technical Measurement and Monitoring Committee with a Groundwater Subcommittee. This Subcommittee is made up of California water professionals from DWR, USBR, the State Water Contractors, and consultants. DWR continues to construct groundwater monitoring infrastructure, now being done in cooperation with the SVWMP Groundwater Subcommittee. Furthermore, ACID has been working with DWR, Northern District, to monitor groundwater levels and look at funding opportunities to expand monitoring activities and infrastructure.

3.2.3 Stakeholder Cooperation and Public Outreach

The participants in the regional planning efforts for the Redding Groundwater Basin have worked cooperatively since the early 1990s, first as the Redding Groundwater Committee and thereafter as the RAWC. The longstanding commitment to work cooperatively toward resolution of common issues is indicative of the level of support for the ongoing water resources planning efforts. In addition, presentations have been given to staff of USBR (at Willows and Shasta Dam offices of the Bureau) and to DWR (at Willows and in DWR's Northern District office in Red Bluff) to apprise them of the progress of the work and to secure their input. Both of these resource management agencies have been supportive of the regional planning effort. DWR, in particular, has been very supportive, providing land use mapping information from its geographic information system database and attending meetings as the planning effort has progressed.

Presentations have also been made to then State Senator Johannnessen, State Senator Aanestad, then-State Assemblymen Dickerson, and current state Assemblyman LaMalfa as the work has progressed, as well as to the Economic Development Corporation of Shasta County, the Greater Redding Chamber of Commerce, various local Rotary Clubs, the League of Women Voters, the Cottonwood Creek Watershed Group, and numerous other community groups. All of these organizations have been supportive of the need for basinwide cooperation.

3.3 Management Objectives

ACID will develop MOs as groundwater management activities progress. ACID will also defer, where appropriate, to the MOs presented in the Shasta County AB 3030 Plan. The District is in agreement with the MOs developed for the County to date, which are as follows:

> **Section 1.08.** The purposes of this Groundwater Management Plan can be summarized as follows:
>
> A. To avoid or minimize conditions that would adversely affect groundwater availability and quality within the Plan area.
> B. To develop a groundwater management program which addresses data collection and which protects and enables reasonable use of the groundwater resources of the Redding Basin.

ACID will work with local partners to develop additional qualitative and quantitative MOs appropriate to the Redding Groundwater Basin's geology and hydrogeology. Management objectives will be consistent with basin history, projected use, and Program goals. Given historically limited use of the groundwater resource in the Redding Groundwater Basin and significant natural recharge potential, statistical basin MOs based on groundwater levels (similar to MOs in other Sacramento Valley groundwater subbasins) are not appropriate for the Redding area.

The District also supports the following management objectives stated in Section 1:

- Protect groundwater quality.
- Minimize long-term drawdown of groundwater levels.
- Expand knowledge of local aquifer characteristics through extensive and continued groundwater monitoring, evaluation of aquifer properties and water flow, and analysis checked against measured data.
- Increase groundwater pumping to increase recharge rates and induce greater natural recharge in Program area.

Additional MOs will be developed over time to address local groundwater management.

3.4 Implementation Reports and Updates

District staff will provide an annual report on implementation of the GMP to the ACID Board of Directors. Updates and modifications will be made, as appropriate, as the Program develops, as funding is obtained for increased monitoring, and as partnerships continue to evolve. See the Shasta County AB 3030 Plan for details on county-level reporting and updates.

SECTION 4.0

Works Cited

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Appendix A
Coordinated AB 3030 Groundwater Management Plan for the Redding Groundwater Basin, April 2004 Draft

Appendix B
ACID Resolution of Intent

PHONE NO. : 5303657623 Apr. 06 2006 10:48AM P2

Resolution 2005-07

RESOLUTION OF THE BOARD OF DIRECTORS

OF THE ANDERSON-COTTONWOOD IRRIGATION DISTRICT

NOTICING THEIR INTENT TO PREPARE A GROUNDWATER MANAGEMENT PLAN UNDER WATER CODE §10750 *et seq.* (AB 3030, STATS 1992 and SB 1938 STATS 2002) FOR THE AREAS OF SHASTA COUNTY NOT COVERED BY ANOTHER GROUNDWATER MANAGEMENT PLAN UNDER THIS AUTHORITY OR ANY OTHER AUTHORITY

WHEREAS, the Legislature finds and declares that groundwater is a valuable natural resource in California and should be managed to ensure both its safe production and its quality; and

WHEREAS, it is the intent of the Legislature through the passage of AB 3030 (Stats 1992) and SB 1938 (Stats 2002) codified as Water Code §10750 *et seq.* to encourage local agencies to work cooperatively to manage groundwater resources within their jurisdictions; and

WHEREAS, the Legislature also finds and declares that the additional study of groundwater resources is necessary to better understand how to manage groundwater effectively to ensure the safe production, quality, and proper storage on groundwater in this state; and

WHEREAS, the adoption of a Groundwater Management Plan is encouraged; but not required by law; and

WHEREAS, any local agency, whose service area includes a groundwater basin, or a portion of a groundwater basin, that is not subject to groundwater management pursuant to other provisions of law or a court order, judgment, or decree, may, by ordinance, or by resolution if the local agency is not authorized to act by ordinance, adopt and implement a groundwater management plan pursuant to this part within all or a portion of its service area not served by a local agency or served by a local agency whose governing body, by a majority vote, declines to exercise the authority to implement a groundwater management plan and enters into an agreement with the local public agency pursuant to Water Code §10750.7 and §10750.8; and

WHEREAS, the Anderson-Cottonwood Irrigation District is interested in the development of a Groundwater Management Plan as defined under Water Code Section 10750, *et seq.* for the areas of the County not covered by another groundwater management plan; and

WHEREAS, prior to adopting a resolution of intention to draft a groundwater management plan, Water Code §10753.2 requires a local agency to hold a hearing, after publication of notice pursuant to Government Code §6066, on whether or not to adopt a resolution of intention to draft a Groundwater Management Plan pursuant to this part for the purposes of implementing the plan and establishing a groundwater management program, and

WHEREAS, such hearing was noticed pursuant to Government Code §6066 and held on March 10, 2005, at 6:00 p.m., in the Anderson City Council Chambers, 1887 Howard Street in Anderson, California.

WHEREAS, at the conclusion of the hearing, the local agency may draft a resolution of intention to adopt a groundwater management plan pursuant to this part for the purposes of implementing the plan and establishing a groundwater management plan.

NOW, THEREFORE, BE IT RESOLVED, that the Board of Directors of the Anderson-Cottonwood Irrigation District hereby agree to:

1. Adopt a Resolution of Intention to Draft a Groundwater Management Plan pursuant to Water Code §10750 *et seq.* for the purposes of implementing the plan and establishing a groundwater management program.

2. Direct the Clerk of the Board to publish the Resolution of Intention under Government Code §6066 pursuant to Water Code §10753.3(a).

3. Direct management to have the groundwater management plan under Water Code §10750 *et seq.* prepared.

4. Direct the management to have the groundwater management plan prepared within two years of the date of the Resolution of Intention pursuant to Water Code §10753.4.

FROM : PHONE NO. : 5303657623 Apr. 06 2006 10:49AM P4

PASSED AND ADOPTED by the Board of Directors of the Anderson-Cottonwood Irrigation District on this the 10th day of March, 2005, by the following vote:

AYES: Andrews, Jordan, Haynes, Leitaker, Sartori

NOES: None

ABSENT: None

NOT VOTING: None

Brenda L. Haynes

Brenda Haynes
President of the Board of Directors

ATTEST:

DEE E. SWEARINGEN
General Manager
and Clerk of the Board

By Dee E. Swearingen

Appendix C
ACID Resolution to Adopt the Groundwater Management Plan

RESOLUTION 2006-02

RESOLUTION OF THE BOARD OF DIRECTORS OF ANDERSON-COTTONWOOD IRRIGATION DISTRICT TO ADOPT THE ANDERSON-COTTONWOOD IRRIGATION DISTRICT GROUNDWATER MANAGEMENT PLAN

WHEREAS, on March 10, 2005 Anderson-Cottonwood Irrigation District provided notice of their intent to prepare a Groundwater Management Plan pursuant to California Water Code §10750 *et seq*, AB 3030, and SB 1938; and

WHEREAS, any local agency, whose service area includes a groundwater basin, or a portion of a groundwater basin, that is not subject to groundwater management pursuant to other provisions of law or a court order, judgment, or decree, may by ordinance, or by resolution if the local agency is not authorized to act by ordinance, adopt and implement a Groundwater Management Plan; and

WHEREAS, Anderson-Cottonwood Irrigation District has prepared a Groundwater Management Plan pursuant to California Water Code §10750 *et seq*, AB 3030, and SB 1938; and

WHEREAS, prior to resolving to adopt a Groundwater Management Plan the local agency must hold a public hearing pursuant to Water Code §10753.5(a), and said meeting must be noticed pursuant to Water Code §10753.2(a); and

WHEREAS, such a hearing was so noticed and held on April 13, 2006 at 6 p.m. in the Anderson City Council Chambers at 1887 Howard Street, Anderson, California.

NOW, THEREFORE, BE IT RESOLVED that Anderson-Cottonwood Irrigation District does hereby adopt, and direct the implementation of, the Anderson-Cottonwood Irrigation District Groundwater Management Plan pursuant to Water Code §10753.6(c)(3).

PASSED AND ADOPTED this 13th day of April, 2006 at Anderson, California, the following Directors voting thereon:

Aye: ANDREWS HAYNES JONES JORDAN SARTORI
No: NONE
Abstain: NONE
Absent: NONE

Brenda L. Haynes
President of the Board of Directors

Attest:

[signature]
Secretary to the Board of Directors

Appendix D
Natural Resources Conservation Service Soil Surveys for Shasta and Tehama Counties