12.2.3 Regional and Local

This section provides information about the regional and local regulatory setting, policies, and programs associated with groundwater resources in the study area.

Existing Conjunctive Use Programs

DWR defines conjunctive use as follows (DWR 1994):

> *Conjunctive use is the operation of a groundwater basin in coordination with a surface water system to increase total water supply availability, thus improving the overall reliability of supplies. The basin is recharged, both directly and indirectly, in years of above-average precipitation so that groundwater can be extracted in years of below average precipitation when surface water supplies are below normal.*

According to this definition, various forms of conjunctive use are practiced throughout California. The form of conjunctive use ranges from incidental conjunctive use benefits to rigorous management programs implemented through detailed operating guidelines. For this discussion, conjunctive use is characterized as incidental conjunctive use, artificial recharge, or active substitution. These three types of conjunctive use can occur individually or may be used in conjunction with one another. In DWR's recent *California Water Plan Update* (DWR 2005b), some of the major conjunctive use programs currently in place are highlighted and discussed below; however, this is not a complete summary of all conjunctive use programs currently in operation or planned.

Incidental Conjunctive Use. Incidental conjunctive use occurs when an area relies on surface water when it is available, and on groundwater when surface water is not available. This is the basic level of conjunctive use. Development of surface water storage and delivery projects by Reclamation, DWR, and others has been an important factor in allowing water users to reduce groundwater pumping and build up groundwater storage for future use. Management techniques may be used to define the timing and location of surface water deliveries and groundwater pumping to maximize water supply reliability.

Numerous water users in the San Joaquin River and Tulare Lake hydrologic regions participate in conjunctive use activities. For example, imported surface water supplies provided by the CVP and SWP lessen the burden on groundwater supplies and help reduce groundwater overdraft. However, groundwater pumping may increase in years of below-average precipitation and reduced availability of imported surface water supplies.

Artificial Recharge. Conjunctive use programs incorporating artificial recharge methods require a source of surface water (imported or reclaimed) that is not needed for immediate use. The surface water is placed directly into the ground by various means, including spreading ponds and injection. This water is then available for use in dry periods. This is a common practice in many areas of the State, especially in the San Joaquin River and Tulare Lake hydrologic regions. Several artificial recharge programs are currently in operation or planned for future operation in the Tulare Lake Hydrologic

Region. In Kern County, Rosedale-Rio Bravo WSD purchases surface water from three sources and recharges local groundwater reserves. These groundwater reserves are then later tapped for irrigation purposes. Also, Arvin-Edison WSD and the Metropolitan Water District of Southern California (MWD) have a long-term water management program in which Arvin-Edison WSD banks MWD SWP supplies when available, and returns a like amount of water to MWD in dry years. In addition, the Kern Water Bank project, which has been in operation for a number years, augments SWP supplies with groundwater in drought years.

Conjunctive use of surface water and groundwater is regionally extensive on the east side of the San Joaquin River and Tulare Lake hydrologic regions. For example, surface water management in the Kings and Kaweah river basins is used for groundwater recharge. This area is also served by the Friant-Kern Canal, which delivers CVP water for direct use and groundwater recharge purposes. In the San Joaquin River Hydrologic Region, the integrated operation of the Madera Canal, together with Hidden Dam and Buchanan Dam on the Fresno and Chowchilla rivers, respectively, also involves extensive groundwater recharge.

Active Conjunctive Use Programs

The following section summarizes active conjunctive use programs in the San Joaquin Valley Groundwater Basin.

Semitropic Water Storage District Groundwater Banking Program. The Semitropic Groundwater Storage Bank began operation in 1990 and is one of the largest groundwater banking programs in the world. The purpose of the Semitropic WSD groundwater banking program is to provide water for agricultural and urban use during drought years. Currently, six banking partners commit surplus water to Semitropic WSD in wet years: MWD, Santa Clara Valley WD, Alameda County WD, Newhall Land and Farming Company, Vidler Water Company, and Alameda County Flood Control and Water Conservation District (Zone 7 Water Agency). These partners have delivered approximately 7,000 TAF of water to Semitropic WSD, and more storage will become available when the expansion of the facility is complete.

The program’s board of directors comprises local farmers who are elected to 4-year terms, and serve the agricultural area in Semitropic WSD. The district is located between the CVP Friant-Kern Canal and the SWP California Aqueduct, near Wasco, California, in Kern County. The bank’s geographical location and sandy soil composition make it an ideal location for a groundwater banking program.

The Semitropic groundwater banking program currently banks 700 TAF of water with a total expanded capacity of 1.65 MAF; approximately 450 TAF of storage are available for use. Semitropic can provide a guaranteed 290 TAF per year to banking partners with a maximum withdrawal rate of 423 TAF per year (delivered into the California Aqueduct), and can recharge a guaranteed 140,5 TAF per year with a maximum of 400 TAF per year. Water can be recovered from groundwater storage quickly with high-flow wells that pump water at 300 cfs (405 gallons per minute).

Total capacity, recharge, and withdrawal rates and totals are based on the intake facility's expansion project, which is currently permitted and ready for construction. Once the facility is completed, the water bank's capacity will be equivalent to approximately 18 percent of the entire SWP yield (Semitropic WSD 2004).

Kern Water Bank Authority, Kern Water Bank. The purpose of the Kern Water Bank is to store, recharge, and recover water to improve water supply for its participants during drought years. The Kern Water Bank also serves as an enhanced habitat for endangered and threatened species, waterfowl, and other wildlife.

The Kern Water Bank Authority, a Joint Powers Authority, was created in October 1995 and includes WDs and a Mutual Water Company (MWC), which form a board of directors to operate the project. Major participants in the project are the Dudley Ridge WD, Kern County Water Agency Improvement District 4, Semitropic WSD, Tejon-Castac WD, Westside MWC, and Wheeler Ridge-Maricopa WSD.

The Kern Water Bank occupies approximately 30 square miles of the southwestern San Joaquin Valley southwest of Bakersfield on the Kern River alluvial fan. The large deposits of sandy materials form an aquifer that is extremely well suited for water storage because water rapidly flows through the soil for recharge, and is easily recovered by high-flow wells. Studies show that the Kern Water Bank has the capability to store over 1 MAF on a long-term basis and has stored approximately 1.3 MAF since the beginning of the water banking program. The Kern Water Bank can possibly maintain long-term recharge rates of 4 inches per day for several months. The program is capable of withdrawing approximately 240 TAF per year using 80 water supply wells located throughout the water bank. The well system is connected to the Kern Water Bank Canal, California Aqueduct, and Cross Valley Canal via 17 miles of pipeline (Kern Water Bank Authority 2008).

City of Fresno, Leaky Acres Water Recharge Facility. Leaky Acres is owned and operated by the City of Fresno in conjunction with the Fresno ID and Fresno Metropolitan Flood Control District. The purpose of the facility, located near the Fresno Yosemite International Airport, is to recharge groundwater via 26 ponds covering 200 acres.

Water used for recharge purposes is delivered to Leaky Acres via canals by Fresno ID nearly year-round. The City of Fresno allocates portions of its Class 1 water entitlement from Reclamation to Leaky Acres in the early summer, and supplements that water with 21 percent of Fresno ID's yearly allotment of water (Class 2 water) from the Kings River later in the season. Over the past 5 years, Leaky Acres has applied approximately 55 acre-feet per day of surface water for recharge purposes, which during recharge, can produce a rise in groundwater levels of 10 feet.

The typical 10-acre basins used for recharge are 3.5 to 4 feet deep and are dried annually for a 45-day period for maintenance. The sandy soil is prime for allowing water to percolate into the groundwater aquifer; however, silt and organic material settle into the fine pores at the surface of the basins, retarding groundwater percolation and recharge rates. When the basins are drained, heavy equipment removes sediments that clog pores at the surface and prevent percolation of water, greatly increasing the infiltration rate of the water.

Leaky Acres also provides natural habitat for many species of waterfowl, and minnows are planted in the basins annually to control the mosquito population. Fresno ID uses Magnacide in the canals to control weed and algae growth several times during the delivery season, and subsequently fish are killed that may swim into the canals. All basins are closed temporarily while the canals are treated (City of Fresno 2008).

Farmington Groundwater Recharge Program. The Stockton East WD has taken a lead role in partnership with the Sacramento District of USACE to create the Farmington Groundwater Recharge Program, launched in 2003, as a solution to the critically over-drafted Eastern San Joaquin Subbasin. The program covers the area bound by Jack Tone Road to the east, Highway 99 to the west, the Mokelumne River to the north, and Temple Creek to the south.

Annually, agricultural and municipal water uses exceed the natural recharge of the basin by up to 135 TAF. This has led to a loss in total groundwater storage capacity of up to 2 MAF, and groundwater levels have declined an average of 1.7 feet per year for the last half-century. To restore the basin to a level of safe yield and, more importantly, to prevent further intrusion of saline water into the freshwater groundwater aquifer, 200 TAF per year of recharge water are needed.

The Farmington Groundwater Recharge Program's objective is to apply 35 TAF of water annually for recharge on 800 to 1,200 acres of land in the Eastern San Joaquin Valley Subbasin. The surface water used for recharge is taken from the Stanislaus, Calaveras, Littlejohns, and Mokelumne rivers during the months of November through April, and delivered via pipelines or open ditches to recharge plots.

The recharge process involves flooding fields up to 18 inches deep; no specialized heavy equipment is required to prepare a plot. This technique allows agricultural landowners to participate in the project through short- and long-term contracts with Stockton East WD, and permits different parcels of land to be rotated in and out of the program quickly and efficiently. The basins used for recharge also provide seasonal habitat for varying species of waterfowl and migrating birds (USACE 2008).

Madera Irrigation District Water Supply Enhancement Project. The proposed Madera ID Water Supply Enhancement Project would create a water bank with a total storage capacity of approximately 250 TAF. The primary project area has been identified by Madera ID as an area that would encompass 13,646 acres south of the Fresno River and north of the San Joaquin River in southwestern Madera County. The proposed project area location is about 5 miles southwest of the City of Madera and about 10 miles northwest of the City of Fresno.

Madera ID has specified that 10 percent of the recharged or banked surface water would be left behind each season to reduce the rate of groundwater overdraft and account for losses to the aquifer, while the remaining 90 percent of banked water would be recovered and used to provide water supply reliability during the irrigation season. Accordingly, over time, the intent would be to alleviate groundwater overdraft in the project area.

The purpose of this water bank would be to increase water supply reliability in the Madera region and provide groundwater resource protection by reducing groundwater degradation (groundwater overdraft) to the greatest extent possible in the study area. Secondary benefits from implementing the proposed project would include providing water contributions to San Joaquin River restoration efforts; improving San Joaquin River water quality; facilitating conjunctive water management in the San Joaquin Valley to reduce groundwater overdraft; and contributing to habitat conservation plan goals, recovery of endangered species, and/or recreation opportunities. Project details proposed by Madera ID are summarized in the *Final EIR for the Madera ID Water Supply Enhancement Project* (Reclamation 2007).

Mendota Pool, Ten-Year Exchange Agreements, Proposed Annual Water Exchange, California. The Mendota Pool Project was proposed by a group of farmers with wells adjacent to the Mendota Pool along the Fresno Slough arm and along the San Joaquin River where it enters the pool. The objective of the proposed project is to provide water supplies to irrigable lands on Mendota Pool Group properties in Westlands WD and San Luis ID to offset reductions in contract water supplies attributable to the CVPIA. The project would allow farmers to pump groundwater from their wells and into the Mendota Pool for conveyance down the California Aqueduct using Westlands WD pump stations at Laterals 6 and 7. Under current limitations of Lateral 7, the proposed project would pump and convey 54 TAF of groundwater. The project total conveyance capacity could be increased to 78 TAF if the Lateral 7 pump station is rehabilitated (Jones & Stokes Associates 1995).

The Mendota Pool Project and similar projects were operated on an interim basis from 1989 – 1994, when the region experienced a drought, and CVP and SWP water supplies to Federal and State contractors were reduced.

Additional Proposed Groundwater Banking Projects. Additional direct and in-lieu recharge groundwater banks have been proposed in the San Joaquin Valley by Friant Division long-term contractors and non-Friant Division contractors. Proposed projects are listed in Tables 12-12 and 12-13.

Additional information on the proposed projects is available in Appendix G, “Plan Formulation.”

Table 12-12.
Proposed In-Lieu Groundwater Banking and Recharge Projects

Project Description
Arvin-Edison WSD In-District, In-Lieu Groundwater Bank
Chowchilla WD Groundwater Recharge Pond and Recovery Well
City of Fresno Southeast Surface Water Treatment
Delano-Earlimart ID and Pixley ID Groundwater Bank
FKC Turnout to Cawelo's North System - 5N
Kern-Tulare/ Rag Gulch WD Ninth Avenue Pipeline - 5N
Orange Cove ID In-District Groundwater Recharge/ Recovery Program
Pixley ID Distribution System Expansion
Semitropic New In-Lieu Service Area (P-565) - 5S
Semitropic Stored Water Recovery Unit In-Lieu Service Areas - 5S
Shafter-Wasco ID Interconnection on Kimberlina Road to Semitropic P-384 Distribution System - 5S
Shafter-Wasco ID Interconnection on Madera Avenue to Semitropic B-320 Distribution System - 5S
Southern San Joaquin MUD Interconnection with Semitropic P-1030 In-Lieu Service Area - 5N
Terra Bella ID Connection of Distribution System to Tule River Distribution System

Key:
5N = 5 North
5S = 5 South
FKC = Friant-Kern Canal
ID = Irrigation District
MUD = Municipal Utilities District
WD = Water District
WSD = Water Storage District

Table 12-13.
Proposed Direct Groundwater Banking and Recharge Projects

Project Description
Arvin-Edison WSD Out-of-District Groundwater Bank
City of Fresno Northwest Recharge Project
City of Fresno Southeast Water Bank
City of Fresno Southwest Recharge Project
City of Fresno Westside Water Bank and Tertiary Treatment at Fresno/Clovis Regional Wastewater Reclamation Facility with Intertie to SJR
Chowchilla WD Groundwater Recharge Pond and Recovery Well
Chowchilla WD River Channel Seepage Enhancement
Deer Creek Basin Water Banking Evaluation
Delano-Earlimart ID and Pixley ID Groundwater Bank
Delano-Earlimart ID Turnipseed Groundwater Banking Project - 5N
FKC Improvement and Conveyance to North Kern Recharge
FKC Turnout to Cawelo's North System - 5N
Fresno ID Water Development and Recovery Facility
Madera ID Water Supply Enhancement Project
Rag Gulch GW Banking Project - 5N
Rancho de Kaweah Surface Water Banking Facility
Saucelito ID Distribution System Evaluation (Groundwater Banking Evaluation)
Semitropic Pond Poso Spreading Grounds - 5S
Tulare ID Conjunctive Use Recharge Basin
Tulare ID Upstream Recharge Basin
Tulare ID Water Use Efficiency Basin
Upgrade of Shafter-Wasco ID Interconnection Facilities with North Kern - 5S
White River GW Banking in Rag Gulch WD - 5N

Key:
5N = 5 North
5S = 5 South
FKC = Friant-Kern Canal
GW = groundwater
ID = Irrigation District
SJR = San Joaquin River
WD = Water District
WSD = Water Storage District

12.3 Environmental Consequences and Mitigation Measures

This section describes the effects that the program alternatives would have on groundwater resources. Methodology, criteria for determining significance of effects, and environmental consequences and mitigation measures associated with effects of each program alternative are discussed. Program alternatives evaluated in this section are described in detail in Chapter 2.0, "Description of Alternatives," and summarized in Table 12-14. Potential impacts to surface water quality and associated mitigation measures are summarized in Table 12-15.

Table 12-14.
Actions Included Under Action Alternatives

Level of NEPA/CEQA Compliance	Actions[1]		Action Alternative					
			A1	A2	B1	B2	C1	C2
Project-Level	Reoperate Friant Dam and downstream flow control structures to route Interim and Restoration flows		✓	✓	✓	✓	✓	✓
Project-Level	Recapture Interim and Restoration flows in the Restoration Area		✓	✓	✓	✓	✓	✓
Project-Level	Recapture Interim and Restoration flows at existing CVP and SWP facilities in the Delta		✓	✓	✓	✓	✓	✓
Program-Level	Common Restoration actions[2]		✓	✓	✓	✓	✓	✓
Program-Level	Actions in Reach 4B1 to provide at least:	475 cfs capacity	✓	✓	✓	✓	✓	✓
Program-Level	Actions in Reach 4B1 to provide at least:	4,500 cfs capacity with integrated floodplain habitat		✓		✓		✓
Program-Level	Recapture Interim and Restoration flows on the San Joaquin River downstream from the Merced River at:	Existing facilities on the San Joaquin River			✓	✓	✓	✓
Program-Level	Recapture Interim and Restoration flows on the San Joaquin River downstream from the Merced River at:	New pumping infrastructure on the San Joaquin River					✓	✓
Program-Level	Recirculation of recaptured Interim and Restoration flows		✓	✓	✓	✓	✓	✓

Note:
[1] All alternatives also include the Physical Monitoring and Management Plan and the Conservation Strategy, which include both project- and program-level actions intended to guide implementation of the Settlement.
[2] Common Restoration actions are physical actions to achieve the Restoration Goal that are common to all action alternatives and are addressed at a program level of detail.

Key:
CEQA = California Environmental Quality Act
cfs = cubic feet per second
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
NEPA = National Environmental Policy Act
PEIS/R = Program Environmental Impact Statement/Report
SWP = State Water Project

Table 12-15.
Summary of Environmental Consequences and Mitigation Measures – Groundwater

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measure	Level of Significance After Mitigation
Hydrology – Groundwater: Program-Level				
GRW-1: Temporary Construction-Related Effects on Groundwater Quality	No-Action	LTS and Beneficial	--	LTS and Beneficial
	A1	PS	GRW-1a: Prepare and Implement a Stormwater Pollution Prevention Plan That Minimizes the Potential Contamination of Surface Waters, and Complies with Applicable Federal Regulations Concerning Construction Activities GRW-1b: Conduct Phase I Environmental Site Assessments	LTS
	A2	PS		LTS
	B1	PS		LTS
	B2	PS		LTS
	C1	PS		LTS
	C2	PS		LTS
Hydrology – Groundwater: Project-Level				
GRW-2: Changes in Groundwater Levels Along the San Joaquin River from Friant Dam to the Delta	No-Action	LTS	--	LTS
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
GRW-3: Changes in Groundwater Quality Along the San Joaquin River from Friant Dam to the Delta	No-Action	LTS and Beneficial	--	LTS and Beneficial
	A1	LTS	--	LTS
	A2	LTS	--	LTS
	B1	LTS	--	LTS
	B2	LTS	--	LTS
	C1	LTS	--	LTS
	C2	LTS	--	LTS
GRW-4: Changes in Groundwater Levels in CVP/SWP Water Service Areas	No-Action	PSU	--	PSU
	A1	PSU	--	PSU
	A2	PSU	--	PSU
	B1	PSU	--	PSU
	B2	PSU	--	PSU
	C1	PSU	--	PSU
	C2	PSU	--	PSU

Table 12-15.
Summary of Environmental Consequences and Mitigation Measures – Groundwater (contd.)

Impacts	Alternative	Level of Significance Before Mitigation	Mitigation Measure	Level of Significance After Mitigation
Hydrology – Groundwater: Project-Level				
GRW-5: Changes in Groundwater Quality in CVP/SWP Water Service Areas	No-Action	PSU	--	PSU
	A1	PSU	--	PSU
	A2	PSU	--	PSU
	B1	PSU	--	PSU
	B2	PSU	--	PSU
	C1	PSU	--	PSU
	C2	PSU	--	PSU

Key:
-- = not applicable
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
LTS = less than significant
PS = potentially significant
PSU = potentially significant and unavoidable
SWP = State Water Project

12.3.1 Impact Assessment Methodology

This section describes modeling, assumptions, and significance criteria used to assess impacts to groundwater resources in the study area. Two geographic regions, the San Joaquin River upstream from Friant Dam and the Delta, were dismissed from further consideration because there would be no impacts to these regions under any of the program alternatives. Significance statements are relative to both existing conditions (2006) and future conditions (2030), unless stated otherwise.

Modeling and Assumptions

A suite of modeling tools was used to evaluate potential adverse and beneficial impacts of program alternatives under consideration on groundwater resources in the study area. Before the technical analysis was conducted, a process to identify the best available analytical tools was completed. This tool selection process involved evaluating the following tools for understanding potential regional effects of SJRRP implementation: CVGSM, Westside Simulation Model (WESTSIM), Kings Groundwater Basin Model (KingIGSM), CVHM, the California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM), and HydroGeoSphere. Although CVHM and C2VSIM were identified as the best candidates for regional-type analysis, neither was ready for application when the analysis was initiated. Therefore, a surrogate analytical or simplified existing numerical tool (Schmidt Tool and Mass Balance Tool) was used to evaluate regional groundwater conditions.

A MODFLOW and HEC-RAS model of the near-river riparian zone and surrounding areas of the lower San Joaquin River (SSP&A 2005; MEI 2005a, b) was used to evaluate potential local effects of SJRRP implementation (e.g., river seepage). Consideration was also given to the application of tools such as the Glover-Balmer Analytic Stream Depletion Model and the Theis Drawdown Solution.

CalSim II was used to simulate potential water supply operations of the program alternatives. Model results were used directly for water supply impact analyses and indirectly as inputs for the regional groundwater analysis, after post-processing.

A subsidence evaluation was also completed for the impact assessment and is described below.

Schmidt Tool. A simplified numerical tool developed by Schmidt (2005b) during San Joaquin River litigation was used to evaluate changes in groundwater conditions in the Friant Division as part of the regional groundwater analysis. This regional groundwater analysis tool estimates the depth to groundwater according to relationships describing annual groundwater pumping and resulting change in depth to groundwater. Annual groundwater pumping estimates for each of the Friant Division long-term contractor areas were developed by Burt (2005) and used to develop relationships with historical change in depth to groundwater (Schmidt 2005b). The report completed by Schmidt in 2005 presents the best available data describing the relationships between groundwater pumping and groundwater depth within the Friant Division. However, the Schmidt Tool did not have the appropriate input data available for all of the Friant Division long-term contractors. Therefore, only a subset of Friant Division long-term contractors are represented using the Schmidt Tool analysis presented below. Groundwater conditions in the remaining Friant Division long-term contractor areas were evaluated using a mass balance approach, described below.

Regional groundwater analysis involved developing a spreadsheet model that uses the Schmidt relationships (2005a, b) together with simulated surface water deliveries from CalSim II. For each of the program alternatives evaluated, surface water delivery output data from CalSim II were post-processed, as described in the section above, to be applied as input to the spreadsheet model. District-level surface water deliveries were used to estimate groundwater pumping, assuming pumping would offset deliveries using a 1:1 relationship. The Schmidt Tool assumes a linear relationship between contractor-area-wide pumping and annual aquifer drawdown, or that groundwater supplies exist in each district to make up for the average annual net reductions in surface water deliveries resulting from program alternatives. However, it is recognized that projected drawdown in an aquifer may not be sustainable in some contractor areas within the Friant Division. Conversely, changes in land and water management practices in the Friant Division, including higher efficiency water application, sowing of different crops, fallowing of land, reduction of irrigated acreage, and water purchases and transfers could potentially result in reduced demand for water supply. To estimate long-term aquifer drawdown for future conditions, annual drawdown within each district region was applied for a 25-year period to correspond to 2030 conditions. The Schmidt relationships used for this analysis, and key assumptions associated with using these relationships, are described in Appendix H, “Modeling.”

Mass Balance Tool. A mass balance approach was used to address potential changes in groundwater conditions within the Friant Division long-term contractor districts that did not have Schmidt relationships available. The mass balance approach provides a quantitative evaluation of how groundwater levels in the Friant Division long-term contractor districts could potentially change as a result of a decrease in surface water deliveries, using the best available information for the different districts. A spreadsheet model that uses post-processed CalSim II data was developed to calculate simulated surface water deliveries within each district for each alternative. The spreadsheet model also estimates the change in depth to groundwater within each region by assuming a uniform drainable porosity (specific yield), and a uniform change in depth to groundwater across the entire area overlying the basin. As with the Schmidt Tool, changes in annual surface water deliveries were assumed to be offset by an increase in groundwater pumping. However, unlike the Schmidt Tool, the mass balance tool does not calculate a change in groundwater levels for the action alternatives, but rather a groundwater level based on initial conditions and the change in surface water deliveries. Therefore, the two methods should not be considered as directly comparable.

Development of this tool involved identifying the groundwater subbasins underlying each of the districts to evaluate subsurface conditions and to estimate an average uniform specific yield within each district. To evaluate the potential change in groundwater elevation, data from all groundwater wells within each district that store data publicly was obtained from the DWR Water Data Library (WDL) (DWR 2010). The groundwater elevation data were evaluated by district to estimate the average existing groundwater level condition for 2005. Although it is recognized that political boundaries do not control the physical environment, it was necessary to treat each district as a hydraulically closed system to estimate conditions using the mass balance approach. Key assumptions associated with this method are described in Appendix H, "Modeling."

Near-River MODFLOW Model. High-resolution riparian zone groundwater models for the near-river zone were developed in MODFLOW, and employ river water boundary conditions developed in the USACE River Analysis System (HEC-2 or HEC-RAS) surface water routing models. These models, termed riparian groundwater models, were constructed for each of the San Joaquin River reaches, 1 through 5, located between Friant Dam and the Merced River (SSPA 2000). Three of the five models were updated in 2005 (Reaches 1, 2, and 4). Models for Reaches 1 and 2 were calibrated using available flow and alluvial monitoring well data from 2004 to 2005, including data collected during the large flood releases in May 2005 (SSPA 2005). The MODFLOW model was updated for Reach 2 of the San Joaquin River using updated HEC-RAS model alignments. The models evaluate near-river groundwater and groundwater/surface water interaction at a high spatial and temporal resolution. Grid spacing is 300 by 50 feet, with an active model domain extending to about 1 half-mile on each side of the river within three vertical layers. Lateral boundary head conditions are specified to correspond to regional groundwater elevations and can be modified, as desired, according to simulation objectives. The original version of these models (SSPA 2000) used up to 13 vertical layers; these layers were aggregated into three model layers in the 2005 model update for practicality and efficiency in analyzing seepage loss from the San Joaquin River under Restoration Flow conditions.

CalSim II. CalSim II is a water supply operations model that includes CVP, SWP, and Friant Division water supply operations. The model simulates an 83-year period of hydrologic record (1922 to 2003) on a monthly time step. CalSim II assumes a constant set of demands, facilities, and operation rules appropriate for each alternative for 83 years. A detailed description of CalSim II is included in Appendix H, “Modeling.”

For each program alternative evaluated, surface water delivery output data from CalSim II was provided as Class 1, Class 2, 215, and 16(b) supplies, by Water Management Area (WMA). To facilitate a program-level evaluation of 16(b) opportunities (as described in Appendix G, “Plan Formulation”), WMAs were developed to group potential projects into geographical regions. WMAs are generally defined by local river crossings, check structures, and capacity changes along the Friant-Kern Canal; historical and current coordination among Friant Division long-term contractors; and access to groundwater basins or the limits of distribution systems with access to 16(a) and 16(b) supplies.

CalSim II model outputs were processed to supply surface water deliveries for the regional simplified numerical tool (using the Schmidt Tool). First, the total volume of Class 1, Class 2, 215,16(a), and 16(b) water for each alternative was calculated from CalSim II results on an annual basis. Class 1 and Class 2 water was then allocated to Friant Division long-term contractors by the respective Class 1 and Class 2 CVP contract amounts. Next, 215 water was allocated to Friant Division long-term contractors by the respective Class 2 CVP contract amounts. Water supply recaptured from the Delta as 16(a) water was allocated to Friant Division long-term contractors by first filling respective Class 1 CVP contract amounts and then, if additional water was available, filling respective Class 2 CVP contract amounts. Finally, 16(b) supplies were allocated to Friant Division long-term contractors using percentages established as equitable among the Friant Division long-term contractors during mediation (personal communication Steve Ottomoller 2009). Additional details regarding how the allocations were made among the Friant Division long-term contractors are available in Appendix H, “Modeling.”

It is important to note the limitation of the above approach in resolving how any 16(b) operation would impact specific water users, particularly with regard to the Settlement assumption that delivery of 16(b) water is intended to replace lost supplies of all Friant Division long-term contractors. Thus, wheeling of 16(b) water supplies among Friant Division long-term contractors was not simulated. For simplicity, time, and authority, the assessment assumes that the 16(b) water does benefit all Friant Division long-term contractors.

Simulated streamflow and reservoir storage data from CalSim II were used in the impact assessments for the near-river groundwater analysis. A detailed description of changes in flow and storage resulting from each of the program alternatives is included in Appendix J, “Surface Water Supplies and Facilities Operations.”

All action alternatives were compared against both existing conditions and future conditions without the project (together, the No-Action Alternative). For existing conditions established for this Draft PEIS/R, the CalSim II simulation used a 2005 level of development for existing conditions. Similarly, the CalSim II simulation used a 2030 level of development for future conditions without the project as a basis of comparison. Each of the action alternatives was simulated using the same levels of development so that any changes from the basis of comparison in groundwater resources could be attributed to the action alternative.

Subsidence Evaluation. As noted above in the existing conditions discussion, subsidence occurred in the San Joaquin Valley beginning approximately in the 1920s, and was induced in drought periods between 1976 – 1977 and 1987 – 1992. Concerns have been raised in recent years that declining groundwater levels have resulted in reactivation of subsidence in parts of the San Joaquin Valley. Subsidence due to groundwater level decline is typically evaluated using leveling surveys for geodetic monitoring or Interferometric Synthetic Aperture Radar (INSAR) techniques, or simulated as a component in a groundwater model. Subsidence was not a component available in the MODFLOW model used to evaluate shallow groundwater conditions along the San Joaquin River. No other groundwater models were publicly available and calibrated before the analysis was initiated. Therefore, a qualitative evaluation was performed to determine the potential for changes in groundwater levels to induce subsidence. The qualitative evaluation consisted of evaluating historical water level data from more than 850 wells in the DWR WDL (DWR 2010) to identify the historical maximum depth to groundwater within each Friant Division long-term contractor district. The historical maximum depth to groundwater within each Friant Division long-term contractor district was used as an indicator of when subsidence could potentially be reactivated in areas that had previously experienced subsidence. Potential effects of continual groundwater level decline due to pumping include costs of lowering pumps or installing larger pumps in wells, installing new wells, higher lift costs, loss of groundwater in storage, potential subsidence, potential loss of aquifer storage capacity, and potential adverse impacts to groundwater quality. The economic effects of potential groundwater level decline are described in Chapter 22.0, "Socioeconomics."

Significance Criteria

The thresholds of significance for impacts are based on the environmental checklist in Appendix G of the State CEQA Guidelines, as amended. These thresholds also encompass factors taken into account under NEPA to determine the significance of an action in terms of its context and the intensity of its impacts. Impacts of an alternative on groundwater resources would be significant if implementation of an alternative would cause either of the following:

- A change in groundwater level resulting in long-term overdraft conditions for the groundwater basins.
- A change in groundwater level adjacent to the San Joaquin River resulting in increased groundwater levels in localized areas already experiencing high groundwater levels.
- A change in groundwater quality resulting in substantially adverse effects to designated beneficial uses of groundwater.

12.3.2 Program-Level Impacts and Mitigation Measures

This section provides a program-level evaluation of the direct and indirect effects of the program alternatives on groundwater resources. Actions under the action alternatives that could result in impacts to groundwater resources include specific channel and structural improvements considered necessary to achieve the Restoration Goal, and the recapture of Interim and Restoration flows either at existing facilities on the San Joaquin River or at new pumping infrastructure. Impacts of all action alternatives related to the release and recapture of Interim and Restoration flows at existing facilities in the Restoration Area are described as project-level impacts in Section 12.3.3.

No-Action Alternative

The following section describes potential program-level impacts of the No-Action Alternative. Changes to groundwater resources under the No-Action Alternative would occur along the San Joaquin River between Friant Dam and the Delta.

Impact GRW-1 (No-Action Alternative): ***Temporary Construction-Related Effects on Groundwater Quality – Program-Level.*** Under the No-Action Alternative, there would be no construction-related impacts on groundwater quality, and salt discharges to the San Joaquin River would be reduced. These effects would be **less than significant** and **beneficial**.

Future conditions for the No-Action Alternative include the *Westside Regional Drainage Plan* (SJREWA et al., 2003), which is anticipated to eliminate salt discharges to the San Joaquin River from the Grassland Drainage Area and improve water quality conditions within Reach 5 and the San Joaquin River from the Merced River to the Delta. This would potentially benefit local groundwater quality along the San Joaquin River where surface water interacts with shallow groundwater.

Alternatives A1 Through C2

This section describes potential program-level impacts on groundwater resources in the study area associated with program-level actions under Alternatives A1 through C2. Alternatives A1 and A2, and B1 and B2, would have the same specific channel and structural improvements outside Reach 4B1. Alternatives A2 and B2 include greater construction activities to increase Reach 4B1 channel capacity to at least 4,500 cfs and, therefore, would have similar but greater effects than Alternatives A1 and B1. Construction-related effects of Alternatives C1 and C2 include those described for Alternatives A1 through B2, as well as effects associated with construction of a new pumping plant on the San Joaquin River below the confluence of the Merced River, as described below. The potential program-level impacts of Alternatives B1 and B2 would also include effects associated with recapture and recirculation of water along the San Joaquin River between the Merced River and the Delta. The potential program-level impacts of Alternatives C1 and C2 on groundwater quality associated with recapture and recirculation of water include those described for Alternatives B1 and B2, as well as effects associated with the operation of new pumping infrastructure on the San Joaquin River.

Impact GRW-1 (Alternatives A1 Through C2): ***Temporary Construction-Related Effects on Groundwater Quality – Program Level.*** Construction associated with channel and structural improvements under Alternatives A1 through C2 would temporarily influence water quality in the Restoration Area and along the San Joaquin River between the Merced River and the Delta, and would potentially lead to changes in groundwater quality. These impacts would be **potentially significant**.

Ground-disturbing activities associated with construction could cause soil erosion and sedimentation in local drainages and the San Joaquin River. Construction activities could also discharge waste petroleum products or other construction-related substances that could enter waterways in runoff. In addition, chemicals associated with operating heavy machinery would be used, transported, and stored on site during construction activities. These substances could be inadvertently introduced into the San Joaquin River through site runoff or on-site spills. Sediment and chemicals could degrade water quality in the San Joaquin River. Alternatives A2, B2, and C2 include greater construction activities to increase Reach 4B1 channel capacity to at least 4,500 cfs (compared to at least 475 cfs with Alternatives A1, B1, and C1) and, therefore, would have similar but greater effects. Similarly, construction activities under Alternatives C1 and C2 would also occur along the San Joaquin river between the Merced River and the Delta.

Construction within the Restoration Area associated with channel and structural improvements would only temporarily influence water quality in the San Joaquin River from the Merced River to the Delta, and the effects would be attenuated with distance from the Restoration Area. This would potentially result in effects to groundwater quality through surface water interaction with underlying groundwater. Construction activities in the Restoration Area under Alternatives A1 through C2 would not be anticipated to affect surface water quality and groundwater quality within the Delta or CVP and SWP water service areas.

Mitigation Measure GRW-1a (Alternatives A1 through C2): ***Prepare and Implement a Stormwater Pollution Prevention Plan That Minimizes the Potential Contamination of Surface Waters, and Complies with Applicable Federal Regulations Concerning Construction Activities – Program-Level.*** This mitigation measure is the same as Mitigation Measure SWQ-1A, as described in Chapter 14.0, "Hydrology – Surface Water Quality." This impact would be **less than significant** after mitigation.

Mitigation Measure GRW-1b (Alternatives A1 and A2): ***Conduct Phase I Environmental Site Assessments – Program-Level.*** This mitigation measure is the same as Mitigation Measure PHH-1, as described in Chapter 20.0, "Public Health and Hazardous Materials." This impact would be **less than significant** after mitigation.

12.3.3 Project-Level Impacts and Mitigation Measures

Potential impacts of the action alternatives compared to the No-Action Alternative would vary based on the quantity of recaptured Interim and Restoration flows that would be recirculated to Friant Division long-term contractors. Tables 12-16 through 12-23 illustrate potential changes in groundwater pumping and groundwater levels for existing conditions and the No-Action Alternative.

If recaptured Interim and Restoration flows are successfully recirculated to Friant Division long-term contractors, the increase in groundwater pumping due to reduced surface water supplies resulting from reoperating Friant Dam would be relatively low. Changes in groundwater pumping and groundwater levels associated with the low level of pumping increase are shown in Tables 12-16, 12-17, 12-20, and 12-21, respectively.

If no water released as Interim and Restoration flows is recirculated to Friant Division long-term contractors, the increase in groundwater pumping due to reoperating Friant Dam would be relatively high. Changes in groundwater pumping and groundwater levels associated with the high level of pumping increase are shown in Tables 12-18, 12-19, 12-22, and 12-23, respectively.

Figures 12-19 through 12-33, which illustrate results from applying the Schmidt Tool, show an estimate of changes in groundwater levels relative to ground surface as a result of groundwater pumping. Unlike the Schmidt Tool, the mass balance method does not incorporate an estimate of the current rate of decline of groundwater levels under existing conditions within the Friant Division long-term contractor areas. Rather, the mass balance method produces an absolute change in groundwater levels relative to the No-Action Alternative for each of the action alternatives. Therefore, there are potential groundwater level declines under existing conditions and the No-Action Alternative that have not been accounted for using the mass balance method. Figures 12-35 through 12-46, which illustrate results from applying the mass balance method, show an estimate of the absolute change in groundwater levels relative to the No-Action Alternative as result of groundwater pumping. These figures illustrate the existing level (2005) and future level (2030) conditions for the following scenarios to capture the full range of impacts under the program alternatives:

- **No Project/No Action –** Includes the No-Action Alternative at existing (no project) and future (no action) levels of development. The no-project scenario is equivalent to the existing condition, as shown in Tables 12-16 through 12-23. The no-action scenario is equivalent to the No-Action Alternative, as shown in Tables 12-16 through 12-23.

- **16(a) + 16(b) –** Includes the full return of recaptured Interim and Restoration flows (including recapture using new pumping infrastructure in this reach). This is equivalent to low groundwater pumping under Alternatives C1 and C2, as shown in Tables 12-16, 12-17, 12-20, and 12-21.

- **16(b) Only –** Includes the full return of recaptured Interim and Restoration flows. This is equivalent to high groundwater pumping under Alternatives A1 and A2, as shown in Tables 12-28, 12-19, 12-22, and 12-23.

Table 12-16.
Average Annual Simulated Groundwater Pumping of All Restoration Year Types Used in Schmidt Tool Calculations – Low[1, 2]

District	Existing Level (2005)[3]				Future Level (2030)[3]			
	Existing Conditions (TAF)	Alt A[4,6] (TAF)	Alt B[4,7] (TAF)	Alt C[4,8] (TAF)	No-Action Alt[4] (TAF)	Alt A[5,6] (TAF)	Alt B[5,7] (TAF)	Alt C[5,8] (TAF)
Arvin-Edison WSD	186	211 (14%)	211 (14%)	211 (13%)	186 (0%)	211 (14%)	211 (14%)	210 (13%)
Chowchilla WD	93	105 (13%)	105 (13%)	104 (12%)	93 (0%)	105 (13%)	105 (13%)	103 (11%)
Delano-Earlimart ID	26	28 (8%)	28 (9%)	27 (2%)	26 (0%)	28 (9%)	29 (10%)	26 (-1%)
Exeter ID	20	21 (6%)	21 (6%)	21 (5%)	20 (0%)	21 (6%)	21 (6%)	21 (5%)
Ivanhoe ID	16	16 (2%)	16 (2%)	16 (2%)	16 (0%)	16 (2%)	16 (3%)	16 (1%)
Lindmore ID	34	35 (2%)	35 (2%)	34 (0%)	34 (0%)	35 (2%)	35 (2%)	34 (0%)
Lindsay-Strathmore ID	7	6 (-15%)	6 (-15%)	6 (-20%)	7 (0%)	6 (-15%)	6 (-14%)	6 (-20%)
Lower Tule River ID	134	152 (14%)	152 (14%)	151 (13%)	134 (0%)	152 (14%)	152 (14%)	151 (13%)
Madera ID	153	166 (8%)	166 (8%)	164 (7%)	153 (0%)	166 (8%)	166 (8%)	164 (7%)
Orange Cove ID	41	39 (-4%)	40 (-4%)	39 (-5%)	41 (0%)	40 (-4%)	40 (-3%)	39 (-5%)
Porterville ID	23	25 (9%)	25 (9%)	25 (7%)	23 (0%)	25 (9%)	25 (9%)	25 (7%)
Saucelito ID	15	17 (13%)	17 (13%)	17 (11%)	15 (0%)	17 (13%)	17 (14%)	17 (10%)
Shafter-Wasco ID	55	56 (3%)	57 (3%)	56 (1%)	55 (0%)	56 (3%)	57 (3%)	55 (1%)
Southern San Joaquin MUD	49	50 (1%)	50 (1%)	48 (-2%)	49 (0%)	50 (1%)	50 (2%)	47 (-3%)
Tulare ID	137	148 (8%)	148 (8%)	148 (8%)	137 (0%)	148 (8%)	148 (8%)	147 (8%)

Input to Schmidt Tool Calculations

Table 12-16.
Average Annual Simulated Groundwater Pumping of All Restoration Year Types Used in Schmidt Tool Calculations – Low[1, 2] (contd.)

Notes:

All results are rounded to the nearest whole number.

[1] Year type as defined by the Restoration Year Type.

[2] Low = full quantity of recaptured Interim and Restoration flows is successfully recirculated to Friant Division long-term contractors. The increase in groundwater pumping due to reoperating Friant Dam would be relatively low.

[3] Simulation period: October 1921 – September 2003.

[4] (%) indicates percent change from existing conditions.

[5] (%) indicates percent change from No-Action Alternative. CalSim II simulation period: October 1921 – September 2003.

[6] Alt A – Low = full return of Interim and Restoration flows by Delta pumping.

[7] Alt B – Low = full return of Interim and Restoration flows by Delta pumping and full return of San Joaquin River exchange flows.

[8] Alt C – Low = full return of Interim and Restoration flows by Delta pumping, full return of San Joaquin River exchange flows, and full return of San Joaquin River pumping.

Key:
Alt = Alternative
ID = Irrigation District
MUD = Municipal Utilities District
TAF = thousand acre-feet
WD = Water District
WSD = Water Storage District

Table 12-17.
Average Annual Groundwater Depth of All Restoration Year Types Using Schmidt Tool – Low[1,2]

District	Existing Level (2005)[3]				Future Level (2030)[3]			
	Existing Conditions (feet)	Alt A[4,6] (feet)	Alt B[4,7] (feet)	Alt C[4,8] (feet)	No-Action Alt[4] (feet)	Alt A[5,6] (feet)	Alt B[5,7] (feet)	Alt C[5,8] (feet)
Arvin-Edison WSD	410	583 (42%)	583 (42%)	579 (41%)	410 (0%)	583 (42%)	584 (42%)	577 (41%)
Chowchilla WD	245	288 (17%)	288 (18%)	285 (16%)	245 (0%)	288 (17%)	289 (18%)	283 (16%)
Delano-Earlimart ID	193	208 (8%)	208 (8%)	196 (2%)	193 (0%)	208 (8%)	211 (9%)	192 (-1%)
Exeter ID	90	114 (27%)	115 (27%)	111 (23%)	90 (0%)	115 (27%)	115 (28%)	109 (21%)
Ivanhoe ID	108	114 (6%)	114 (6%)	112 (4%)	108 (0%)	114 (6%)	115 (7%)	111 (3%)
Lindmore ID	95	105 (10%)	105 (11%)	97 (2%)	95 (0%)	105 (11%)	107 (12%)	93 (-2%)
Lindsay-Strathmore ID	53	42 (-20%)	42 (-19%)	39 (-26%)	52 (0%)	42 (-19%)	43 (-18%)	39 (-26%)
Lower Tule River ID	238	286 (20%)	286 (20%)	283 (19%)	238 (0%)	286 (20%)	286 (20%)	282 (19%)
Madera ID	246	255 (4%)	255 (4%)	254 (3%)	246 (0%)	255 (4%)	255 (4%)	254 (3%)
Orange Cove ID	33	-46 (-242%)	-45 (-237%)	-71 (-319%)	32 (0%)	-45 (-238%)	-39 (-219%)	-71 (-319%)
Porterville ID	73	115 (59%)	116 (60%)	110 (52%)	73 (0%)	116 (59%)	117 (61%)	108 (49%)
Saucelito ID	208	242 (17%)	242 (17%)	236 (14%)	208 (0%)	242 (17%)	243 (17%)	234 (13%)
Shafter-Wasco ID	403	416 (3%)	417 (4%)	409 (2%)	403 (0%)	417 (4%)	418 (4%)	406 (1%)
Southern San Joaquin MUD	243	243 (0%)	243 (0%)	242 (0%)	243 (0%)	243 (0%)	243 (0%)	241 (0%)
Tulare ID	223	284 (27%)	284 (28%)	281 (26%)	223 (0%)	284 (27%)	284 (28%)	280 (26%)

Source: Schmidt Tool Calculations

Table 12-17.
Average Annual Groundwater Depth of All Restoration Year Types Using Schmidt Tool – Low[1,2] (contd.)

Notes:
All results are rounded to the nearest whole number.
[1] Year type as defined by the Restoration Year Type.
[2] Low = full quantity of recaptured Interim and Restoration flows is successfully recirculated to Friant Division long-term contractors. The increase in groundwater pumping due to reoperating Friant Dam would be relatively low, and corresponding change in groundwater depth would be small.
[3] Simulation period: October 1921 – September 2003.
[4] (%) indicates percent change from existing conditions.
[5] (%) indicates percent change from No-Action Alternative. CalSim II simulation period: October 1921 – September 2003.
[6] Alt A – Low = full return of Interim and Restoration flows by Delta pumping.
[7] Alt B – Low = full return of Interim and Restoration flows by Delta pumping and full return of San Joaquin River exchange flows.
[8] Alt C – Low = full return of Interim and Restoration flows by Delta pumping, full return of San Joaquin River exchange flows, and full return of San Joaquin River pumping.

Key:
Alt = Alternative
ID = Irrigation District
MUD = Municipal Utilities District
TAF = thousand acre-feet
WD = Water District
WSD = Water Storage District

Table 12-18.
Average Annual Simulated Groundwater Pumping of All Restoration Year Types Used in Schmidt Tool Calculations – High[1,2]

District	Existing Level (2005)[3]				Future Level (2030)[3]			
	Existing Conditions (TAF)	Alt A[4,6] (TAF)	Alt B[4,7] (TAF)	Alt C[4,8] (TAF)	No-Action Alt[4] (TAF)	Alt A[5,6] (TAF)	Alt B[5,7] (TAF)	Alt C[5,8] (TAF)
Arvin-Edison WSD	186	214 (15%)	214 (15%)	213 (15%)	186 (0%)	214 (15%)	214 (15%)	213 (14%)
Chowchilla WD	93	109 (17%)	108 (16%)	107 (15%)	93 (0%)	109 (17%)	108 (16%)	107 (15%)
Delano-Earlimart ID	26	36 (39%)	35 (36%)	33 (29%)	26 (0%)	36 (39%)	35 (35%)	32 (24%)
Exeter ID	20	22 (10%)	22 (10%)	22 (9%)	20 (0%)	22 (10%)	22 (10%)	22 (8%)
Ivanhoe ID	16	17 (6%)	17 (6%)	17 (5%)	16 (0%)	17 (6%)	17 (5%)	17 (4%)
Lindmore ID	34	37 (9%)	37 (8%)	36 (6%)	34 (0%)	37 (9%)	37 (8%)	36 (5%)
Lindsay-Strathmore ID	7	8 (14%)	8 (11%)	7 (4%)	7 (0%)	8 (14%)	8 (10%)	7 (-1%)
Lower Tule River ID	134	157 (17%)	156 (17%)	155 (16%)	134 (0%)	157 (17%)	156 (16%)	154 (15%)
Madera ID	153	172 (12%)	171 (12%)	170 (11%)	153 (0%)	172 (12%)	171 (12%)	169 (10%)
Orange Cove ID	41	42 (3%)	42 (3%)	41 (1%)	41 (0%)	42 (3%)	42 (2%)	41 (0%)
Porterville ID	23	26 (14%)	26 (13%)	26 (12%)	23 (0%)	26 (14%)	26 (13%)	26 (11%)
Saucelito ID	15	19 (24%)	18 (23%)	18 (20%)	15 (0%)	19 (24%)	18 (22%)	18 (19%)
Shafter-Wasco ID	55	60 (9%)	60 (9%)	59 (7%)	55 (0%)	60 (9%)	60 (8%)	58 (6%)
Southern San Joaquin MUD	49	57 (16%)	56 (14%)	54 (11%)	49 (0%)	57 (16%)	56 (14%)	53 (8%)
Tulare ID	137	150 (10%)	150 (9%)	149 (9%)	137 (0%)	150 (10%)	150 (9%)	149 (9%)

Source: Input to Schmidt Tool Calculations

Table 12-18. Average Annual Simulated Groundwater Pumping of All Restoration Year Types Used in Schmidt Tool Calculations – High[1,2] (contd.)

Notes:

All results are rounded to the nearest whole number.

[1] Year type as defined by the Restoration Year Type.

[2] High = no water released as Interim and Restoration flows is recirculated to Friant Division long-term contractors. The increase in groundwater pumping due to reoperating Friant Dam would be relatively high.

[3] Simulation period: October 1921 – September 2003.

[4] (%) indicates percent change from existing conditions.

[5] (%) indicates percent change from No-Action Alternative. CalSim II simulation period: October 1921 – September 2003.

[6] Alt A – High = no return of Interim and Restoration flows by Delta pumping.

[7] Alt B – High = no return of Interim and Restoration flows by Delta pumping and full return of San Joaquin River exchange flows.

[8] Alt C – High = no return of Interim and Restoration flows by Delta pumping, full return of San Joaquin River exchange flows, and full return of San Joaquin River pumping.

Key:

Alt = Alternative
ID = Irrigation District
MUD = Municipal Utilities District
TAF = thousand acre-feet
WD = Water District
WSD = Water Storage District

Table 12-19.
Average Annual Groundwater Depth of All Restoration Year Types Using Schmidt Tool – High[1,2]

District	Existing Level (2005)[3]				Future Level (2030)[3]			
	Existing Conditions (feet)	Alt A[4,6] (feet)	Alt B[4,7] (feet)	Alt C[4,8] (feet)	No-Action Alt[4] (feet)	Alt A[5,6] (feet)	Alt B[5,7] (feet)	Alt C[5,8] (feet)
Arvin-Edison WSD	410	603 (47%)	601 (47%)	596 (45%)	410 (0%)	603 (47%)	600 (46%)	593 (45%)
Chowchilla WD	245	303 (24%)	301 (23%)	297 (21%)	245 (0%)	303 (24%)	301 (23%)	295 (20%)
Delano-Earlimart ID	193	264 (37%)	258 (34%)	244 (27%)	193 (0%)	264 (37%)	256 (33%)	236 (22%)
Exeter ID	90	132 (46%)	130 (44%)	126 (40%)	90 (0%)	132 (46%)	129 (44%)	123 (37%)
Ivanhoe ID	108	124 (15%)	123 (15%)	121 (12%)	108 (0%)	124 (15%)	123 (14%)	119 (11%)
Lindmore ID	95	144 (51%)	140 (47%)	130 (37%)	95 (0%)	144 (51%)	139 (46%)	124 (31%)
Lindsay-Strathmore ID	53	62 (18%)	60 (14%)	55 (5%)	52 (0%)	62 (18%)	59 (13%)	52 (-1%)
Lower Tule River ID	238	298 (25%)	296 (25%)	293 (24%)	238 (0%)	298 (25%)	296 (25%)	292 (23%)
Madera ID	246	259 (6%)	259 (5%)	258 (5%)	246 (0%)	259 (6%)	259 (5%)	257 (5%)
Orange Cove ID	33	103 (217%)	88 (172%)	51 (57%)	32 (0%)	103 (217%)	83 (156%)	29 (-12%)
Porterville ID	73	141 (95%)	139 (91%)	132 (82%)	73 (0%)	141 (94%)	138 (90%)	128 (77%)
Saucelito ID	208	269 (30%)	266 (28%)	259 (25%)	208 (0%)	269 (30%)	265 (28%)	255 (23%)
Shafter-Wasco ID	403	451 (12%)	448 (11%)	439 (9%)	403 (0%)	451 (12%)	447 (11%)	434 (8%)
Southern San Joaquin MUD	243	248 (2%)	248 (2%)	246 (2%)	243 (0%)	248 (2%)	248 (2%)	246 (1%)
Tulare ID	223	296 (33%)	295 (32%)	292 (31%)	223 (0%)	296 (33%)	294 (32%)	290 (30%)

Source: Schmidt Tool Calculations

Table 12-19.
Average Annual Groundwater Depth of All Restoration Year Types Using Schmidt Tool – High[1,2] (contd.)

Notes:
All results are rounded to the nearest whole number.
[1] Year type as defined by the Restoration Year Type.
[2] High = no water released as Interim and Restoration flows is recirculated to Friant Division long-term contractors. The increase in groundwater pumping due to reoperating Friant Dam would be relatively high, and corresponding change in groundwater depth would be large.
[3] Simulation period: October 1921 – September 2003.
[4] (%) indicates percent change from existing conditions.
[5] (%) indicates percent change from No-Action Alternative. CalSim II simulation period: October 1921 – September 2003.
[6] Alt A – High = no return of Interim and Restoration flows by Delta pumping.
[7] Alt B – High = no return of Interim and Restoration flows by Delta pumping and full return of San Joaquin River exchange flows.
[8] Alt C – High = no return of Interim and Restoration flows by Delta pumping, full return of San Joaquin River exchange flows, and full return of San Joaquin River pumping.

Key:
Alt = Alternative
ID = Irrigation District
MUD = Municipal Utilities District
TAF = thousand acre-feet
WD = Water District
WSD = Water Storage District

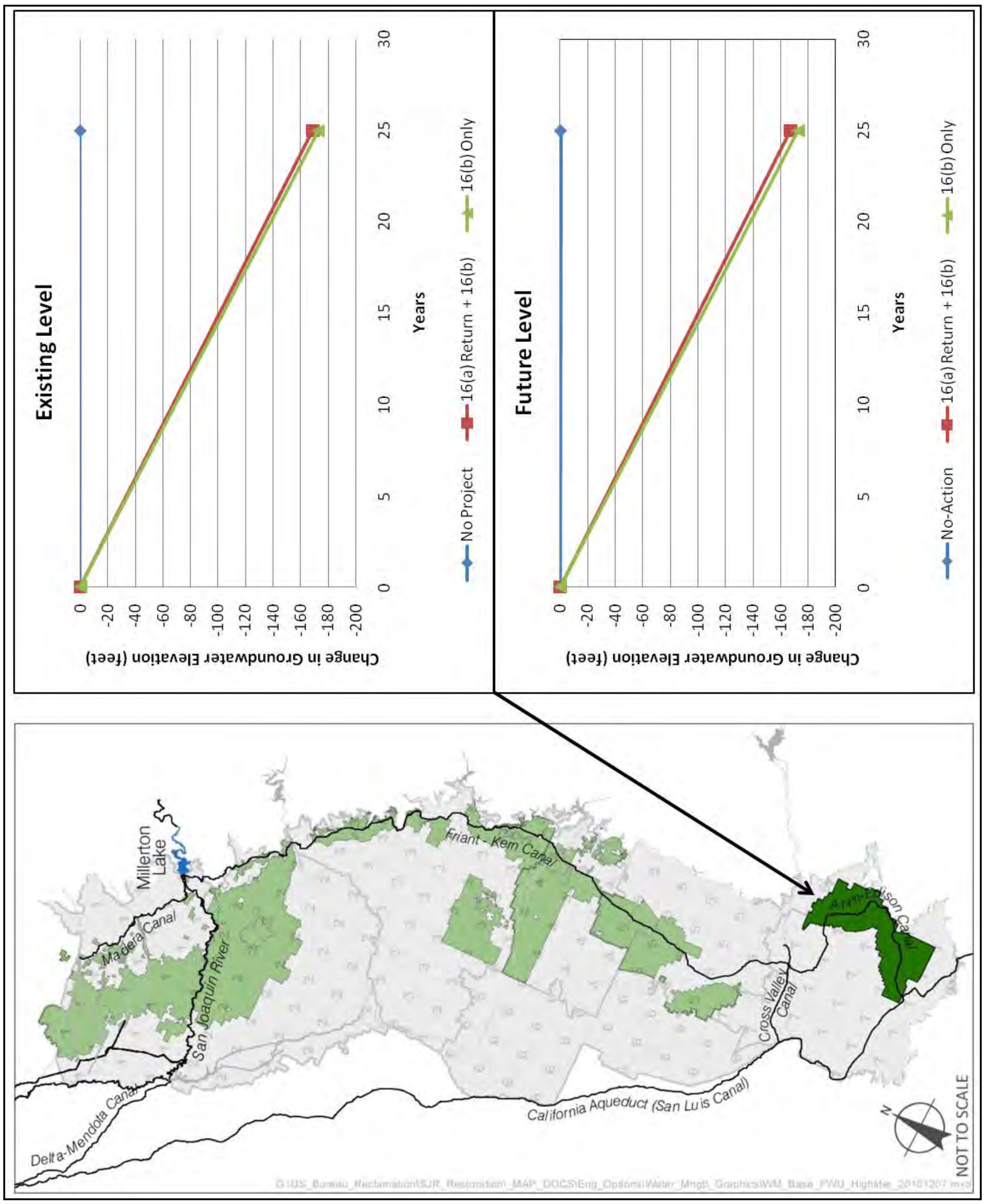

Figure 12-19.
Average Annual Change in Groundwater Depth for Arvin-Edison Water Storage District Using Schmidt Tool

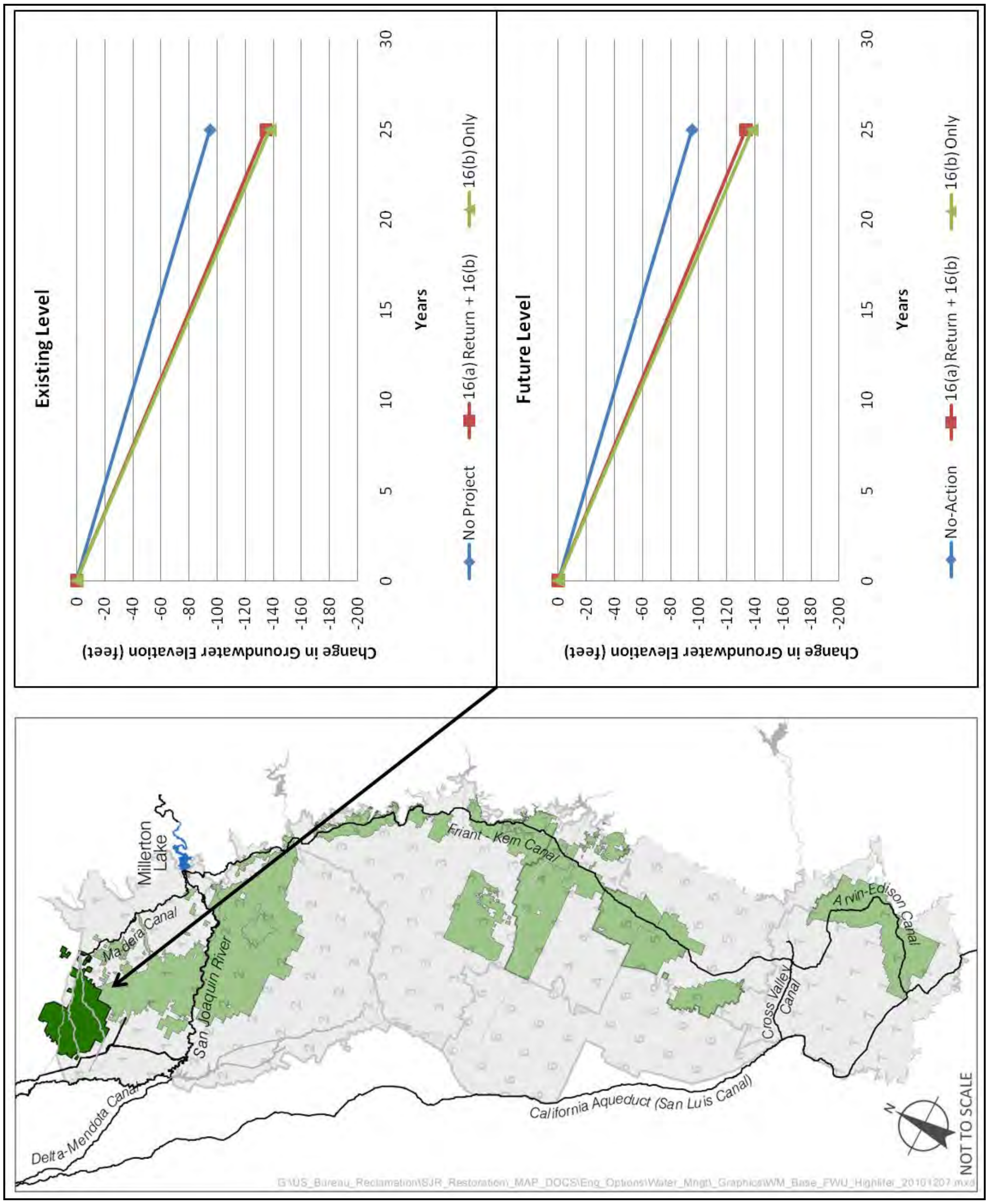

Figure 12-20.
Average Annual Change in Groundwater Depth for Chowchilla Water District Using Schmidt Tool

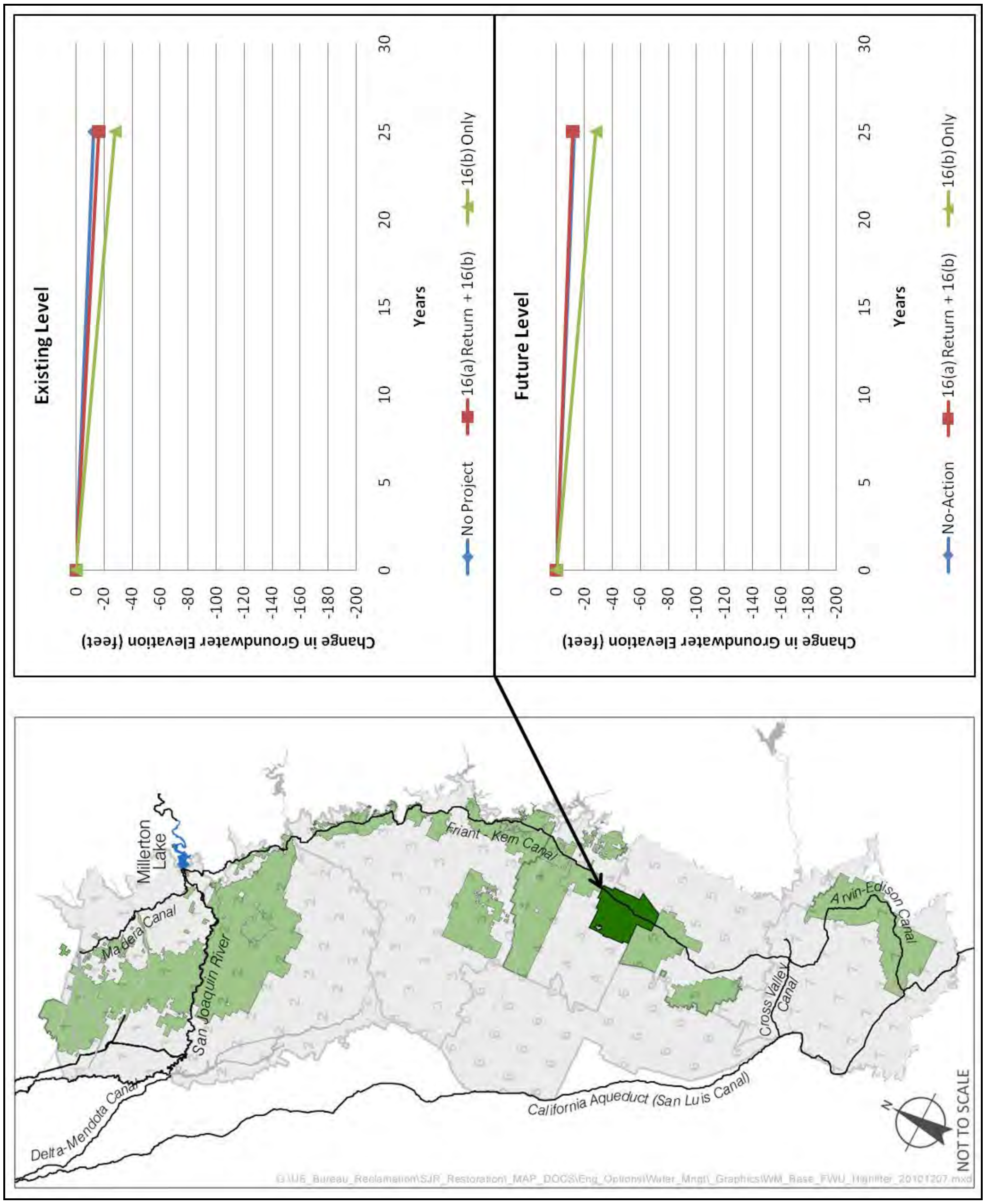

Figure 12-21.
Average Annual Change in Groundwater Depth for Delano-Earlimart Irrigation District Using Schmidt Tool

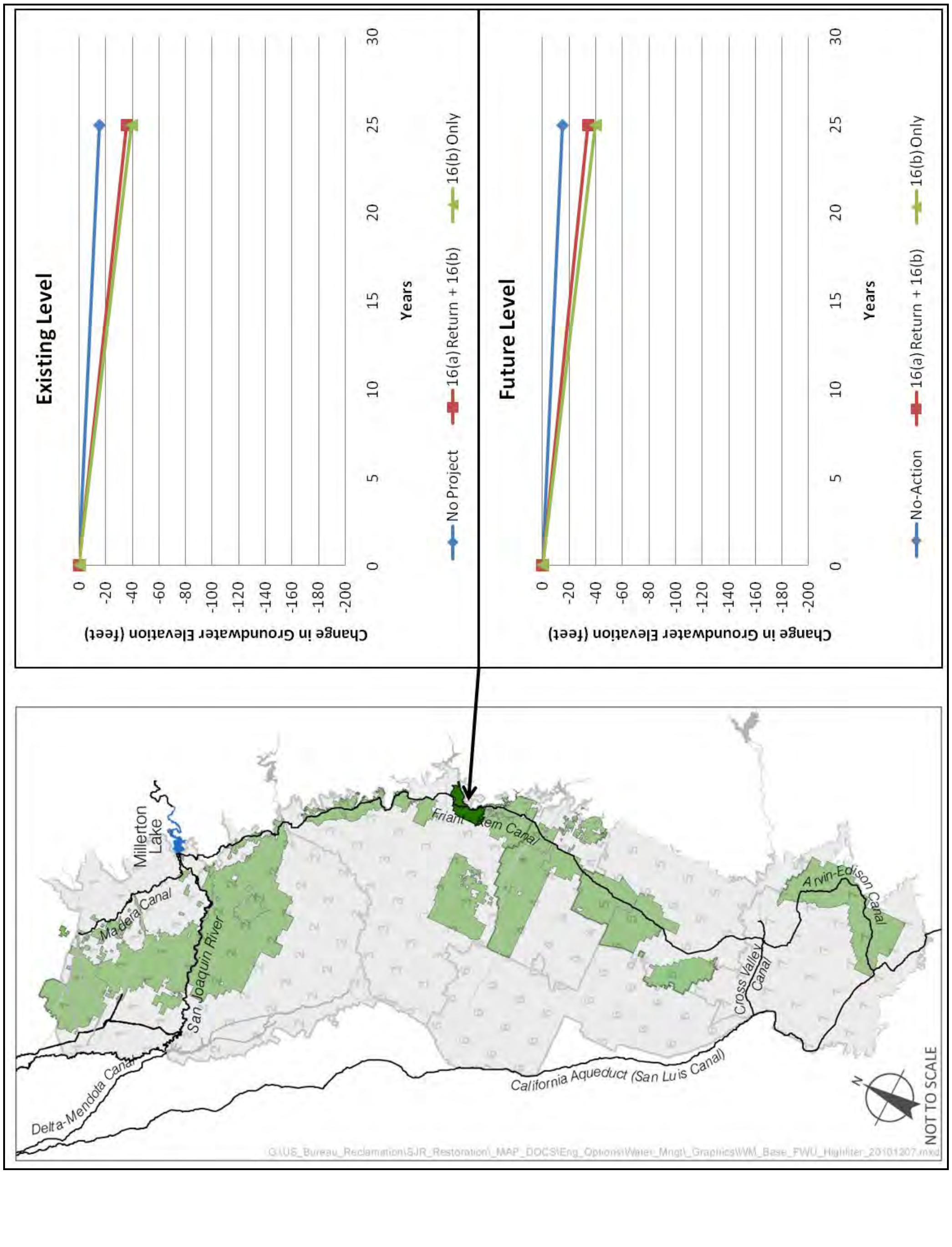

Figure 12-22.
Average Annual Change in Groundwater Depth for Exeter Irrigation District Using Schmidt Tool

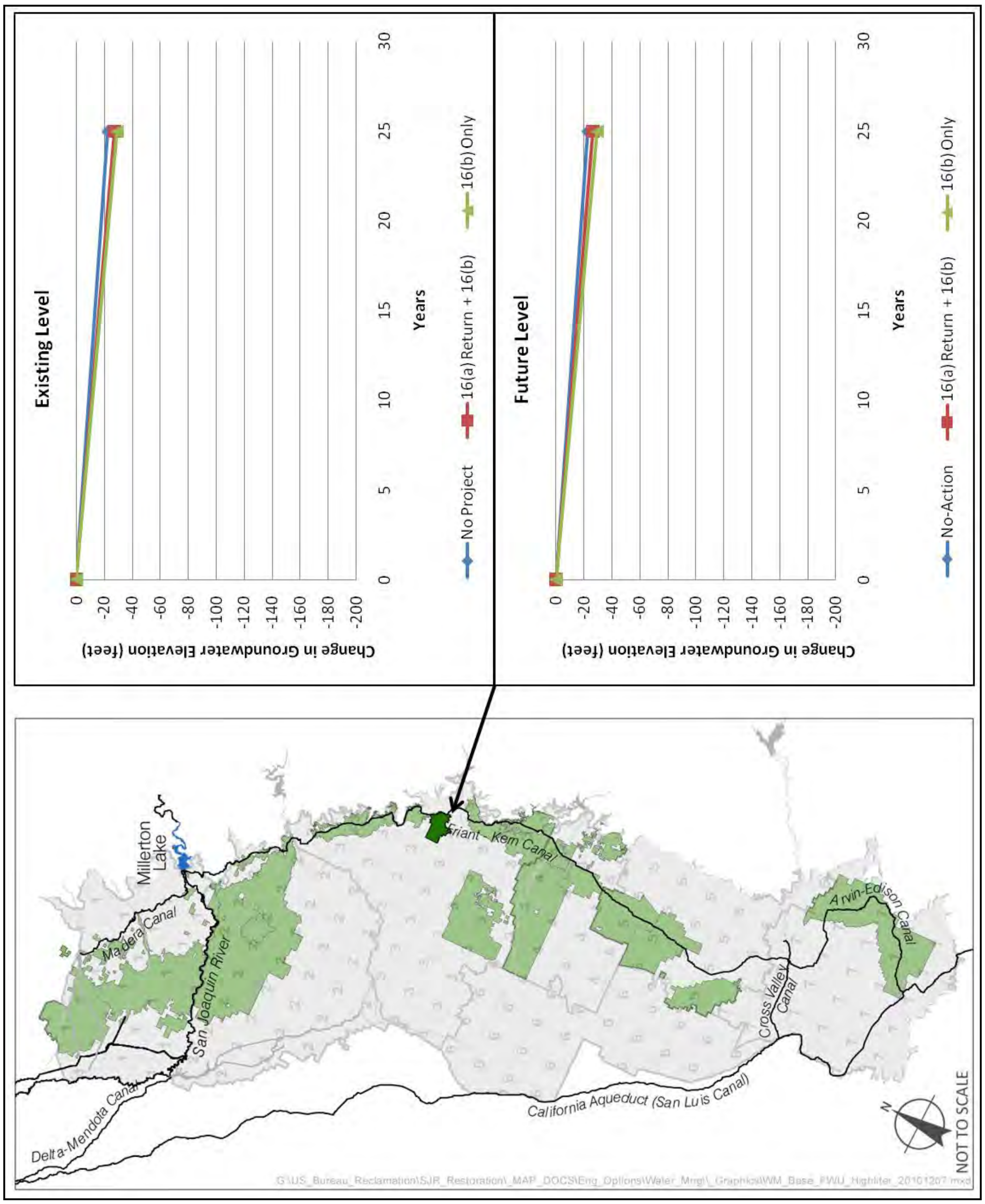

Figure 12-23.
Average Annual Change in Groundwater Depth for Ivanhoe Irrigation District Using Schmidt Tool

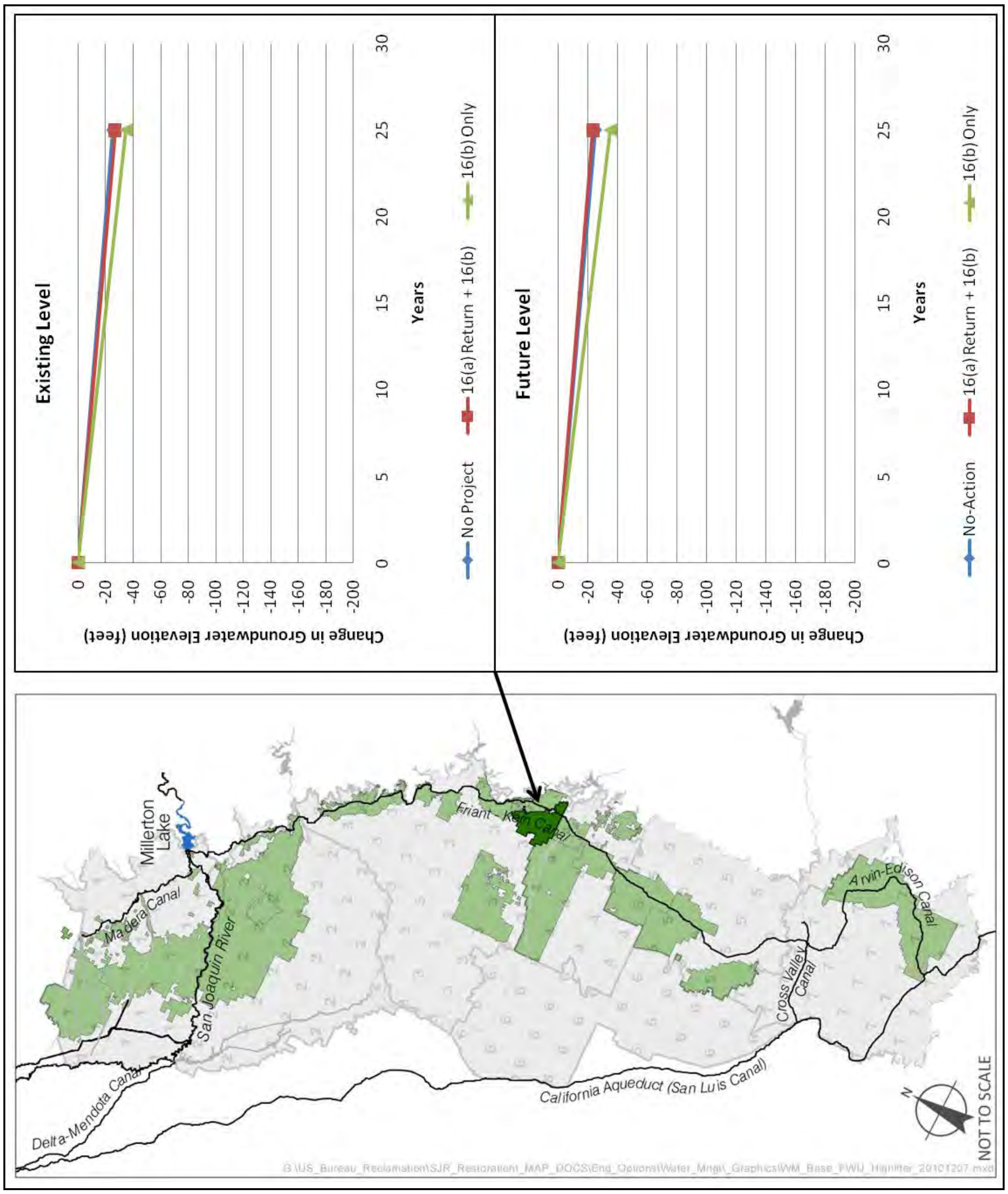

Figure 12-24.
Average Annual Change in Groundwater Depth for Lindmore Irrigation District Using Schmidt Tool

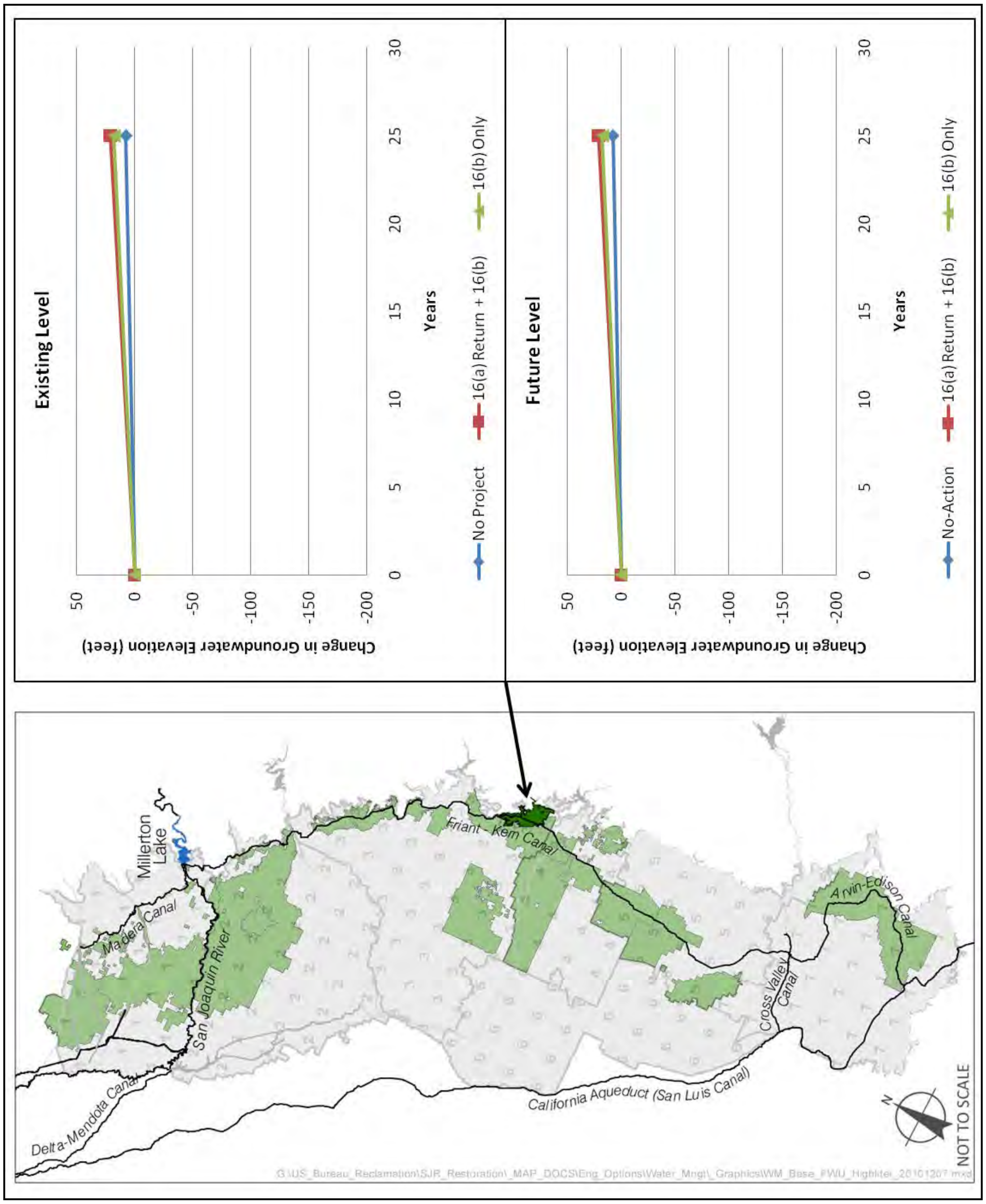

Figure 12-25.
Average Annual Change in Groundwater Depth for Lindsay-Strathmore Irrigation District Using Schmidt Tool

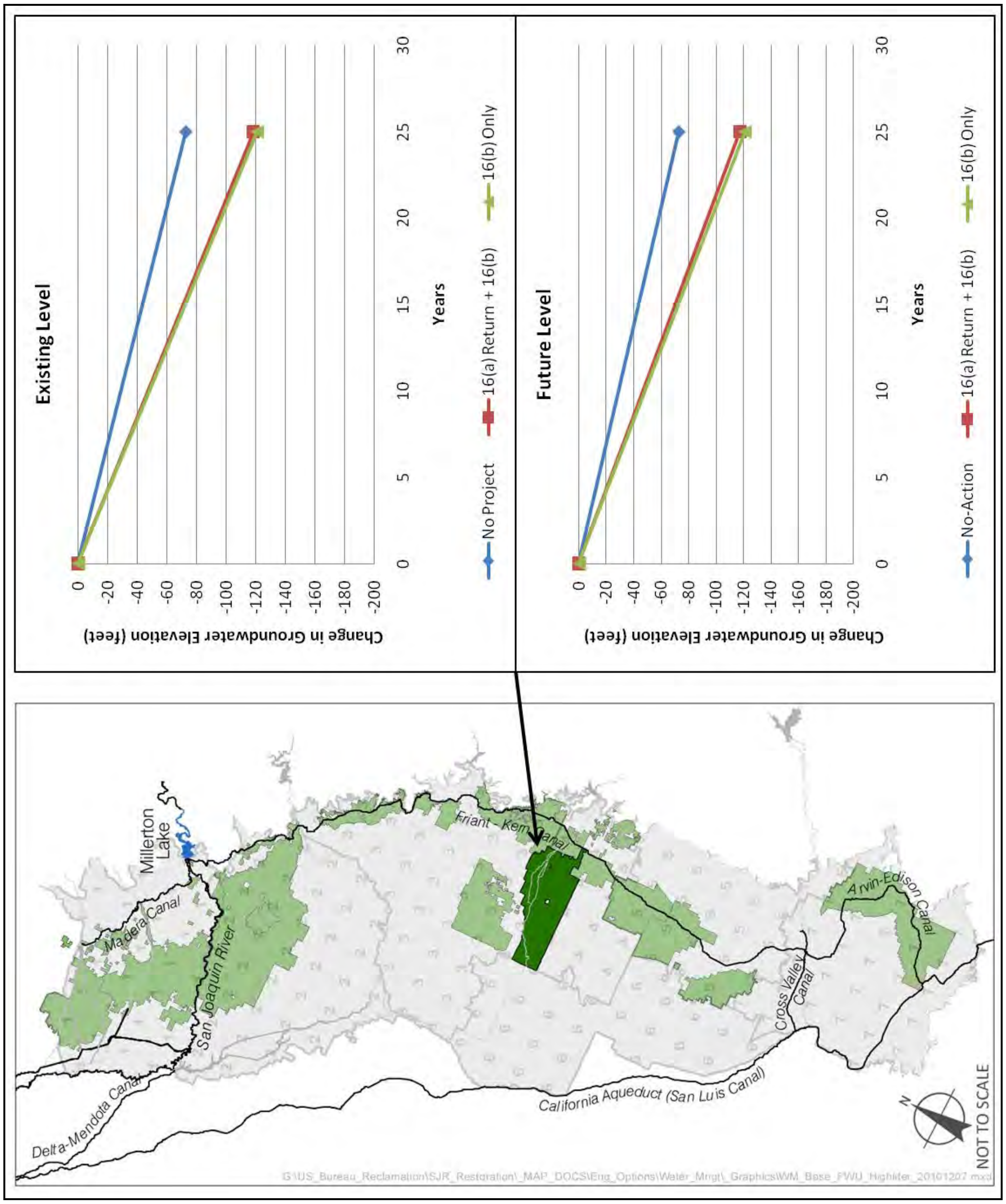

Figure 12-26.
Average Annual Change in Groundwater Depth for Lower Tule River Irrigation District Using Schmidt Tool

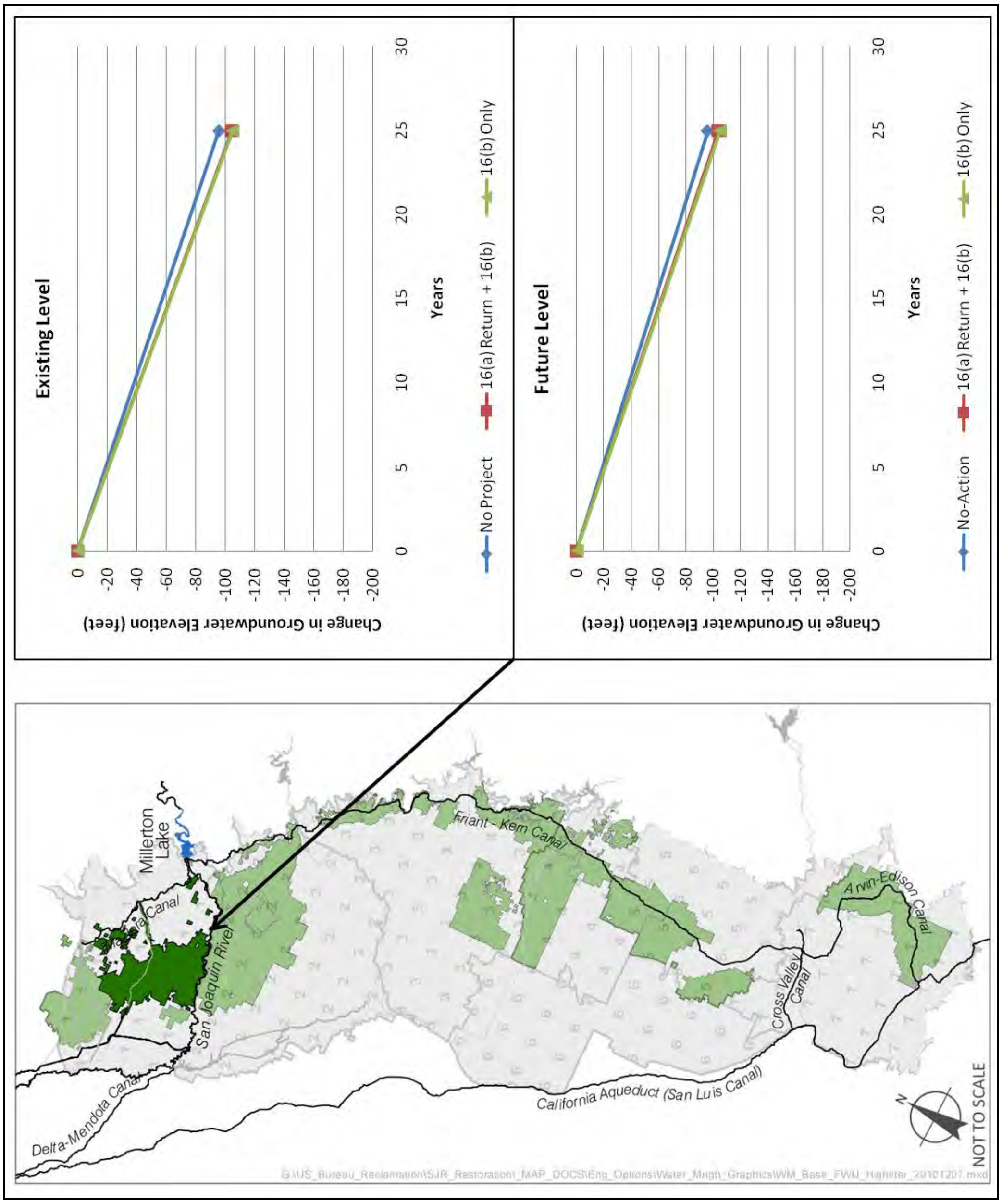

Figure 12-27.
Average Annual Change in Groundwater Depth for Madera Irrigation District Using Schmidt Tool

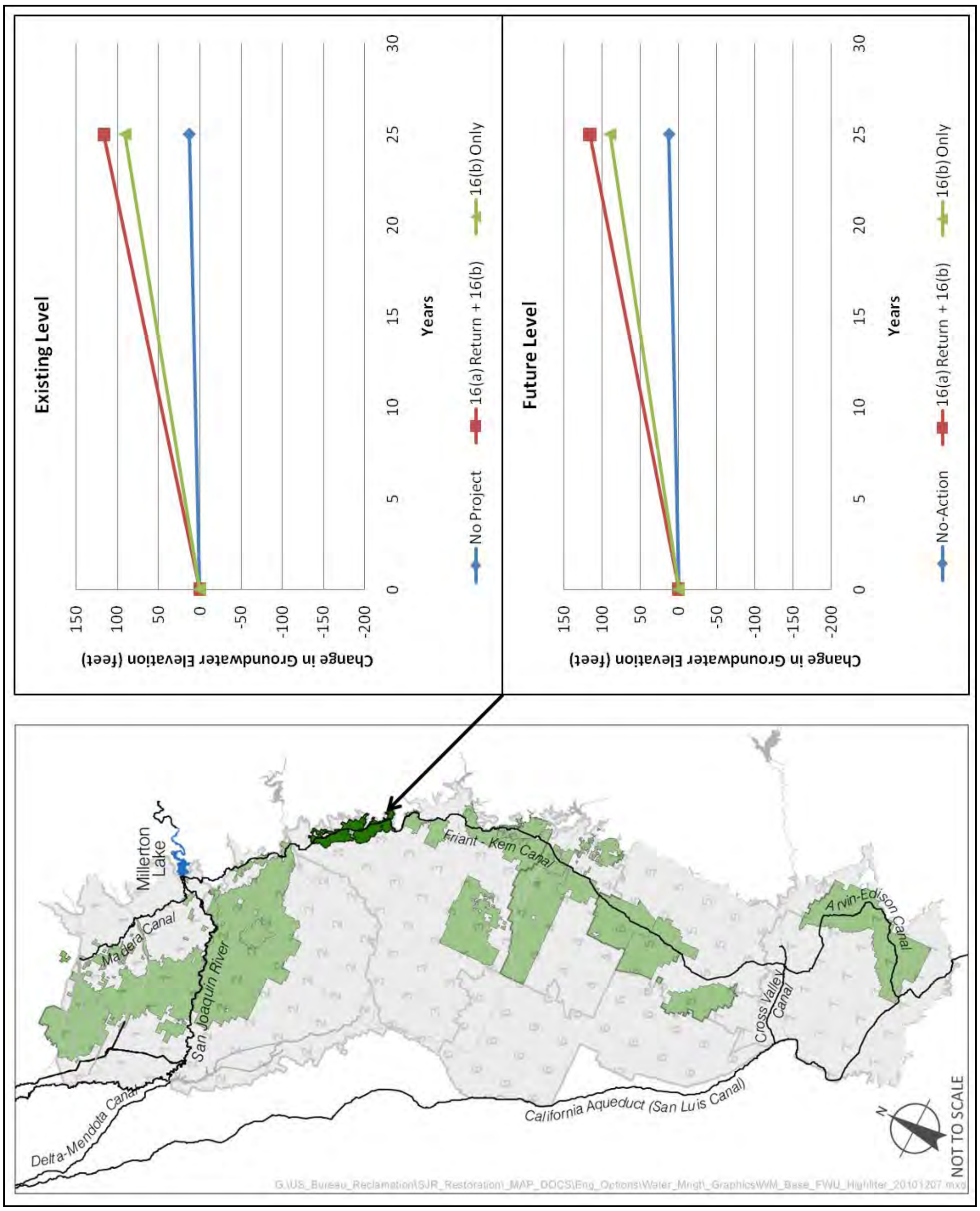

Figure 12-28.
Average Annual Change in Groundwater Depth for Orange Cove Irrigation District Using Schmidt Tool

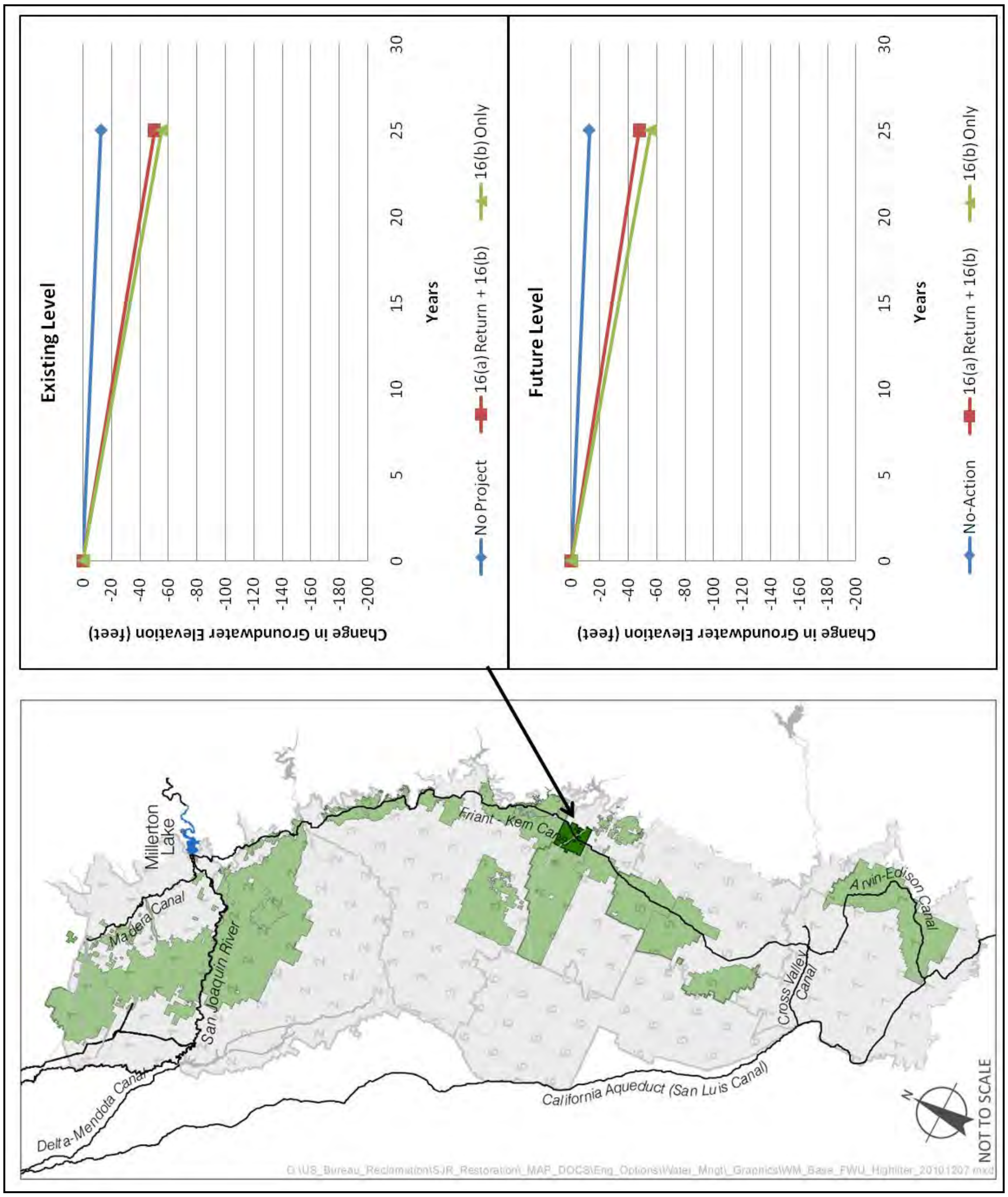

Figure 12-29.
Average Annual Change in Groundwater Depth for Porterville Irrigation District Using Schmidt Tool

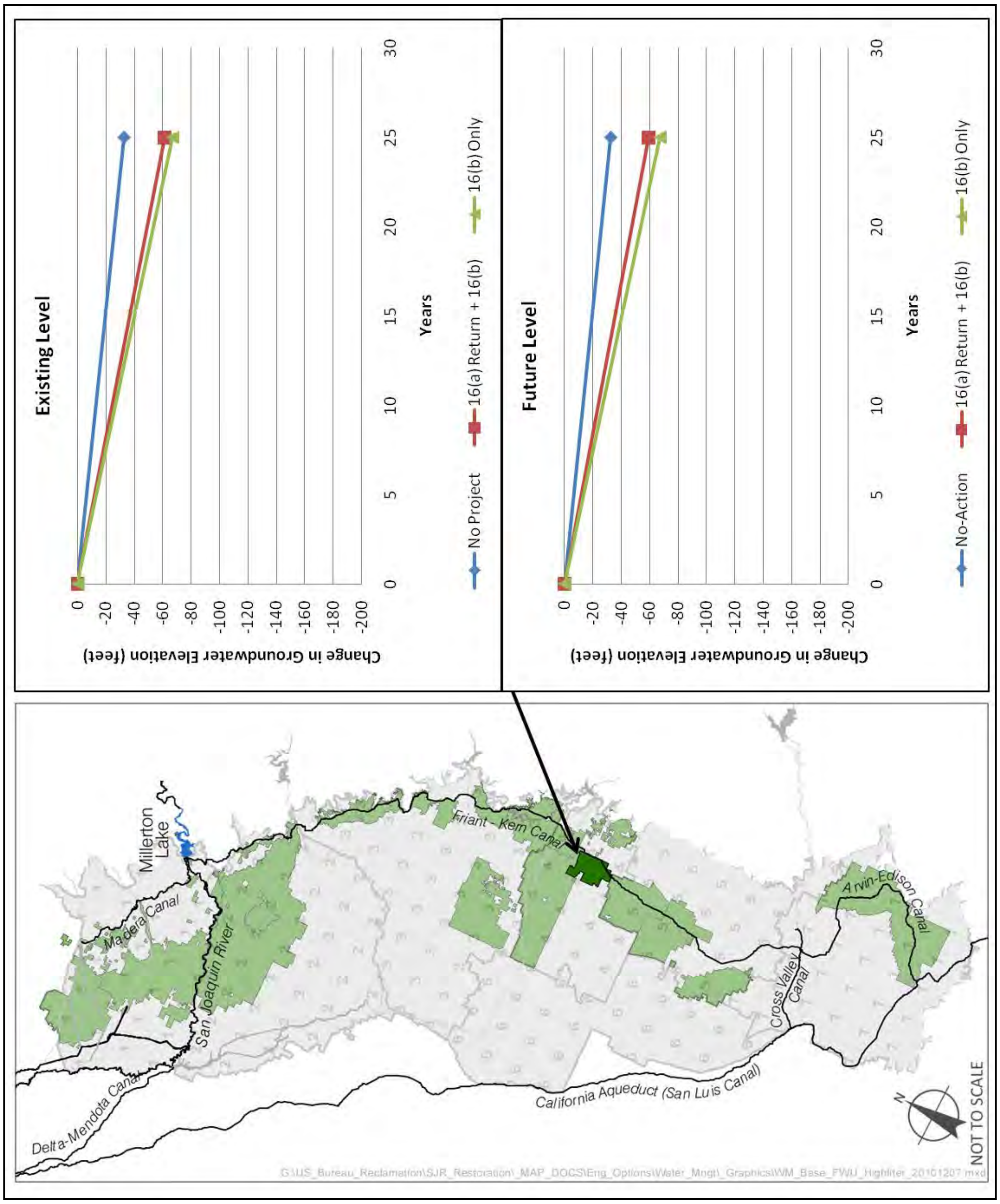

Figure 12-30.
Average Annual Change in Groundwater Depth for Saucelito Irrigation District Using Schmidt Tool

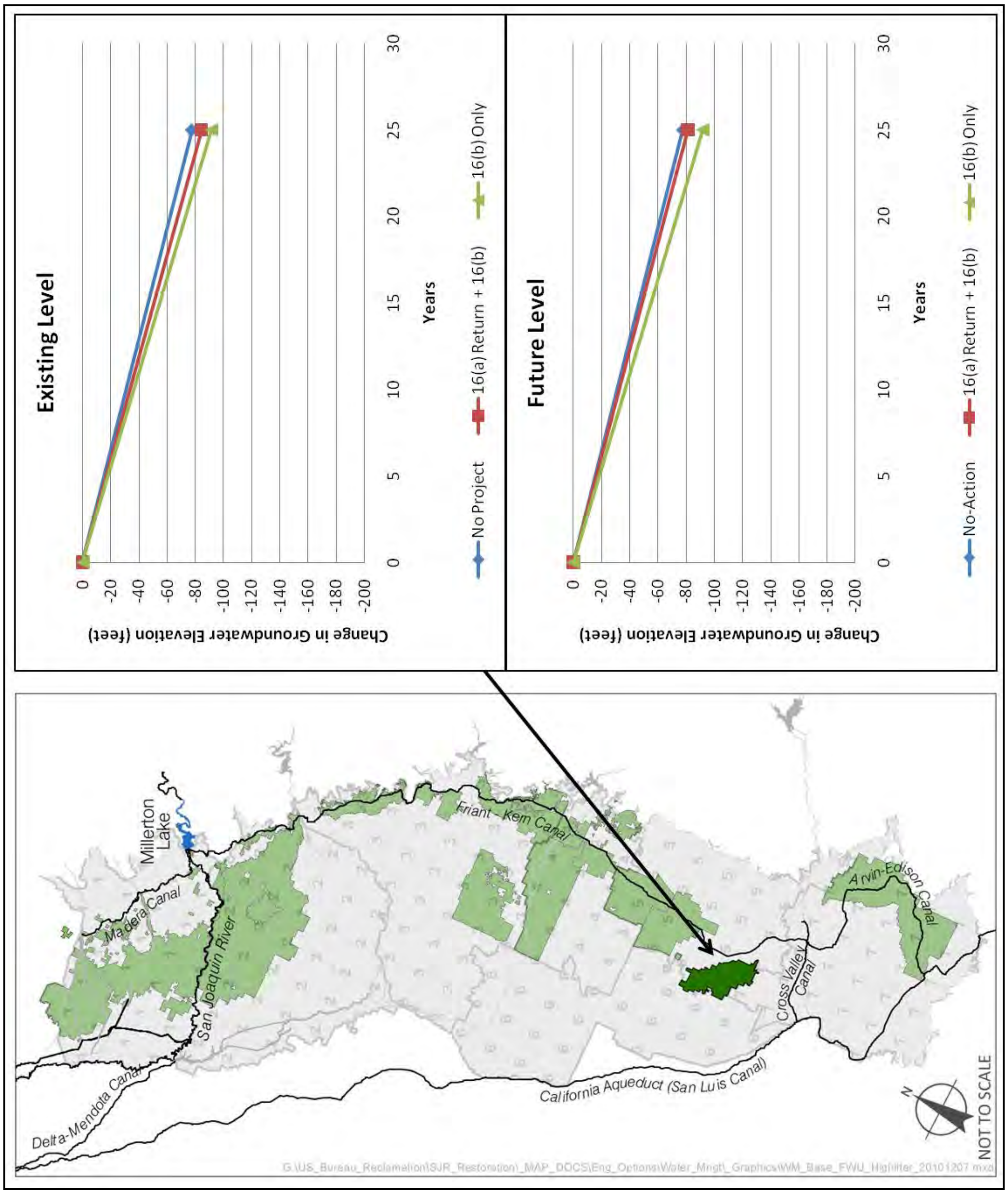

Figure 12-31.
Average Annual Change in Groundwater Depth for Shafter-Wasco Irrigation District Using Schmidt Tool

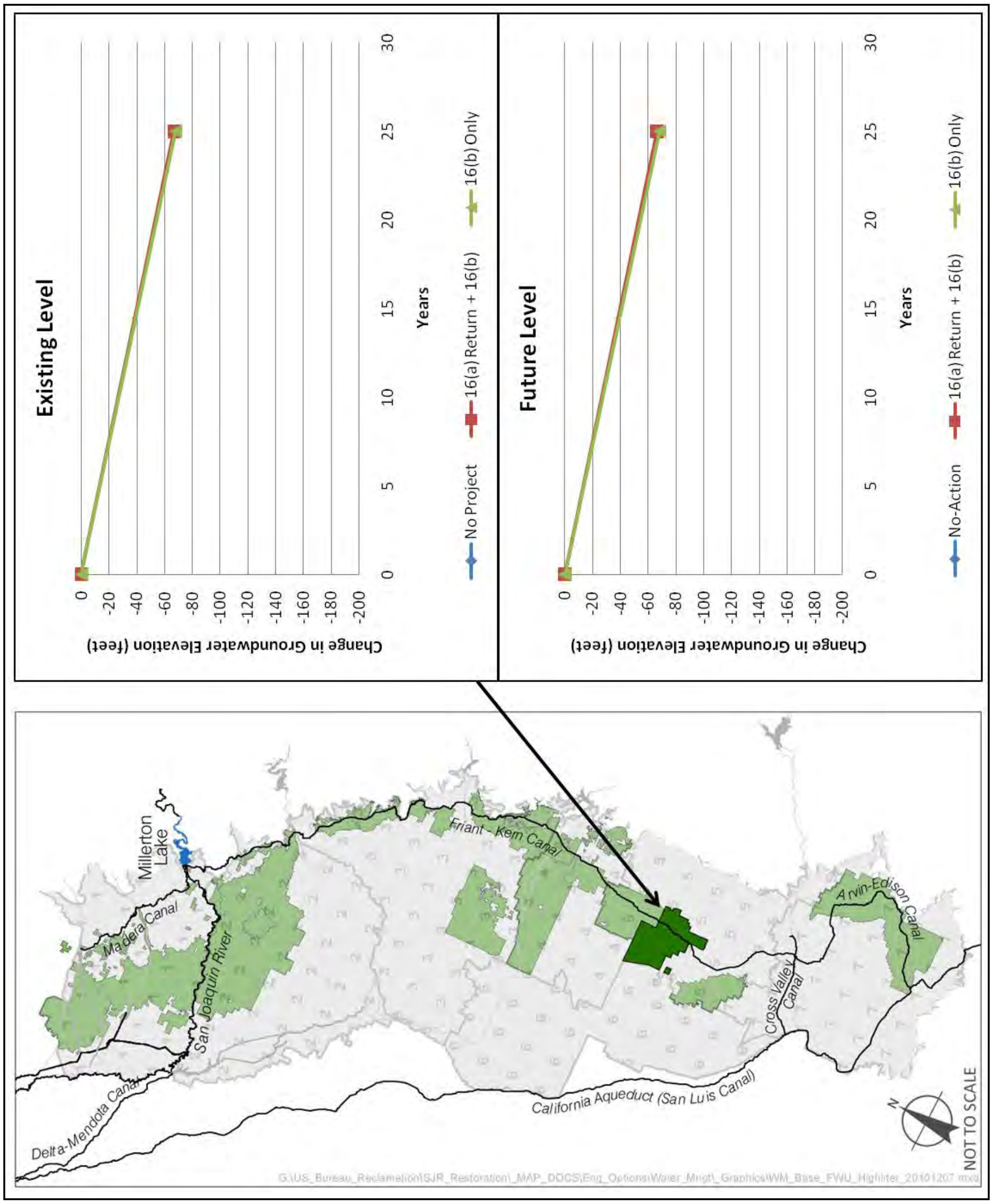

Figure 12-32.
Average Annual Change in Groundwater Depth for Southern San Joaquin Municipal Utility District Using Schmidt Tool

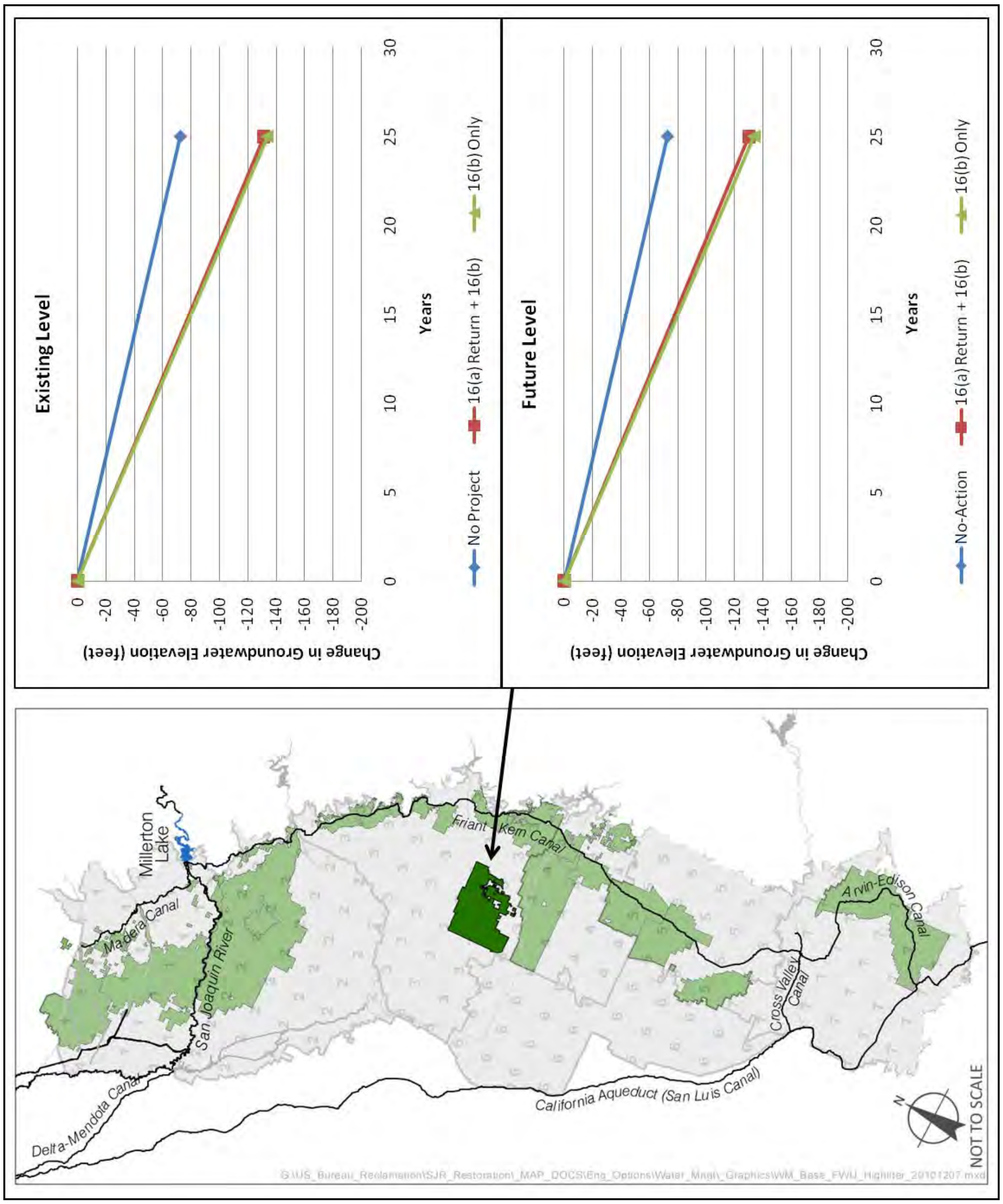

Figure 12-33.
Average Annual Change in Groundwater Depth for Tulare Irrigation District Using Schmidt Tool

Table 12-20.
Change in Average Annual Simulated Groundwater Pumping of All Restoration Year Types Used In Mass Balance Calculations – Low[1,2]

District	Existing Conditions (TAF)	Existing Level (2005)[3] Alt A[4,6] (TAF)	Existing Level (2005)[3] Alt B[4,7] (TAF)	Existing Level (2005)[3] Alt C[4,8] (TAF)	Future Level (2030)[3] No-Action Alt[4] (TAF)	Future Level (2030)[3] Alt A[5,6] (TAF)	Future Level (2030)[3] Alt B[5,7] (TAF)	Future Level (2030)[3] Alt C[5,8] (TAF)
City of Fresno	NA	-2 (-4%)	-2 (-4%)	-3 (-5%)	0 (0%)	-2 (-4%)	-2 (-4%)	-3 (-5%)
City of Lindsay	NA	0 (-4%)	0 (-4%)	0 (-5%)	0 (0%)	0 (-4%)	0 (-4%)	0 (-5%)
City of Orange Cove	NA	0 (-4%)	0 (-4%)	0 (-5%)	0 (0%)	0 (-4%)	0 (-4%)	0 (-5%)
Fresno County Waterworks District No. 18	NA	0 (-4%)	0 (-4%)	0 (-5%)	0 (0%)	0 (-4%)	0 (-4%)	0 (-5%)
Fresno ID	NA	6 (36%)	6 (36%)	6 (36%)	0 (0%)	6 (36%)	6 (36%)	6 (36%)
Garfield WD	NA	0 (36%)	0 (36%)	0 (36%)	0 (0%)	0 (36%)	0 (36%)	0 (36%)
Gravelly Ford WD	NA	1 (36%)	1 (36%)	1 (36%)	0 (0%)	1 (36%)	1 (36%)	1 (36%)
International WD	NA	0 (-4%)	0 (-4%)	0 (-5%)	0 (0%)	0 (-4%)	0 (-4%)	0 (-5%)
Lewis Creek WD	NA	0 (-4%)	0 (-4%)	0 (-5%)	0 (0%)	0 (-4%)	0 (-4%)	0 (-5%)
Madera County (Hidden Lake Estates)	NA	0 (-4%)	0 (-4%)	0 (-5%)	0 (0%)	0 (-4%)	0 (-4%)	0 (-5%)
Stone Corral ID	NA	0 (-4%)	0 (-4%)	-1 (-5%)	0 (0%)	0 (-4%)	0 (-4%)	-1 (-5%)
Tea Pot Dome WD	NA	0 (-4%)	0 (-4%)	0 (-5%)	0 (0%)	0 (-4%)	0 (-4%)	0 (-5%)
Terra Bella ID	NA	-1 (-4%)	-1 (-4%)	-1 (-5%)	0 (0%)	-1 (-4%)	-1 (-4%)	-1 (-5%)

Inputs to Mass Balance Method Calculations

Table 12-20.
Average Annual Simulated Groundwater Pumping of All Restoration Year Types Used In Mass Balance Calculations – Low[1,2] (contd.)

Notes:
All results are rounded to the nearest whole number.
[1] Year type as defined by the Restoration Year Type.
[2] High = no water released as Interim and Restoration flows is recirculated to Friant Division long-term contractors. The increase in groundwater pumping due to reoperating Friant Dam would be relatively high, and corresponding change in groundwater depth would be large.
[3] Simulation period: October 1921 – September 2003.
[4] (%) indicates percent change from existing conditions.
[5] (%) indicates percent change from No-Action Alternative. CalSim II simulation period: October 1921 – September 2003.
[6] Alt A – High = no return of Interim and Restoration flows by Delta pumping.
[7] Alt B – High = no return of Interim and Restoration flows by Delta pumping and full return of San Joaquin River exchange flows.
[8] Alt C – High = no return of Interim and Restoration flows by Delta pumping, full return of San Joaquin River exchange flows, and full return of San Joaquin River pumping.
Key:
Alt = Alternative
ID = Irrigation District
TAF = thousand acre-feet
WD = Water District

Table 12-21.
Average Annual Simulated Groundwater Depth of All Restoration Year Types Using Mass Balance Method – Low[1,2]

District	Existing Level (2005)[3]				Future Level (2030)[3]			
	Existing Conditions (feet)	Alt A[4,6] (feet)	Alt B[4,7] (feet)	Alt C[4,8] (feet)	No-Action Alt[4] (feet)	Alt A[5,6] (feet)	Alt B[5,7] (feet)	Alt C[5,8] (feet)
City of Fresno	115	114 (0%)	114 (0%)	114 (0%)	115 (0%)	114 (0%)	114 (0%)	114 (0%)
City of Lindsay	53	53 (-1%)	53 (-1%)	52 (-1%)	53 (0%)	53 (-1%)	53 (-1%)	52 (-1%)
City of Orange Cove	27	26 (-2%)	26 (-2%)	26 (-2%)	27 (0%)	26 (-2%)	26 (-2%)	26 (-2%)
Fresno County Waterworks District No. 18	69	69 (0%)	69 (0%)	69 (0%)	69 (0%)	69 (0%)	69 (0%)	69 (0%)
Fresno ID	85	85 (0%)	85 (0%)	85 (0%)	85 (0%)	85 (0%)	85 (0%)	85 (0%)
Garfield WD	160	159 (0%)	159 (0%)	159 (-1%)	160 (0%)	159 (0%)	159 (0%)	159 (-1%)
Gravelly Ford WD	140	141 (1%)	141 (1%)	141 (1%)	140 (0%)	141 (1%)	141 (1%)	141 (1%)
International WD	55	54 (-1%)	54 (-1%)	54 (-1%)	55 (0%)	54 (-1%)	54 (-1%)	54 (-1%)
Lewis Creek WD	55	55 (-1%)	55 (-1%)	54 (-1%)	55 (0%)	55 (-1%)	55 (-1%)	54 (-1%)
Madera County (Hidden Lake Estates)	112	112 (0%)	112 (0%)	112 (-1%)	112 (0%)	112 (0%)	112 (0%)	112 (-1%)
Stone Corral ID	40	39 (-1%)	39 (-1%)	39 (-2%)	40 (0%)	39 (-1%)	40 (-1%)	39 (-2%)
Tea Pot Dome WD	155	154 (-1%)	154 (-1%)	154 (-1%)	155 (0%)	154 (-1%)	154 (-1%)	154 (-1%)
Terra Bella ID	140	139 (-1%)	139 (-1%)	139 (-1%)	140 (0%)	139 (-1%)	139 (-1%)	139 (-1%)

Mass Balance Method Calculations

Table 12-21.
Average Annual Simulated Groundwater Depth of All Restoration Year Types Using Mass Balance Method – Low[1,2] (contd.)

Notes:
All results are rounded to the nearest whole number.
[1] Year type as defined by the Restoration Year Type.
[2] High = no water released as Interim and Restoration flows is recirculated to Friant Division long-term contractors. The increase in groundwater pumping due to reoperating Friant Dam would be relatively high, and corresponding change in groundwater depth would be large.
[3] Simulation period: October 1921 – September 2003.
[4] (%) indicates percent change from existing conditions.
[5] (%) indicates percent change from No-Action Alternative. CalSim II simulation period: October 1921 – September 2003.
[6] Alt A – High = no return of Interim and Restoration flows by Delta pumping.
[7] Alt B – High = no return of Interim and Restoration flows by Delta pumping and full return of San Joaquin River exchange flows.
[8] Alt C – High = no return of Interim and Restoration flows by Delta pumping, full return of San Joaquin River exchange flows, and full return of San Joaquin River pumping.

Key:
Alt = Alternative
ID = Irrigation District
TAF = thousand acre-feet
WD = Water District

Table 12-22.
Change in Average Annual Simulated Groundwater Pumping of All Restoration Year Types Used in Mass Balance Calculations – High[1,2]

District	Existing Level (2005)[3]				Future Level (2030)[3]			
	Existing Conditions (TAF)	Alt A[4,6] (TAF)	Alt B[4,7] (TAF)	Alt C[4,8] (TAF)	No-Action Alt[4] (TAF)	Alt A[5,6] (TAF)	Alt B[5,7] (TAF)	Alt C[5,8] (TAF)
City of Fresno	NA	2 (4%)	2 (3%)	1 (1%)	0 (0%)	2 (4%)	2 (3%)	0 (0%)
City of Lindsay	NA	0 (4%)	0 (3%)	0 (1%)	0 (0%)	0 (4%)	0 (3%)	0 (0%)
City of Orange Cove	NA	0 (4%)	0 (3%)	0 (1%)	0 (0%)	0 (4%)	0 (3%)	0 (0%)
Fresno County Waterworks District No. 18	NA	0 (4%)	0 (3%)	0 (1%)	0 (0%)	0 (4%)	0 (3%)	0 (0%)
Fresno ID	NA	6 (36%)	6 (36%)	6 (36%)	0 (0%)	6 (36%)	6 (36%)	6 (36%)
Garfield WD	NA	0 (36%)	0 (36%)	0 (36%)	0 (0%)	0 (36%)	0 (36%)	0 (36%)
Gravelly Ford WD	NA	1 (36%)	1 (36%)	1 (36%)	0 (0%)	1 (36%)	1 (36%)	1 (36%)
International WD	NA	0 (4%)	0 (3%)	0 (1%)	0 (0%)	0 (4%)	0 (3%)	0 (0%)
Lewis Creek WD	NA	0 (4%)	0 (3%)	0 (1%)	0 (0%)	0 (4%)	0 (3%)	0 (0%)
Madera County (Hidden Lake Estates)	NA	0 (4%)	0 (3%)	0 (1%)	0 (0%)	0 (4%)	0 (3%)	0 (0%)
Stone Corral ID	NA	0 (4%)	0 (3%)	0 (1%)	0 (0%)	0 (4%)	0 (3%)	0 (0%)
Tea Pot Dome WD	NA	0 (4%)	0 (3%)	0 (1%)	0 (0%)	0 (4%)	0 (3%)	0 (0%)
Terra Bella ID	NA	1 (4%)	1 (3%)	0 (1%)	0 (0%)	1 (4%)	1 (3%)	0 (0%)

Inputs to Mass Balance Method Calculations

Table 12-22.
Average Annual Simulated Groundwater Pumping of All Restoration Year Types Used in Mass Balance Calculations – High[1,2] (contd.)

Notes:
All results are rounded to the nearest whole number.
[1] Year type as defined by the Restoration Year Type.
[2] High = no water released as Interim and Restoration flows is recirculated to Friant Division long-term contractors. The increase in groundwater pumping due to reoperating Friant Dam would be relatively high, and corresponding change in groundwater depth would be large.
[3] Simulation period: October 1921 – September 2003.
[4] (%) indicates percent change from existing conditions.
[5] (%) indicates percent change from No-Action Alternative. CalSim II simulation period: October 1921 – September 2003.
[6] Alt A – High = no return of Interim and Restoration flows by Delta pumping.
[7] Alt B – High = no return of Interim and Restoration flows by Delta pumping and full return of San Joaquin River exchange flows.
[8] Alt C – High = no return of Interim and Restoration flows by Delta pumping, full return of San Joaquin River exchange flows, and full return of San Joaquin River pumping.
Key:
Alt = Alternative
ID = Irrigation District
TAF = thousand acre-feet
WD = Water District

Table 12-23.
Average Annual Simulated Groundwater Depth of All Restoration Year Types Using Mass Balance Method – High[1,2]

District	Existing Level (2005)[3]				Future Level (2030)[3]			
	Existing Conditions (feet)	Alt A[4,6] (feet)	Alt B[4,7] (feet)	Alt C[4,8] (feet)	No-Action Alt[4] (feet)	Alt A[5,6] (feet)	Alt B[5,7] (feet)	Alt C[5,8] (feet)
City of Fresno	115	115 (0%)	115 (0%)	115 (0%)	115 (0%)	115 (0%)	115 (0%)	115 (0%)
City of Lindsay	53	54 (1%)	54 (1%)	53 (0%)	53 (0%)	54 (1%)	53 (1%)	53 (0%)
City of Orange Cove	27	27 (2%)	27 (1%)	27 (0%)	27 (0%)	27 (2%)	27 (1%)	27 (0%)
Fresno County Waterworks District No. 18	69	69 (0%)	69 (0%)	69 (0%)	69 (0%)	69 (0%)	69 (0%)	69 (0%)
Fresno ID	85	85 (0%)	85 (0%)	85 (0%)	85 (0%)	85 (0%)	85 (0%)	85 (0%)
Garfield WD	160	161 (0%)	160 (0%)	160 (0%)	160 (0%)	161 (0%)	160 (0%)	160 (0%)
Gravelly Ford WD	140	141 (1%)	141 (1%)	141 (1%)	140 (0%)	141 (1%)	141 (1%)	141 (1%)
International WD	55	56 (1%)	55 (1%)	55 (0%)	55 (0%)	56 (1%)	55 (1%)	55 (0%)
Lewis Creek WD	55	55 (1%)	55 (1%)	55 (0%)	55 (0%)	55 (1%)	55 (0%)	55 (0%)
Madera County (Hidden Lake Estates)	112	113 (0%)	113 (0%)	113 (0%)	112 (0%)	113 (0%)	113 (0%)	112 (0%)
Stone Corral ID	40	40 (1%)	40 (1%)	40 (0%)	40 (0%)	40 (1%)	40 (1%)	40 (0%)
Tea Pot Dome WD	155	156 (0%)	156 (0%)	155 (0%)	155 (0%)	156 (0%)	156 (0%)	155 (0%)
Terra Bella ID	140	141 (1%)	141 (0%)	140 (0%)	140 (0%)	141 (1%)	141 (0%)	140 (0%)

Mass Balance Method Calculations

Table 12-23.
Average Annual Simulated Groundwater Depth of All Restoration Year Types Using Mass Balance Method – High[1,2] (contd.)

Notes:
All results are rounded to the nearest whole number.
[1] Year type as defined by the Restoration Year Type.
[2] High = no water released as Interim and Restoration flows is recirculated to Friant Division long-term contractors. The increase in groundwater pumping due to reoperating Friant Dam would be relatively high, and corresponding change in groundwater depth would be large.
[3] Simulation period: October 1921 – September 2003.
[4] (%) indicates percent change from existing conditions.
[5] (%) indicates percent change from No-Action Alternative. CalSim II simulation period: October 1921 – September 2003.
[6] Alt A – High = no return of Interim and Restoration flows by Delta pumping.
[7] Alt B – High = no return of Interim and Restoration flows by Delta pumping and full return of San Joaquin River exchange flows.
[8] Alt C – High = no return of Interim and Restoration flows by Delta pumping, full return of San Joaquin River exchange flows, and full return of San Joaquin River pumping.

Key:
Alt = Alternative
ID = Irrigation District
TAF = thousand acre-feet
WD = Water District

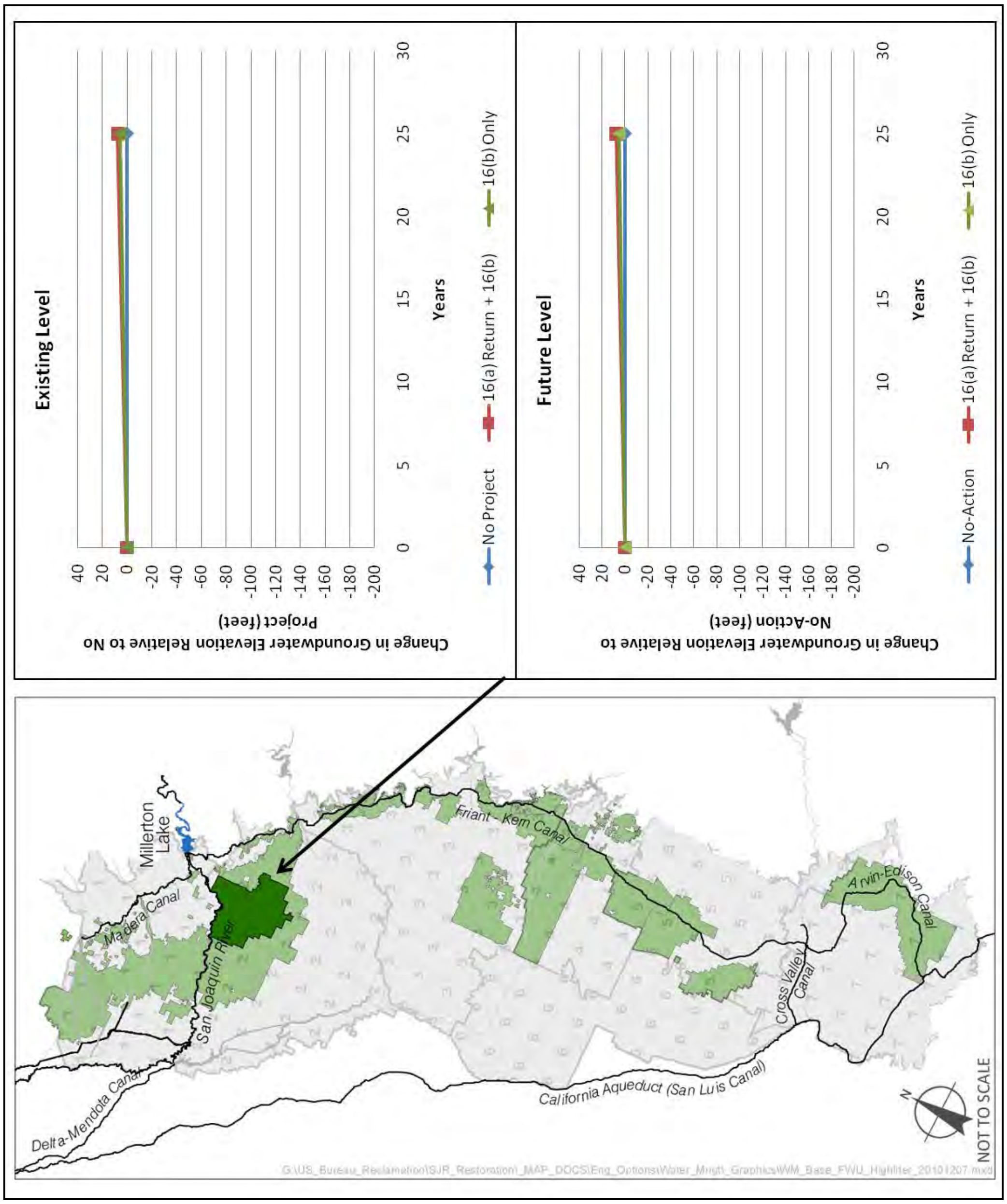

Figure 12-34.
Average Annual Change in Groundwater Depth for City of Fresno Using Mass Balance Method

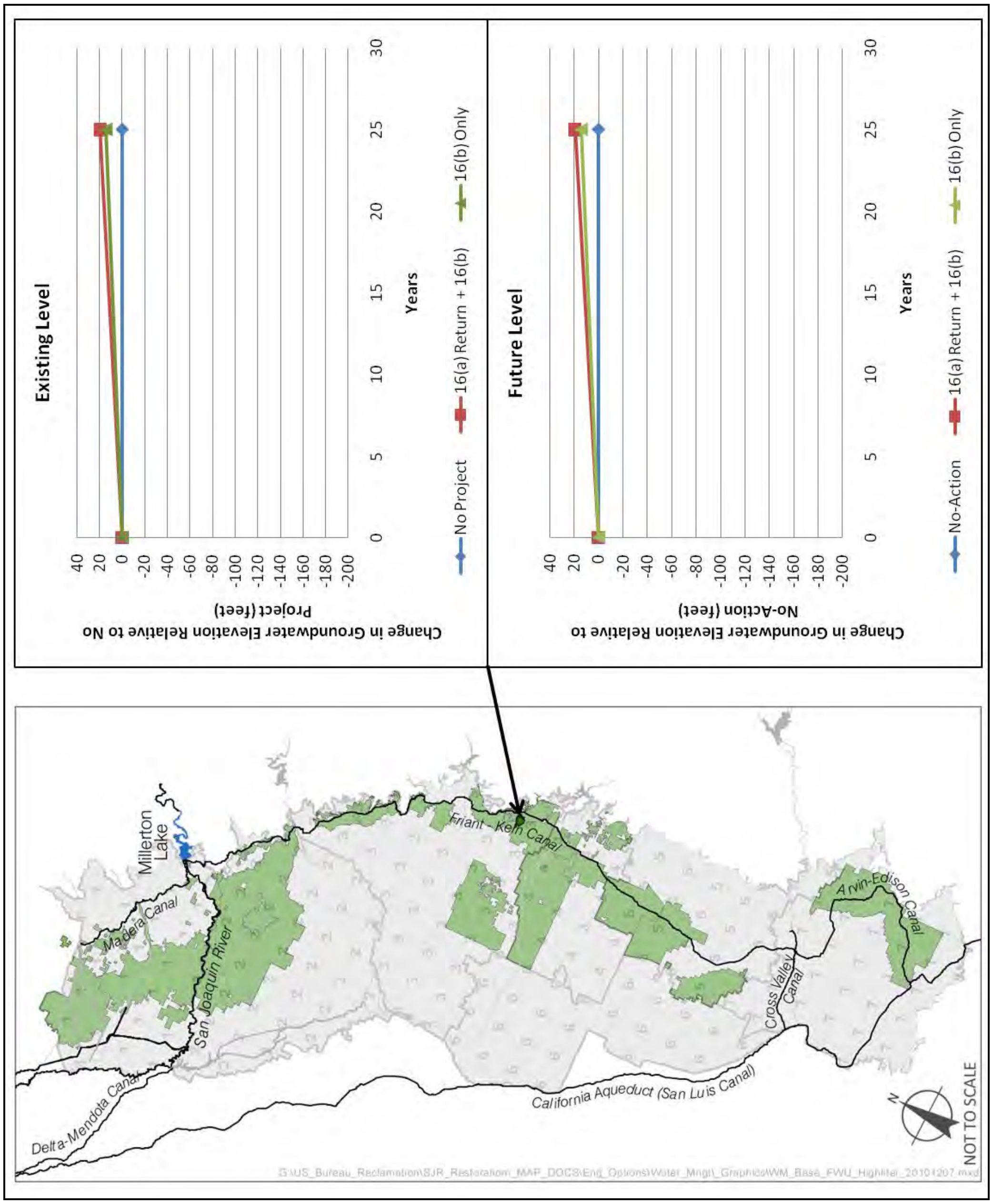

Figure 12-35.
Average Annual Change in Groundwater Depth for City of Lindsay Using Mass Balance Method

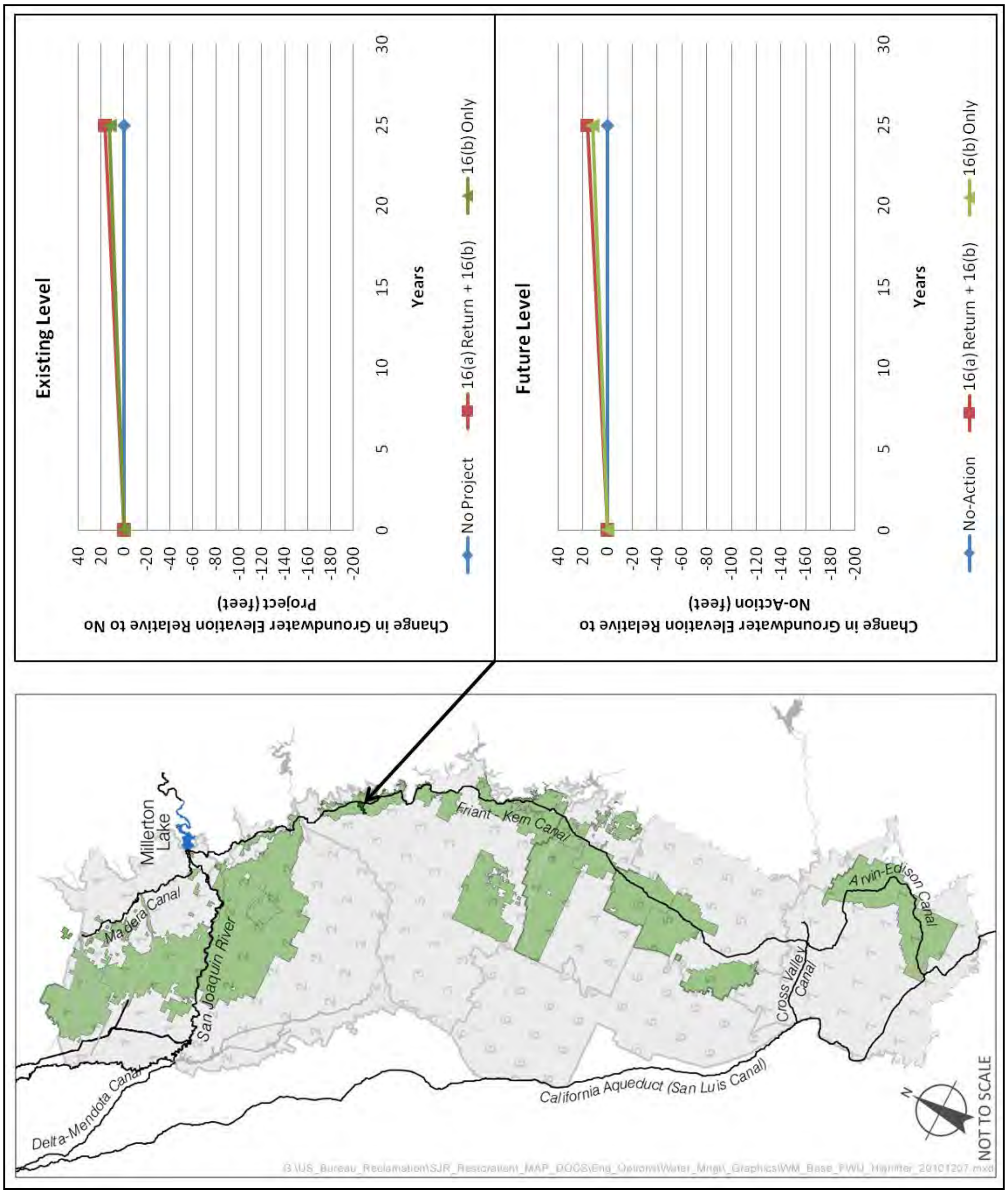

Figure 12-36.
Average Annual Change in Groundwater Depth for City of Orange Cove Using Mass Balance Method

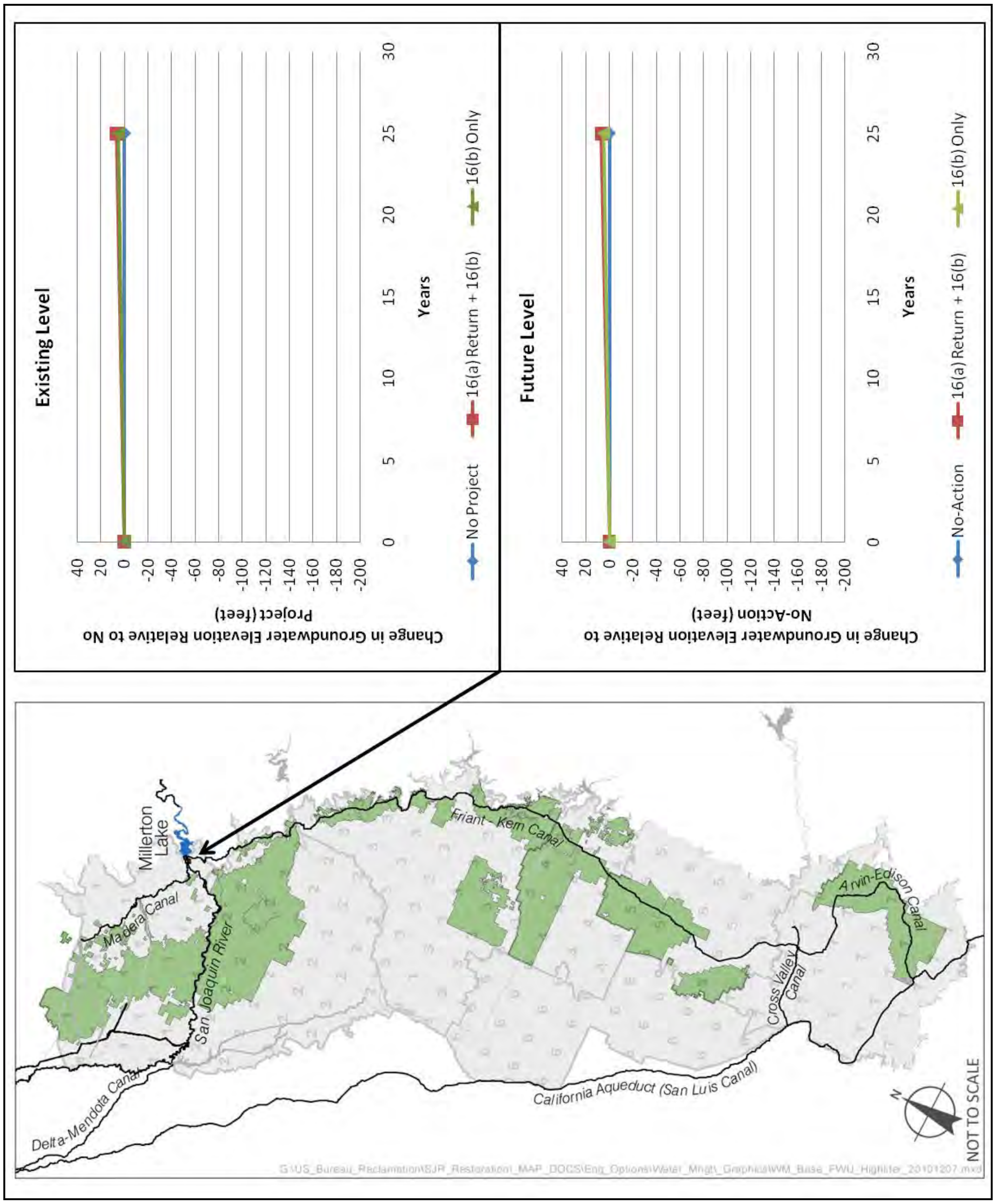

Figure 12-37.
Average Annual Change in Groundwater Depth for Fresno County Waterworks District No. 18 Using Mass Balance Method

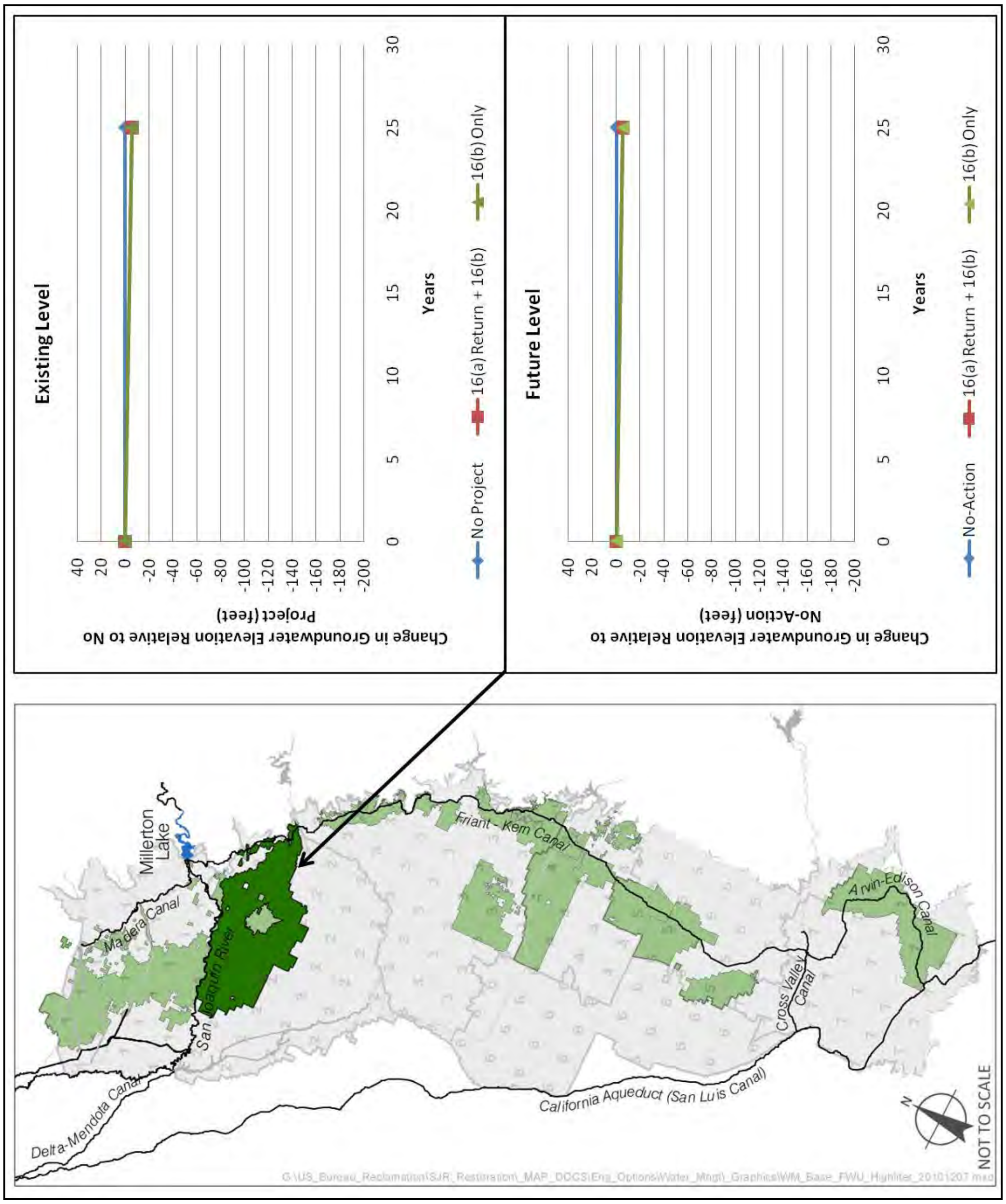

Figure 12-38.
Average Annual Change in Groundwater Depth for Fresno Irrigation District Using Mass Balance Method

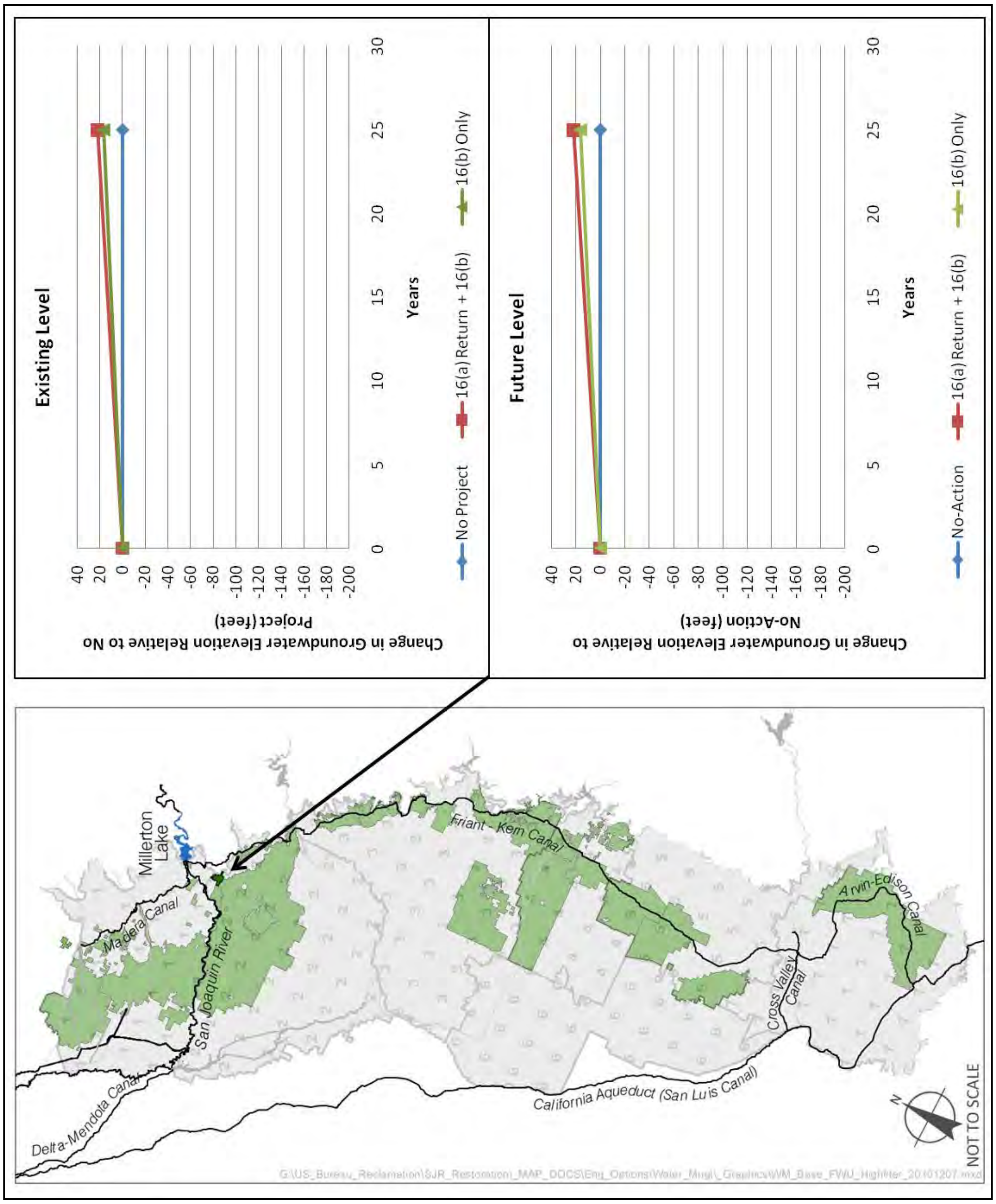

Figure 12-39.
Average Annual Change in Groundwater Depth for Garfield Water District Using Mass Balance Method

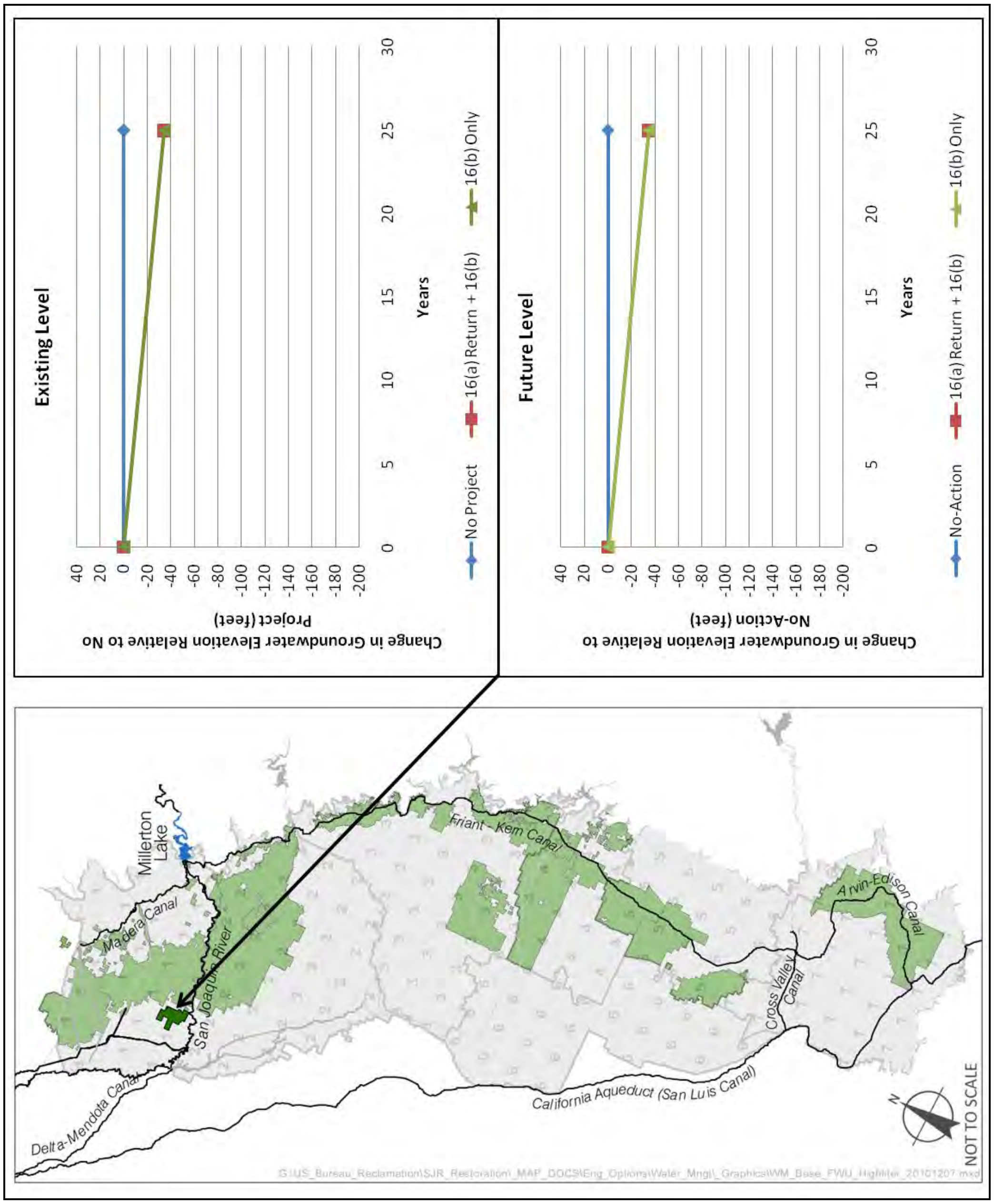

Figure 12-40.
Average Annual Change in Groundwater Depth for Gravelly Ford Water District Using Mass Balance Method

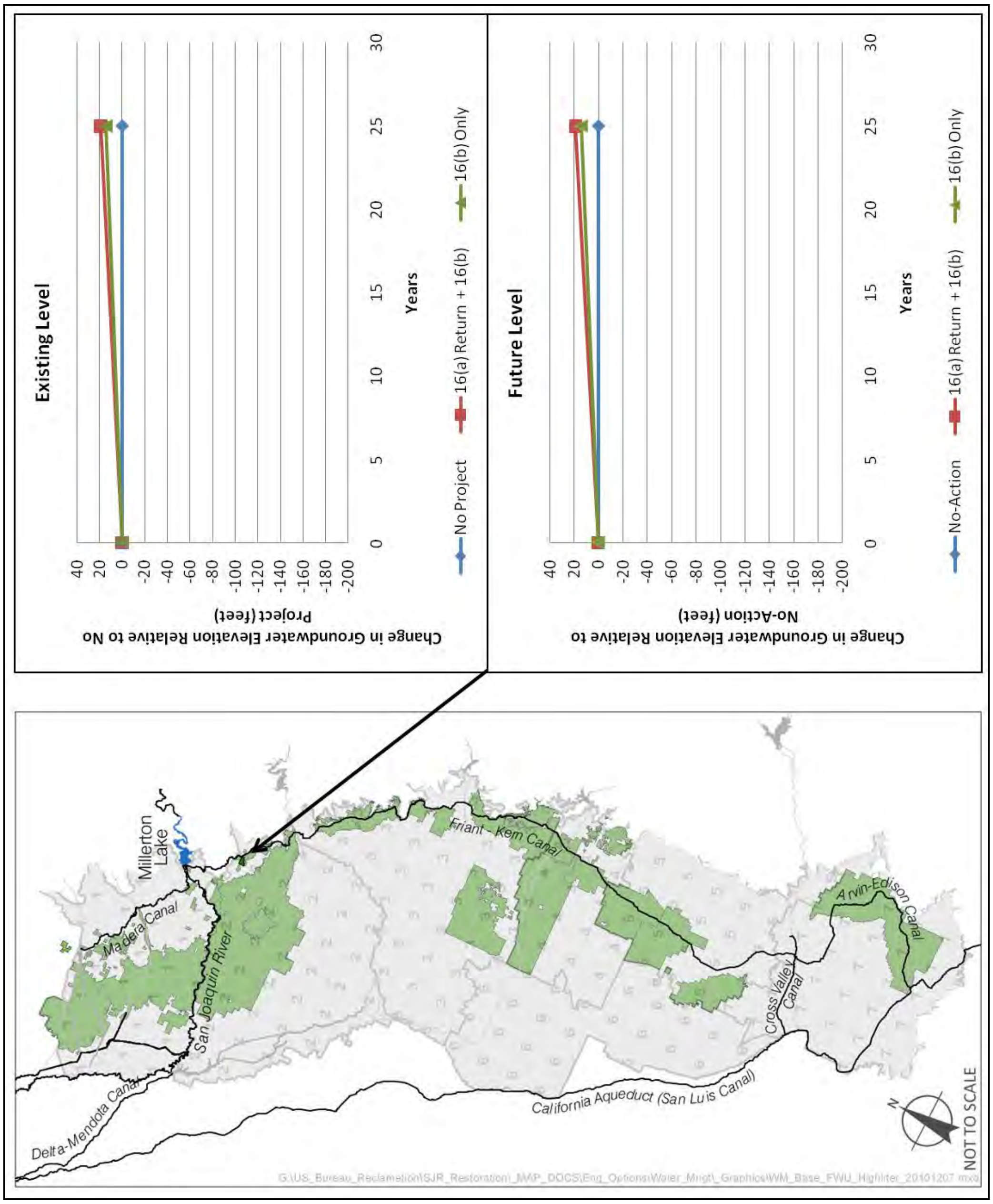

Figure 12-41.
Average Annual Change in Groundwater Depth for International Water District Using Mass Balance Method

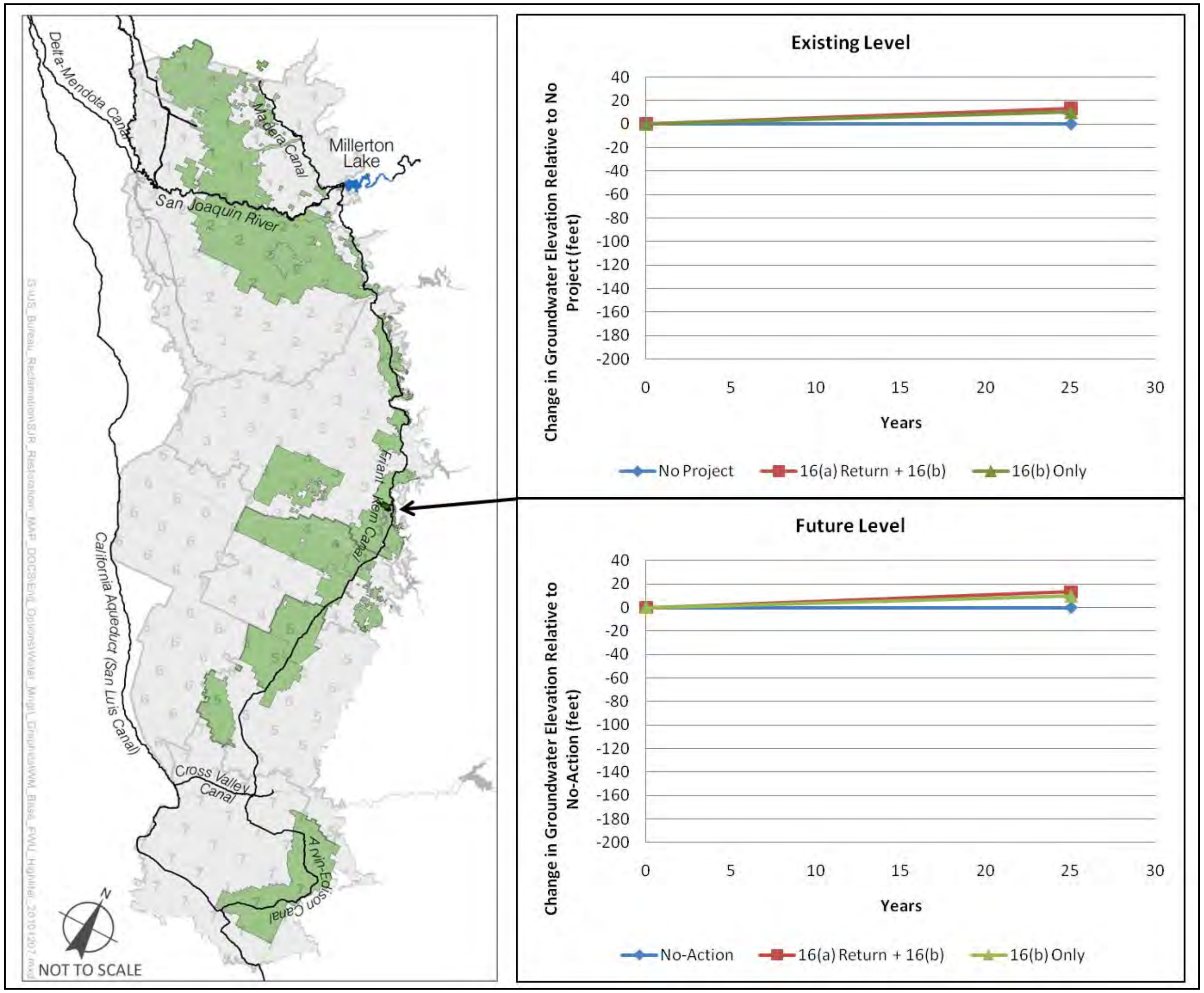

Figure 12-42.
Average Annual Change in Groundwater Depth for Lewis Creek Water District Using Mass Balance Method

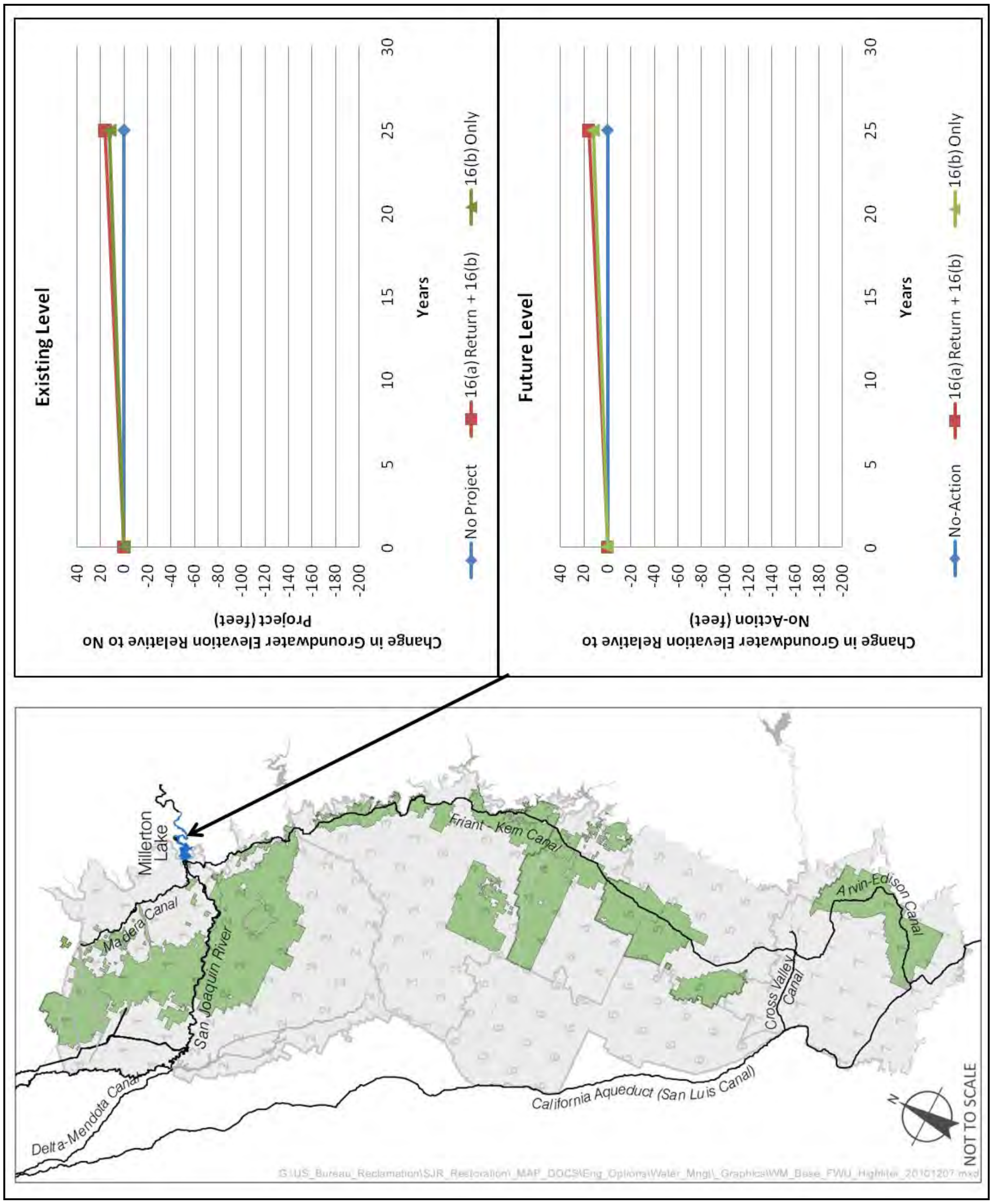

Figure 12-43.
Average Annual Change in Groundwater Depth for Madera County (Hidden Lake Estates) Using Mass Balance Method

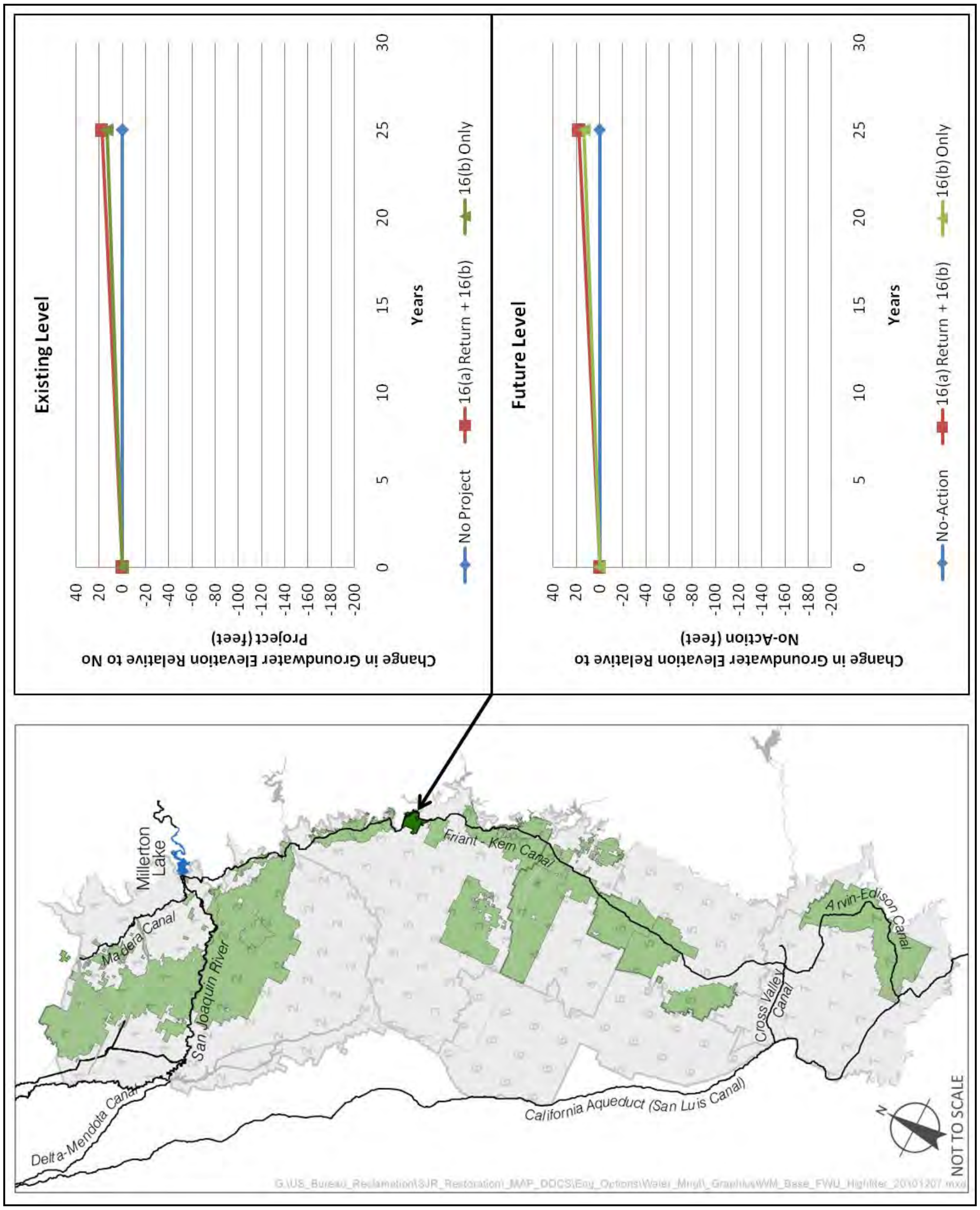

Figure 12-44.
Average Annual Change in Groundwater Depth for Stone Corral Irrigation District Using Mass Balance Method

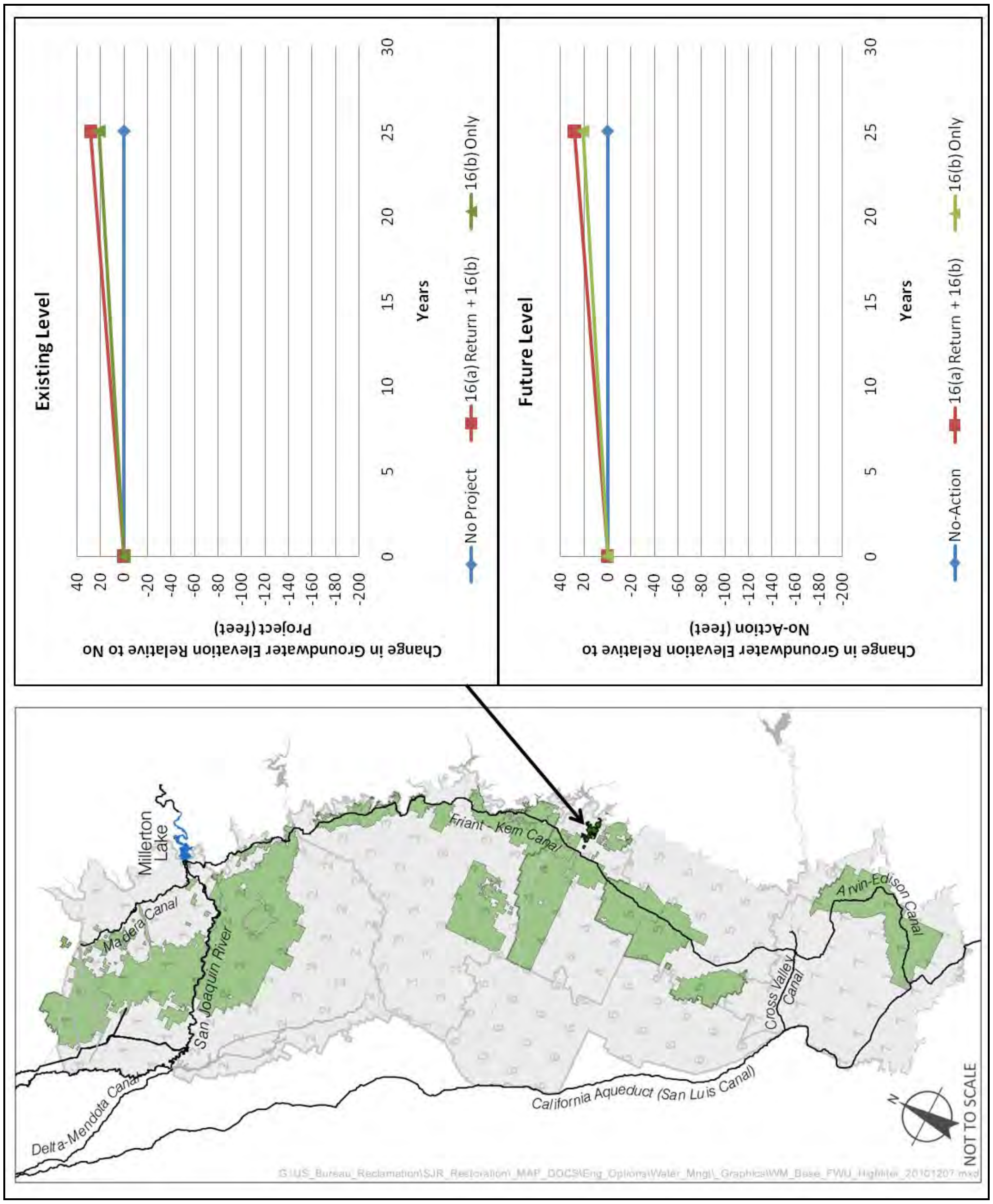

Figure 12-45.
Average Annual Change in Groundwater Depth for Tea Pot Dome Water District Using Mass Balance Method

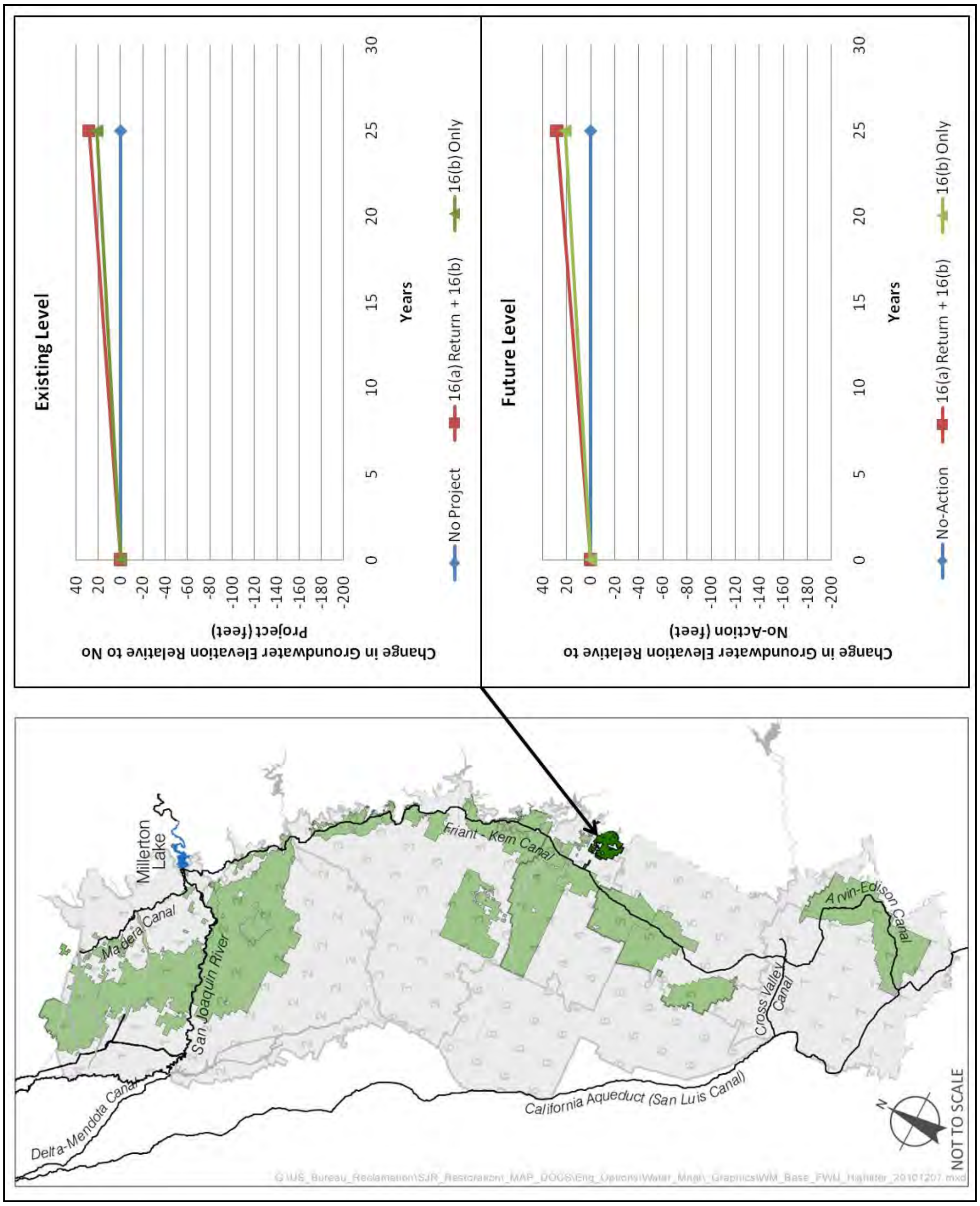

Figure 12-46.
Average Annual Change in Groundwater Depth for Terra Bella Irrigation District Using Mass Balance Method

No-Action Alternative

The following section describes potential impacts of the No-Action Alternative. Changes to groundwater resources under the No-Action Alternative would occur along the San Joaquin River between Friant Dam and the Delta and in the CVP/SWP water service areas.

Impact GRW-2 (No-Action Alternative): ***Changes in Groundwater Levels Along the San Joaquin River from Friant Dam to Merced River – Project-Level.*** Under the No-Action Alternative, shallow groundwater levels could occur along the San Joaquin River from Friant Dam to the Merced River because of seasonal recharge of precipitation. However, shallow groundwater levels are not likely to be sustained because of seasonal variability resulting in lowering of local groundwater levels during dry portions of the year. Therefore, this impact would be **less than significant**.

Groundwater levels in the Restoration Area associated with the No-Action Alternative were evaluated qualitatively, based on results from the near-river MODFLOW simulation model developed during San Joaquin River litigation to characterize shallow groundwater movement and groundwater-surface water interactions. Under the No-Action Alternative, fluctuations in groundwater levels would be expected, depending on year type, seasonal fluctuations, and other unaccounted-for factors contributing to changes in the aquifer system. The rise in groundwater levels along each reach of the San Joaquin River would likely be rapid near the river during initial seasonal precipitation, representing a rise in the hydrograph. The extent of area impacted by higher groundwater levels would expand throughout the spring peak in the hydrograph. During this period when groundwater levels were highest, groundwater seepage could potentially cause temporary impacts to lands adjacent to the San Joaquin River by increasing water levels such that crop yields would be adversely affected by the high groundwater table. Groundwater levels would fall as river flow falls, and shallow groundwater inflow would contribute to diminished infiltration losses later in the season. This impact would be less than significant.

Impact GRW-3 (No-Action Alternative): ***Changes in Groundwater Quality Along the San Joaquin River from Friant Dam to Merced River – Project-Level.*** Under the No-Action Alternative, the water quality of shallow groundwater would not be anticipated to change substantially along the San Joaquin River between Friant Dam and the Merced River, and groundwater quality would not be substantially degraded. This impact would be **less than significant** and **beneficial**.

Groundwater development in the San Joaquin Valley in the last 80 years has resulted in changes to groundwater quality. Irrigation of crops along the west side of the San Joaquin Valley has resulted in increased salts and trace metals in the localized shallow groundwater table. As described previously for program-level impacts, continued implementation of the *Westside Regional Drainage Plan* is anticipated to eliminate salt discharges to the San Joaquin River from the Grasslands Drainage Area and improve water quality conditions within Reach 5 of the Restoration Area. This would potentially benefit local groundwater quality along the San Joaquin River where surface water interacts with shallow groundwater.

Impact GRW-4 (No-Action Alternative): ***Changes in Groundwater Levels in CVP/SWP Water Service Areas – Project-Level.*** Under the No-Action Alternative, the current state of overdraft in the San Joaquin Valley Groundwater Basin and declining groundwater levels would continue. This impact would be **potentially significant and unavoidable**.

As discussed previously, groundwater overdraft describes the condition of a basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years during which water supply conditions approximate average conditions. The San Joaquin Valley Groundwater Basin currently experiences groundwater overdraft and would be expected to continue experiencing groundwater overdraft into the future.

A continued state of overdraft under existing conditions could potentially lead to private well owners abandoning or deepening groundwater wells if groundwater levels are drawn below existing well screens. Costs for deepening groundwater wells, lowering pumps in the wells, constructing new groundwater wells, or abandoning wells would be the responsibility of private well owners. A discussion of the potential cost implications of deepening groundwater wells, lowering pumps, constructing new wells, or abandoning wells is discussed in Chapter 22.0, “Socioeconomics.” If groundwater wells are abandoned, it would also be the responsibility of private well owners to decommission the wells properly in accordance with standards developed by DWR pursuant to Section 13800 of the California Water Code and adopted by SWRCB or local agencies in accordance with Section 13801 of the California Water Code.

An impact analysis was completed using the Schmidt Tool and mass balance method to identify potential impacts of the program alternatives to Friant Division long-term contractors. Existing groundwater levels identified under both methods were developed by Schmidt (2005a, b), and may exceed those reported as maximum historical groundwater depths in Table 12-24, because the initial conditions for these analyses may have used different data sources or periods of record to determine existing conditions.

Table 12-24.
Maximum Historical Groundwater Depth by Friant Division Long-Term Contractor District

District	Maximum Historical Groundwater Depth[1] (ft bgs)	Year of Occurrence	Month	Well	Number of Wells
Arvin-Edison Water Storage District	694	1982	December	11N19W21Q001S	65
Chowchilla Water District	271.5	1998	October	09S14E27R001M	84
City of Fresno	158	2004	October	12S20E36J001M	48
City of Lindsay	248	1948	September	20S26E01P001M	1
City of Orange Cove	N/A	N/A	N/A	N/A	0
Delano-Earlimart Irrigation District	444	1997	October	24S26E03P002M	33
Exeter Irrigation District	189.2	1951	October	19S26E11R001M	34
Fresno County Waterworks District No. 18	N/A	N/A	N/A	N/A	0
Fresno Irrigation District	167.7	1994	January	14S17E01E001M	117
Garfield Water District	241	1962	March	12S21E07A002M	7
Gravelly Ford Water District	123.9	1992	October	12S16E26H001M	2
International Water District	56.7	2003	September	12S22E30D001M	1
Ivanhoe Irrigation District	105.9	1961	September	17S25E27R001M	41
Lewis Creek Water District	89.9	1977	August	19S27E30P001M	3
Lindmore Irrigation District	272.5	1950	October	20S26E13P001M	132
Lindsay-Strathmore Irrigation District	196.7	1950	October	19S27E31D001M	8
Lower Tule River Irrigation District	194	1994	October	22S26E07Q001M	61

Table 12-24.
Maximum Historical Groundwater Depth by Friant Division Long-Term Contractor District (contd.)

District	Maximum Historical Groundwater Depth[1] (ft bgs)	Year of Occurrence	Month	Well	Number of Wells
Madera County (Hidden Lake Estates)	N/A	N/A	N/A	N/A	0
Madera Irrigation District	317.5	1999	February	10S16E12K001M	105
Orange Cove Irrigation District[2]	132.9	1949	October	15S24E26B001M	33
Porterville Irrigation District	101	1977	September	22S27E04A001M	4
Saucelito Irrigation District	241	1961	October	23S26E09C001M	16
Shafter-Wasco Irrigation District	N/A	N/A	N/A	N/A	0
Southern San Joaquin Municipal Utilities District	506	1997	September	25S26E36R001M	11
Stone Corral Irrigation District	N/A	N/A	N/A	N/A	
Tea Pot Dome Water District	153.7	2004	October	22S27E15G001M	1
Terra Bella Irrigation District	N/A	N/A	N/A	N/A	0
Tulare Irrigation District	172	1994	October	21S23E08R001M, 20S23E11C001M	57

Notes:
[1] Maximum historical groundwater depths were based on data from all groundwater wells within each district that store data publicly in the DWR Water Data Library (DWR 2010). These reported depths may be exceeded by those reported as existing conditions groundwater depths under the Schmidt or mass balance analysis methods, because the initial conditions for these analyses were developed by Schmidt (2005a, b) and may have used different data sources or periods of record to determine existing conditions.
[2] A measurement of 342 feet below ground surface reported in October 1994 appears to be an outlier at well 15S24E14H001M; therefore, it was noted, but not called out as the maximum historical groundwater depth.

Key:
bgs = below ground surface
ft = feet
N/A = not available

The Schmidt Tool does not identify impacts outside the Friant Division. However, decreasing groundwater levels due to pumping in the Friant Division would likely affect groundwater levels outside the Friant Division because the alluvial aquifer is assumed to be hydraulically connected. Without a better understanding of historical pumping practices in these areas, it is assumed that this interaction is effectively built into the relationships applied by the Schmidt Tool, as part of the analysis of historical groundwater levels within each of the contractor areas used to develop the Schmidt Tool. The impact analysis using the mass balance method did not incorporate an estimate of the current rate of decline of groundwater levels under existing conditions within the Friant Division long-term contractor areas identified in Tables 12-21 and 12-23. Therefore, the annual change in groundwater levels under existing conditions using the mass balance method is shown as an absolute change in groundwater levels from existing conditions to each of the program alternatives. Consequently, under existing conditions and the No-Action Alternative, there are potential groundwater level declines that have not been accounted for using the mass balance method. Because of these differences in analytical approaches, the impact analysis below is presented separately for each method.

- **Schmidt Tool** – The change in groundwater pumping under the No-Action Alternative compared to existing conditions is less than 1 percent for all of the Friant Division districts evaluated using the Schmidt Tool (see Tables 12-17 and 12-19). Chowchilla WD and Madera ID are the only two Friant Division long-term contractors identified in Tables 12-17 and 12-19 that are located within one of the three critically overdrafted groundwater subbasins located in the San Joaquin River Hydrologic Region (DWR 2010). The analysis indicates that two contractors, Ivanhoe ID and Lower Tule River ID, could potentially draw groundwater levels below the maximum historical groundwater depths (see Table 12-24). The potential for groundwater levels to be drawn below the historical maximum groundwater low could potentially lead to reactivation or activation of inelastic subsidence in these districts. The qualitative subsidence analysis is based on data from 41 wells from Ivanhoe ID and 61 wells from Lower Tule River ID and depends on the accuracy of the information from the historical records. Additional field data would be necessary to evaluate and approximate the potential for and magnitude of potential subsidence in these regions. A historical map of subsidence in the San Joaquin Valley between 1926 and 1970 (Figure 12-11) indicates that Ivanhoe ID is outside the regions that have historically been impacted by subsidence, but that Lower Tule River ID is within the region that experienced between 1 and 8 feet of subsidence.

- **Mass balance method** – The change in groundwater pumping under the No-Action Alternative compared to existing conditions is less than 1 percent for all of the Friant Division long-term contractors evaluated using the mass balance method (see Tables 12-21 and 12-23). The analysis indicates that one contractor, Gravelly Ford WD, could potentially draw groundwater levels below the maximum historical groundwater depths (see Table 12-24). Gravelly Ford WD is the only one of the Friant Division long-term contractors identified in Tables 12-21 and 12-23 that is located within one of the three critically overdrafted groundwater subbasins located in the San Joaquin River Hydrologic Region

(DWR 2010). The potential for groundwater levels to be drawn below the historical maximum groundwater low could potentially lead reactivation or activation of inelastic subsidence in this district. The qualitative subsidence analysis is based upon data from two wells in Gravelly Ford WD, and depends on the accuracy of the information from the historical records. Additional field data would be necessary to evaluate and approximate the potential for and magnitude of potential subsidence in these regions. A historical map of subsidence in the San Joaquin Valley between 1926 and 1970 (Figure 12-11) indicates that Gravelly Ford WD is within the region that experienced between 1 and 4 feet of subsidence.

Therefore, under existing conditions and the No-Action Alternative, groundwater levels throughout much of the San Joaquin Valley Groundwater Basin evaluated for this PEIS/R would continue declining. This decline would be a potentially significant and unavoidable impact to groundwater levels.

Impact GRW-4 (No-Action Alternative): ***Changes in Groundwater Quality in CVP/SWP Water Service Areas – Project-Level.*** Under the No-Action Alternative, the current state of overdraft in the San Joaquin Valley Groundwater Basin and declining groundwater levels is expected to continue under the No-Action Alternative. This in turn could lead to upwelling of poorer quality groundwater. This impact would be **potentially significant and unavoidable**.

Alternatives A1 Through C2

This section describes potential project-level impacts of the action alternatives to groundwater resources in the study area. The potential impact to groundwater associated with implementing the action alternatives includes elevated groundwater levels and changes in groundwater quality along the San Joaquin River from Friant Dam to the Merced River, and in the CVP/SWP water service areas. High groundwater levels along Reaches 1 through 5 could create favorable conditions for lateral seepage, a potential issue identified in Chapter 11.0, "Flood Management."

Impact GRW-2 (Alternatives A1 through C2): ***Changes in Groundwater Levels Along the San Joaquin River from Friant Dam to Merced River – Project-Level.*** Implementing each action alternative could elevate groundwater levels within the Restoration Area, causing surface water infiltration that could potentially lead to development of a shallow groundwater table or provide additional recharge along losing reaches of the San Joaquin River. The potential for impacts resulting from infiltration would be avoided or substantially reduced by taking the appropriate actions identified in the *Physical Monitoring and Management Plan* Appendix D. In addition, increased recharge along losing reaches of the San Joaquin River that have depleted groundwater levels would be a beneficial impact of implementing any of the action alternatives. This impact would be **less than significant**.

Impacts to groundwater levels in the Restoration Area associated with the action alternatives are described below by reach. This section qualitatively discusses results from the near-river MODFLOW simulation model developed during San Joaquin River litigation to characterize shallow groundwater movement and groundwater-surface water interactions. Groundwater levels along Reaches 1 through 5 of the San Joaquin River from Friant Dam to the Merced River are expected to rise under the action alternatives compared to existing conditions. Infiltration of surface water could potentially lead to development of a shallow groundwater table where one was not previously observed. A shallow groundwater table could potentially lead to waterlogging of crops and mobilizing of salts in the soil profile. Appendix D, "Physical Monitoring and Management Plan," identifies performance standards and immediate responses to avoid potential impacts such as those identified above. The potential impacts associated with reduced crop production as a result of the shallow groundwater table altering inundation patterns or causing soil saturation are addressed in Chapter 16.0, "Land Use and Planning." The potential for impacts resulting from infiltration would be avoided or substantially reduced by taking the appropriate actions identified in the *Physical Monitoring and Management Plan*. Therefore, this impact would be less than significant.

Potential changes in groundwater levels within the Restoration Area under Alternatives A1 through C2 are described below by reach.

Reach 1. As river flow increases, the river stage increases, which can lead to infiltration losses, as identified in Exhibit B of the Settlement. These infiltration losses would increase groundwater elevations (i.e., shallower depths to groundwater). The rise in groundwater elevations would likely be rapid near the river during the initial rise of the hydrograph. The extent of area impacted by higher groundwater levels would expand throughout the duration of the spring peak. Groundwater levels would fall as river flow falls, and shallow groundwater inflow would contribute to diminished infiltration losses later in the season.

From previous studies using the near-river MODFLOW model (SSPA 2005), in Wet years, the extent of high groundwater (where groundwater is within 5 feet of the land surface elevation) is relatively broad, extending through most of the lower ground surface elevation areas in and around the gravel pits within Reach 1A (see Chapter 10.0, "Geology and Soils"), but are generally limited to the area within riverbanks or confined by nearby bluffs. These conditions are considered applicable to a Wet year under both the No-Action Alternative and the action alternatives, as both have similar high-flow levels, and because the differences in flow are generally confined by the channel and overbank area geometry in this reach (SSPA 2005).

For the other Restoration year types, including Normal-Wet, Normal-Dry, and Dry, full Restoration Flows would exceed flows under the No-Action Alternative. Consequently, groundwater elevations within the near-river zone of Reach 1 would be higher under the action alternatives than under the No-Action Alternative, and would be beneficial in Reach 1, where groundwater elevations are generally deep below the ground surface. This impact would be less than significant.

Reach 2. Modeling results demonstrate the presence of overall higher groundwater conditions in the near-river zone under the action alternatives compared to existing conditions (see Appendix H, "Modeling"). Under the action alternatives, the range of fluctuations of groundwater elevations would be reduced during Dry, Normal-Dry, and Normal-Wet years, when higher groundwater conditions would persist longer throughout the rainy season because of the presence of Interim and Restoration flows. These impacts would be less than significant.

Reach 3. Previously conducted modeling, assuming top-of-reach flows of 200, 500, and 2,000 cfs, demonstrated the sensitivity of groundwater levels to alternate river conditions in Reach 3 (SSPA 2000). These previous model simulations of Reach 3 provide a reasonable means for qualitatively evaluating areas of high groundwater levels.

Under the action alternatives, groundwater levels would likely increase in Reach 3, particularly at higher flows, with the greatest sensitivity along the river and west of the river in the lower half of the reach (SSPA 2000). Through the actions identified in Appendix D, "Physical Monitoring and Management Plan," potential adverse effects of an elevated groundwater level, such as waterlogging of crops and mobilizing of salts in the soil profile, would be avoided or substantially reduced. Therefore, these impacts would be less than significant.

Reach 4. Existing model simulations for existing conditions and the action alternatives in Reach 4B1, between Sand Slough and the Mariposa Bypass return, are not available. However, previous model simulations of Reach 4B2 are available for two scenarios, assuming top-of-reach inflows of 3,500 cfs and 200 cfs (SSPA 2005). These previous simulations indicate areas of vulnerability with respect to high groundwater levels. These previous model simulations of Reach 4B2 provide a reasonable means for qualitatively evaluating areas of high groundwater levels.

In Reach 4B1, which does not convey flow under existing conditions, the action alternatives could contribute to high groundwater conditions. In Reach 4B2, from the Mariposa Bypass return to Bear Creek, relatively high flows in the range of 1,000 to 3,000 cfs occur in Wet years, with occasional spikes over 4,000 cfs. During low flows, below 200 cfs, high groundwater conditions dissipate (SSPA 2005). Under continual wetted conditions, the higher groundwater conditions established during the periods of higher flows are less likely to dissipate, and generally higher groundwater elevations are expected if regional groundwater conditions and other factors remain unchanged. The largest increase in groundwater levels under the action alternatives, compared to existing conditions, would occur during Normal-Wet, Normal-Dry, and Dry years, when flows ranging between 100 and 500 cfs would be maintained throughout the year, sustaining groundwater levels raised during previous high flows. Alternatives A2, B2, and C2 would have higher flows in Reach 4B1 than Alternatives A1, B1, and C1 and, therefore, have greater potential to influence groundwater levels based on this analysis.

Through the actions identified in Appendix D, "Physical Monitoring and Management Plan," potential adverse effects of an elevated groundwater level, such as waterlogging of crops and mobilizing of salts in the soil profile, would be avoided or substantially reduced. Therefore, these impacts would be less than significant.

Reach 5. Previous model simulations of this reach examined the sensitivity of groundwater levels, assuming top-of-reach flows of 10, 120, and 6,500 cfs (SSPA 2000). These previous model simulations of Reach 5 provide a reasonable means for qualitatively evaluating areas of high groundwater levels.

The generally high regional groundwater conditions in this area contribute to shallow groundwater over a wide range of river conditions. For example, results of previously conducted simulations found potential for high groundwater and ponding to occur in a broad area through most of Reach 5 at a flow of 6,500 cfs. At a lower simulated flow, 120 cfs, groundwater remained at least a few feet below the ground surface (SSPA 2000). These observations indicate that elevated groundwater conditions would occur under the action alternatives because flows would be sustained at higher levels more frequently under the action alternatives. However, the elevation of groundwater that would occur under the action alternatives in this reach is unclear. Through the actions identified in Appendix D, "Physical Monitoring and Management Plan," potential adverse effects of an elevated groundwater level, such as waterlogging of crops and mobilizing of salts in the soil profile, would be avoided or substantially reduced. Therefore, these impacts would be less than significant.

Eastside and Mariposa Bypasses. Groundwater elevations within the vicinity of the Eastside and Mariposa bypasses are anticipated to behave similarly to groundwater elevations in Reaches 4 and 5, rising as flows increase in the bypasses. Through the actions identified in Appendix D, "Physical Monitoring and Management Plan," potential adverse effects of an elevated groundwater level, such as waterlogging of crops and mobilizing of salts in the soil profile, would be avoided or substantially reduced. These impacts would be less than significant.

Impact GRW-3 (Alternatives A1 through C2): ***Change in Groundwater Quality Along the San Joaquin River from Friant Dam to Merced River – Project-Level.*** Groundwater levels in the Restoration Area could increase, causing infiltration of surface water. This increase could potentially mobilize salts that have evaporated in the soil column, causing degradation of groundwater quality. However, through implementing the *Physical Monitoring and Management Plan* (see Appendix D), these impacts would be avoided or substantially reduced. This impact would be **less than significant**.

Under the action alternatives, groundwater levels in the Restoration Area could increase because of infiltration of surface water, as previously described. The potential rise in groundwater levels could mobilize salts that have evaporated in the unsaturated soil column. Appendix D, "Physical Monitoring and Management Plan," identifies potential immediate responses to avoid or reduce potential impacts due to infiltration of surface water. The potential for degradating groundwater quality would be avoided or substantially reduced to less than significant by taking the appropriate actions identified in Appendix D, "Physical Monitoring and Management Plan." Therefore, these impacts would be less than significant.

Impact GRW-4 (Alternatives A1 Through C2): ***Change in Groundwater Levels in CVP/SWP Water Service Areas – Project-Level.*** Surface water deliveries to Friant Division long-term contractors would be reduced under the action alternatives, increasing the need to pump groundwater, and thereby increasing groundwater overdraft. This impact would be **potentially significant and unavoidable**.

The action alternatives would reduce surface water deliveries to Friant Division long-term contractors, increasing the need to pump groundwater. The increase in groundwater pumping for a prolonged period would not only decrease groundwater levels, but could potentially lead to upwelling of poorer quality groundwater under the action alternatives. The San Joaquin Valley Groundwater Basin is in a state of overdraft, and groundwater levels are expected to continue in a downward trend under the No-Action Alternative. Implementing the action alternatives would increase overdraft and accelerate the downward groundwater level trend.

Although implementing the action alternatives would introduce water to the San Joaquin River and lead to some natural recharge, groundwater levels near the San Joaquin River are not anticipated to rise significantly enough to change regional groundwater levels in the surrounding CVP/SWP water service areas. Existing and proposed groundwater banks, such as Semitropic Water Storage District Groundwater Banking Program, Madera Irrigation District Water Supply Enhancement Project, and Kern Water Bank, could potentially result in additional groundwater recharge in the CVP/SWP water service areas that are not accounted for in this analysis.

The impact analysis was completed, using the Schmidt Tool and the mass balance method, to identify the change in potential groundwater pumping and groundwater levels for each of the action alternatives for the 2005 and 2030 levels of development. Because of the differences in these analytical approaches, as previously described, the impact analysis below is presented separately for each method.

- **Schmidt Tool** – The change in groundwater pumping under the action alternatives compared to existing conditions ranges from negative 15 percent to 39 percent for Friant Division long-term contractor districts evaluated using the Schmidt Tool (see Tables 12-17 and 12-19). The analysis indicates that 5 out of 15 Friant Division districts evaluated using this method, including Chowchilla WD, Ivanhoe ID, Lower Tule River ID, Porterville ID, and Saucelito ID, could potentially draw groundwater levels below maximum historical groundwater depths (see Table 12-24). As previously mentioned, Chowchilla WD is located within one of the three critically overdrafted groundwater subbasins located in the San Joaquin River Hydrologic Region (DWR 2010). Also as previously described, drawdown of groundwater levels below the historical maximum groundwater low could potentially lead to reactivation or activation of inelastic subsidence in these districts. This qualitative subsidence analysis is based on data from 84 wells from Chowchilla WD, 41 wells from Ivanhoe ID, 61 wells from Lower Tule River ID, 4 wells from Porterville ID, and 16 wells from Saucelito ID, and depends on the accuracy of the information from the historical records. Additional field data would be necessary to evaluate and approximate the potential for and magnitude of potential subsidence in these regions. A historical map of subsidence in the San Joaquin Valley between 1926 and 1970 (Figure 12-11) indicates that Ivanhoe ID is outside the regions that have historically been impacted by subsidence, but that Chowchilla WD is within the region that experienced between 1 and 4 feet of subsidence, Lower Tule River ID is within the region that experienced between 1 and 8 feet of subsidence, Porterville ID is within the region that experienced 1 to 4 feet of subsidence, and Saucelito ID is within the region that experienced between 1 and 12 feet of subsidence.

- **Mass balance method –** The change in groundwater pumping under the action alternatives compared to existing conditions ranges from negative 15 percent to 39 percent for the Friant Division long-term contractor districts evaluated using the mass balance method (see Tables 12-21 and 12-23). The analysis indicates that 1 of 13 of the Friant Division districts evaluated using this method, Gravelly Ford WD, could potentially draw groundwater levels below the maximum historical groundwater depths (see Table 12-24). As previously mentioned, Gravelly Ford WD is located within one of the three critically overdrafted groundwater subbasins located in the San Joaquin River Hydrologic Region (DWR 2010). Also as previously described, drawdown of groundwater levels below the historical maximum groundwater low could potentially lead to reactivation or activation of inelastic subsidence in this district. The qualitative subsidence analysis is based on data from two wells in Gravelly Ford WD, and depends on the accuracy of the information from the historical records. Additional field data would be necessary to evaluate and approximate the potential for and magnitude of potential subsidence in these regions. A historical map of subsidence in the San Joaquin Valley between 1926 and 1970 (Figure 12-11) indicates that Gravelly Ford WD is within the region that experienced between 1 and 4 feet of subsidence.

Because the action alternatives would potentially increase reliance on groundwater, it is anticipated that the action alternatives would result in adverse impacts to groundwater levels and quality. This impact is considered potentially significant. Reclamation would consider regional overdraft conditions in evaluating candidate groundwater banking projects developed under Title III of the Act. It is not known if remaining groundwater overdraft would be potentially significant. There are no mitigation measures to reduce the impact and, therefore, the impact would remain potentially significant and unavoidable.

Impact GRW-5 (Alternatives A1 Through C2): ***Change in Groundwater Quality in CVP/SWP Water Service Areas – Project-Level.*** Surface water deliveries to Friant Division long-term contractors would be reduced under the action alternatives, increasing the need to pump groundwater, and thereby increasing groundwater overdraft, as discussed in GRW-4 (Alternatives A1 Through C2). This in turn could lead to upwelling of poorer quality groundwater. This impact would be **potentially significant and unavoidable**.

The action alternatives would reduce surface water deliveries to Friant Division long-term contractors, increasing the need to pump groundwater. The increase in groundwater pumping for a prolonged period would not only decrease groundwater levels, but could potentially lead to upwelling of poorer quality groundwater under the action alternatives. The San Joaquin Valley Groundwater Basin is in a state of overdraft, and groundwater levels are expected to continue in a downward trend under the No-Action Alternative. Implementing the action alternatives would increase overdraft and accelerate the downward groundwater level trend.

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