



ATTACHMENT 4. PROJECT DESCRIPTION

INTRODUCTION

The Fresno Metropolitan Flood Control District (FMFCD) is pleased to submit this application to the Department of Water Resources for a grant to fund the proposed ***Basin Recharge Improvement and Soil Sampling Project*** under the Local Groundwater Management Assistance Act of 2000. This application follows the requirements outlined in the Guidelines and Proposal Solicitation Package dated May 2012.

GENERAL

The Fresno Metropolitan Flood Control Act became law May 13, 1955, and created a special district to address drainage and flood control. In 1956, the Fresno Metropolitan Flood Control District was created to meet the flood control, drainage and water resources management needs of its constituency.

LOCATION

FMFCD is located in the geographic center of Fresno County and is bound by the San Joaquin River to the north, the Kings River to the south, the foothills of the Sierra Nevada to the east, and by agricultural land to the west. FMFCD covers an area of 399 square miles. A map of the Fresno Metropolitan Flood Control District is shown in Figure 1-2.

WATER SUPPLY

The Fresno Irrigation District and the cities of Fresno and Clovis own numerous wells within the Fresno-Area Regional Groundwater Management Plan (GWMP) boundary, whereas all other wells are privately owned and operated. Groundwater is the primary source of potable water, and over time municipal and industrial groundwater pumping has created a significant cone of depression beneath the Fresno/Clovis metropolitan area. Groundwater levels in the Fresno area have declined by an average of 1.5 feet per year since 1990 (2008 City of Fresno Final Urban Water Management Plan). The average depth to groundwater within the Fresno-Area Regional GWMP boundary was calculated to be 87.0 feet below ground surface (draft 2010 Fresno Area Regional GWMP annual report). Refer to Figures 3 and 4 in the draft 2010 Annual Groundwater Report for groundwater elevation and groundwater depth in the Fresno-Area Regional GWMP boundary. Figure 4 shows depth to water in wells to be deepest in the northeastern portion of the City of Fresno area, as well as the central portion of the City of Clovis. Within the urban area, the deepest depth to water measurement recorded was 173.2 feet.

EXISTING FACILITIES AND PROGRAMS

FMFCD owns, operates, and maintains 154 stormwater basins sites ranging in size from six (6) to forty (40) acres in the Fresno/Clovis metropolitan area, roughly 640 miles of storm drain pipeline, and ten (10) major flood control facilities including dams, reservoirs, and detention basins.

FMFCD provides usage of its stormwater management basins in the local Groundwater Recharge Program. The City of Clovis, the City of Fresno, Fresno Irrigation District (FID) and FMFCD all participate together to implement a comprehensive groundwater management program. Each agency plays an important role to help maximize the amount of surface water directed to basins for groundwater recharge purposes. The Cities of Fresno and Clovis each allocate a portion of their surface water entitlement to be delivered to FMFCD basins via the FID canal system. FMFCD utilizes eighty-five (85)

basins in Fresno and Clovis for artificial recharge during dry weather, in addition to their primary function of capturing, retaining, and recharging stormwater during the rainy season.

Apart from the multi-agency local Groundwater Recharge Program using FMFCD basins, the City of Clovis operates a year-round 85-acre recharge basin at Alluvial and Sunnyside Avenues; the City of Fresno has one (1) year-round recharge site, the 200-acre Leaky Acres at Ashlan Avenue and Freeway 168; and FID and the City of Fresno jointly operate two (2) recharge basins in the Fresno/Clovis area, along with FID owning and operating one (1) recharge basin in the urban area consisting of a combined area that equals to roughly eighty (80) acres. Each year approximately 60,000 acre-feet of imported surface water is artificially recharged through the teamwork of the FMFCD, Cities of Clovis and Fresno, and Fresno Irrigation District. Letters of support from the City of Clovis, City of Fresno, and Fresno Irrigation District are attached.

Surface water and stormwater recharge accomplished solely at FMFCD basins together average 50,000 acre-feet annually. In the 2012/2013 FMFCD budget, \$157,000 is allocated for ‘maintaining facilities related directly to recharging water to replenish the underground aquifer of Fresno and Clovis’ (2012/2013 FMFCD Budget). The Cities of Fresno and Clovis reimburse FMFCD the majority of that maintenance cost. Thus the cost is \$3.14 per acre-foot for basin maintenance to return that volume of water to the community’s groundwater aquifer for future use.

To help ease demand on groundwater, the Cities of Clovis and Fresno each operate surface water treatment plants that together provide up to forty-five (45) million gallons per day. However, at present groundwater still accounts for roughly eight-five (85) percent of the water used in Fresno and Clovis.

PURPOSE

The purpose of the project is to demonstrate that physical modifications of near surface soils in an existing basin (Basin “P”) can economically improve recharge performance and to study basin soils in six (6) or more other basins, selecting one of those six (6) or selecting Basin “CM” (limited to one by available grant funding) and modifying it similar to Basin “P”. Basin “CM” has existing soil data that makes it a potential candidate; however, FMFCD proposes utilizing the soils data of the six (6) to evaluate the best potential basin for modification with grant funding. The remaining soils data will be available to select basins for future modification.

The project will determine whether soil modification is an economical technique of recharge, while improving and protecting the groundwater supply. Increased groundwater recharge efforts are critically important to address the local groundwater overdraft within the Fresno/Clovis aquifer’s cone of depression. Collection of soil data is a prerequisite to evaluating, developing, or improving additional basins in the future. The initial basin chosen for physical modification is located within the northerly portion of the GWMP area and it is referred to as Basin “P”.

GOALS AND OBJECTIVES

The **goal and objective** of the project is to:

1. Demonstrate that a physical modification to certain existing basin sites is more economical than acquiring new basin sites.
2. Collect underlying soil profiles from six (6) or more other basin sites in Fresno and Clovis to evaluate the potential for additional future projects, and



3. Utilize remaining funds to make physical modifications at one (1) or more of the six (6) basin sites where soil data was collected or Basin “CM” to install gravity drains to maximize groundwater recharge.

DESCRIPTION OF WORK

FMFCD owns the basin sites included in the proposed project, making property acquisition unnecessary. Using existing basins to improve percolation is an economical approach to groundwater recharge in an urban area. The entire grant amount would be used to collect soil data and make physical modifications to basin sites to improve their groundwater recharge capability. As an example of the advantage of improving existing facilities, as compared to new property acquisition, in Fresno a budget of \$250,000 would be necessary to buy a three-acre basin site with the capability of recharging 80 acre-feet of groundwater annually. In contrast, the initial basins selected for physical modifications are anticipated to yield an increase of 340 acre-feet per year of groundwater recharge at a cost of less than \$80,000, for cost of \$235 per acre-feet per year.

FMFCD has a longstanding, cooperative groundwater recharge program that produces an annual average of nearly 50,000 acre-feet of storm water and imported surface water. It seeks to improve the efficiency of the program by maximizing the use of existing water resources and increasing the efficiency of basin sites.

Basin recharge improvements entail using one or a combination of the methods listed below.

- Installation of gravity drains.
- Over-excavating of confining layers and backfilling with sand.
- Modifying excavation configuration considering permeable soil layers.

After consultation with a geotechnical engineer, it was decided that the most cost-effective method of improving percolation rates is by installing gravity drains for the two sites proposed for physical modification.

Soil borings will be performed at six (6) or more basin sites to collect soils data. From the soil data collected, FMFCD will prioritize the basin sites based on feasibility of increasing the infiltration rates by penetrating restrictive layers and replacing the material with pea gravel and sandy soil. The sites chosen for testing lack soil profile data, have poor performance (less than or equal to 0.10 feet/day), and/or are under-performing when compared to nearby basins. Table 4-1, lists the basin sites chosen for collecting soil data.

Basin	Municipality	Basin Floor Acreage	Proposed # of 50' Borings	Proposed # of 15' Borings	Inadequate Soils Data?	Under-Performing Recharge Basin	Poor Performing Recharge Basin
1G	Clovis	3.6	2	4	X		X
2D	Clovis	2.8	2	4	X		X
AE	Fresno	12.3	2	8	X	X	
AF	Fresno	13.0	2	8	X	X	
AG	Fresno	6.2	2	4	X	X	
CL	Clovis	9.1	2	6	X	X	
CY	Fresno	5.5	2	4	X		X
J	Fresno	3.7	2	4	X	X	
K	Fresno	3.7	2	4	X		X
RR3	Fresno	6.5	2	4	X	X	

Table 4-1

The basin FMFCD is proposing to improve is referenced as Basin “P”, located near the northwest corner of East Bullard Avenue and North Cedar Avenue. The area of Basin “P” is 9.13± acres. At present, Basin “P” recharges approximately 40 acre-feet per year. Following the improvements, Basin “P” is anticipated to recharge 380 acre-feet per year.

Please reference Figure 1-3 for the configuration of Basin “P”. At Basin “P”, the majority of the upper floor has a layer of clay and silt that ranges from 2 – 12 feet in thickness that reduces the percolation. Below those layers is more permeable sand. The proposed recharge improvement for this site is to drill twenty (20) gravity drains to a depth past the impeding layer and five (5) feet into the sand. With a bucket auger, the contractor will drill three (3) foot diameter wells to an average depth of thirteen (13) feet. A layer of Mirafi 140N filter fabric, or similar, will be placed inside the drains to keep the gravel in place and help prevent the top sand layer from mixing into the pea gravel. The gravity drains would be back filled with 3/8” pea gravel to 1.5 feet or more from the surface. A minimum of 1.5 foot-thick layer of sand will be placed on top to filter suspended solids. A detailed drawing that identifies the layout of the gravity drains for Basin “P” is shown in Figure 1-3. A typical cross section of the proposed gravity drains is shown in Figure 1-5.

FMFCD has existing soil data that would make Basin “CM” another good candidate for physical modification and it is located southwest of Cedar Avenue and Herndon Avenue. Basin “CM” has site area of 10.14± acres. The FMFCD anticipates that this basin will recharge an additional 340 acre-feet per year following improvements. Currently Basin “CM” recharges approximately 100 acre-feet per year. Following the improvements, Basin “CM” is anticipated to recharge 440 acre-feet per year.

Basin “CM” has an impeding layer of 3 – 15 feet thick with a sand layer beneath it. This allows Basin “CM” to be a potential basin for recharge improvements. Please reference Figure 1-4 for the configuration of Basin “CM”. If this site is selected, the proposed recharge improvement is to drill twenty (20) gravity drains through the obstructing layer and five (5) feet into the sand layer. With a bucket auger, the contractor will drill three (3) foot diameter wells to an average depth of fifteen (15) feet for each gravity drain. A layer of Mirafi 140N filter fabric, or similar, will be placed inside the drains



to keep the gravel in place and help prevent the top sand layer from mixing into the pea gravel. The gravity drains would be back filled with 3/8" pea gravel to 1.5 feet or more from the surface. A minimum of 1.5 foot-thick layer of sand will be placed on top to filter suspended solids. A detailed drawing that demonstrates the layout of the gravity drains for Basin "CM" is shown in Figure 1-4.

As identified above FMFCD will improve Basin "P", collect soil data at the proposed six (6) basins and then select from the six (6) sites, or choose Basin "CM" as the second site to complete the gravity drains. FMFCD will consult with its local groundwater program partners in this determination.

Purpose for the Fresno-Area Regional Groundwater Management Plan (page 1-5): The purpose is "to implement effective groundwater management that works toward maintaining a high quality and dependable water resource for the water users and landowners within the Plan Area, while minimizing negative impacts to other affected parties. The Plan documents the existing groundwater management efforts in the Plan Area that have been successful. The Plan also develops a coordinated and comprehensive approach to the future evaluation and management of groundwater resources within the Plan Area, in concert with other groundwater management activities within the groundwater basin.

The Basin Recharge Improvement and Soil Sampling Project supports the Fresno-Area Groundwater Management Plan's (GWMP) purpose and objectives as shown above, and found in Section 1.3 (page 1-5) of the GWMP. The map of Participating Agencies (Figure 1-2) and some other maps contained in the GWMP are included here and listed below with the GWMP page reference:

- | | |
|----------------------------|----------------------------|
| • Groundwater Basin Map | Figure 1-1, page 1-3 GWMP |
| • Participating Agencies | Figure 1-2, page 1-4 GWMP |
| • Surface Water Facilities | Figure 2-1, page 2-3 GWMP |
| • Neighboring Agency Map | Figure 2-2, page 2-10 GWMP |
| • Well Hydrographs | Figure 3-2, page 3-4 GWMP |
| • Groundwater Contours | Figure 3-3, page 3-5 GWMP |

As mentioned in the Fresno-Area GWMP (page 4-1), "the Plan Area is, and will continue to be, dependent on groundwater as a significant water supply source. The Plan objectives have been developed to monitor, protect, and sustain groundwater within the region.

These objectives of the **Fresno-Area Regional Groundwater Management Plan** include:

1. Preserve and enhance the existing quality of the area's groundwater.
2. Correct the overdraft and stabilize groundwater levels at the highest practical beneficial levels.
3. Preserve untreated groundwater as the primary source of domestic water.
4. Maximize the available water supply, including conjunctive use of surface water and groundwater.
5. Conserve the water resource for long-term beneficial use and to assure an adequate supply for the future.
6. Manage groundwater resources to the extent necessary to ensure reasonable, beneficial, and continued use of the resource.



7. *Monitor groundwater quality and quantity to provide the requisite information for establishing groundwater policies, goals, and recommended actions.*
8. *Improve coordination and consistency amongst agencies responsible for the monitoring and management of groundwater in the Plan Area."*

This proposal supports the objectives of the Fresno-Area Regional Groundwater Management Plan (GWMP). The objectives are *italicized* in the following supporting text.

Preserve and enhance the existing quality of the area's groundwater and monitor groundwater quality and quantity to provide the requisite information for establishing groundwater policies, goals, and recommended actions.

FMFCD has been a leader in studying the water quality impacts of stormwater management basins' usage for recharging stormwater and imported surface water. One of the principle goals of the FMFCD's Stormwater Management Program is "to protect from degradation by urban runoff the resources and beneficial uses" of the groundwater aquifer. The use of stormwater basins in drainage areas has historically served to control floods and to recharge underlying groundwater, which is necessary to maintain the existing beneficial use of groundwater.

In 1978, the U.S. Environmental Protection Agency (USEPA) established the Nationwide Urban Runoff Program (NURP) to characterize the quality of urban runoff from a number of communities across the country. Fresno was selected as a local sponsor for one of these sites to study the water quality impacts of stormwater recharge basins. The United States Geological Survey (USGS) subsequently studied the impacts of recharge from industrial drainage areas in the Fresno area on water quality.

The NURP and USGS studies included sampling and analyses to examine pollutant retention in stormwater basin soils and groundwater. The reports demonstrated that trace elements and synthetic organic were elevated above background near the surface in stormwater basins but that the concentrations decrease rapidly with increasing sediment depth and showed that concentrations of nearly all contaminants decrease to background levels at a depth of 4 cm. No contaminants generated in the urban stormwater were detected below a depth of 16 cm.

The NURP study found the concentrations were generally very low in interstitial water from the unsaturated zone in groundwater beneath the basins and also found that a stormwater basin serving industrial land uses had a wide variety of inorganic and organic contaminants in the top 4 cm of sediment and had not degraded ground-water quality beneath the basin.

The use of stormwater basins to recharge groundwater does not result in significant impacts on groundwater quality, and any uncertainty about these impacts is removed by periodic removal of contaminants in sediment that has accumulated on the bottom of retention basins.

In addition to studying water quality with respect to recharge, the FMFCD has also studied the impact of discharge of excess flood water to the San Joaquin River. No statistical difference in water quality exists in the San Joaquin River in samples taken from locations on the San Joaquin River upstream and downstream of the metropolitan area based on an analysis of monitoring data. Thus, not only has the system of urban stormwater management basins served to control flood waters, it has also protected

water quality in both surface and groundwater. The use of the sand filter at the surface of the gravity drains and substantial soil remaining between the bottoms of the gravity drains will continue to protect the quality of water percolated to groundwater.

Correct the overdraft and stabilize groundwater levels at the highest practical beneficial levels.

The soil data collected from the six (6) or more sites will allow FMFCD staff to alter basin designs and geometry in the future to increase infiltration rates, and also to use data to determine a second basin site to maximize its infiltration. This will contribute to correcting the overdraft; along with helping stabilize the groundwater levels at the highest practical beneficial levels.

Preserve untreated groundwater as the primary source of domestic water.

With the proposed recharge improvements to the selected basins, FMFCD will help preserve the untreated groundwater in the area's aquifer by increasing the volume of storm water and surface water that percolates back into the ground.

Maximize the available water supply, including conjunctive use of surface water and groundwater; and Manage groundwater resources to the extent necessary to ensure reasonable, beneficial, and continued use of the resource.

Increasing the volume of surface water and stormwater that can percolate to the local area's aquifers allows the Cities of Fresno and Clovis to maximize the amount of surface water entitlement delivered to FMFCD basins via the FID canal system.

In addition, gaining information for the soil profiles of six (6) or more recharge basins and testing and monitoring physical recharge improvements at two additional sites will help build the knowledge base in the Fresno-Clovis area for GWMP member agencies. Such knowledge will assist FMFCD, the Cities of Fresno and Clovis, Fresno Irrigation District and others in individual and regional planning to meet this objective.

Conserve the water resource for long-term beneficial use and to assure an adequate supply for the future.

The increase to the infiltration rate to the selected basins will enhance groundwater recharge efforts and assure adequate supply for drought years and for the upcoming years.

Improve coordination and consistency amongst agencies responsible for the monitoring and management of groundwater in the Plan Area.

FMFCD is an active member in the GWMP and the two IRWMP groups. FMFCD contacted other Plan participants to inform them of this proposal and to ask for their support of this proposal. Their support and the communication involved have and also will continue to improve coordination and consistency with other agencies with the group members and those agencies part of the local Groundwater Recharge Program.

Purpose for the Upper Kings Basin Integrated Regional Water Management Plan: "The Water Forum was formed by the local land and water agencies and stakeholders to improve communication, collaboration, and cooperation; to develop a consensus on the regional problems and solutions; and to

resolve or avoid conflicts. A general consensus has been achieved concerning the purpose of the Upper Kings Basin IRWMP.”

As mentioned in the Upper King Basin IRWMP (page 1-6), *“The need for the IRWMP is clear. The continued groundwater overdraft is not sustainable and the urban growth pressure in the region, coupled with the need to sustain the agricultural economy, call for improved water resources management in the Kings Basin.”*

The Regional Goals in the Upper Kings Basin IRWMP (page 5-5) include:

- *“Halt, and ultimately reverse, the current overdraft and provide for sustainable management of surface and groundwater;*
- *Increase the water supply reliability, enhance operational flexibility, and reduce system constraints;*
- *Improve and protect water quality;*
- *Provide additional flood protection; and*
- *Protect and enhance aquatic ecosystems and wildlife habitat.”*

This proposal supports the preceding goals of the Upper Kings Basin Integrated Regional Water Management Plan. The goals are *italicized* in the following supporting text.

Halt, and ultimately reverse, the current overdraft and provide for sustainable management of surface and groundwater and increase the water supply reliability, enhance operational flexibility, and reduce system constraints.

Increasing the volume of surface water and storm water that can percolate to the local area’s aquifers allows the Cities of Fresno and Clovis to maximize the amount of surface water entitlement delivered to FMFCD basins via the FID canal system.

In addition, gaining information for the soil profiles of six (6) or more recharge basins and testing and monitoring physical recharge improvements at two additional sites will help build the knowledge base in the Fresno-Clovis area for GWMP member agencies. Such knowledge will assist FMFCD, the Cities of Fresno and Clovis, Fresno Irrigation District and others in individual and regional planning to meet this objective.

Improve and protect water quality.

The description of the Groundwater Management Plan’s objectives one (1) and seven (7) explains how the study and proposal supports this objective.

Provide additional flood protection.

The increase to the infiltration rate to the selected basins will enhance groundwater recharge efforts and allow stormwater and surface water to percolation at a rapid pace, providing additional flood protection and minimizing any water losses due to evaporation.

Protect and enhance aquatic ecosystems and wildlife habitat.

Periodic standing water present in the local storm drainage system provides temporary wetland habitat. These habitats are temporary due to the limited rain season. FMFCD has implemented the wildlife program to conserve and enhance habitats in its facilities, and to provide related environmental education and awareness opportunities to the public. Basin “P”, Basin “CM”, and the basins listed in Table 1-1 all provide wildlife habitat temporarily each year. Even with an increase to the infiltration rate to the selected basins for recharge improvements, the Cities of Fresno and Clovis have significant entitlements to the San Joaquin and Kings Rivers that can be used to provide additional waters for groundwater recharge of surface water and to provide aquatic ecosystems and a wildlife habitat temporarily.

DISCUSSION

Improvement to the infiltration rates at the proposed sites will increase the volume of water percolating to the Plan Area’s aquifers. Historically, groundwater has been the primary source of drinking water for the Fresno/Clovis area. While two surface water treatment plants now provide a portion of the community’s potable water, groundwater accounts for roughly 85% of water used. Future population growth is expected to create greater demand on the region’s water supply. Fresno-Area GWMP members regularly engage in water conservation public education and other water saving efforts to help decrease demand, and in cooperative groundwater recharge efforts to help reverse the community’s present critical groundwater overdraft condition. The proposed project will produce real gains in the volume of surface water recharged to the groundwater aquifers.

From this project, the District will be able to determine the effectiveness of penetrating through impermeable soils and compare the new results with existing data.

The soil profiles will provide valuable basin information that will be used for selecting several basins to improve their current percolation rates and for future operation. Better understanding of the soil profiles at a basin may lead to suggestions for modification to basin excavation and prioritize projects at basin sites to enhance recharge efforts.

Project data will be made available to other agencies, including DWR, stakeholders, interested agencies, municipalities, and the public. Quarterly and annual groundwater reports will publish the results.

USE AND ANALYSIS OF INFORMATION

The two basins sites proposed for recharge improvement currently have very slow percolation rates. One of the basins, Basin “P”, will be improved initially. Basin “CM” will serve as a potential second site should a better basin candidate not be found from the soil testing sites. The soil logs for these sites indicate there is an impeding layer at or near the basin floor. By drilling through the impermeable layer and backfilling with gravel and sandy soil, FMFCD improves the percolation rate and the overall water recharged to the local area’s aquifer.

The improvement to the proposed basins will identify the efficiency of the gravity drains as they will be monitored by FMFCD. This will give a better understanding of how gravity drains affect not only surface water recharge, but stormwater recharge as well. Over time, data will help in long-term studies that will assist in future design of similar projects.



The six (6) or more basin locations proposed for collecting soil data currently have limited or no data available on their soil profiles. FMFCD proposes to collect two 50-foot borings at each site along with 15 foot borings per every 1.5 acres of basin floor. This will provide a representation of soil characteristics at each location. Specifically, boring results will identify:

- Soil types
- Consistency of soils within basin sites
- Locations of desirable, high permeability soils
- Locations and depths/thickness of obstructive soils
- Potential secondary use basin sites
- Potential alteration to basin design and geometry to increase infiltration rates
- Potential alteration to soil profile data by over-excavating and backfilling with more permeable material to maximize infiltration

With this information, FMFCD will be better able to identify and prioritize projects at and near the basin sites to enhance recharge efforts at those locations. Data may also indicate locations where such projects would not be beneficial.

The proposed project consists of four elements, including:

- 1) Project Management
 - A. Pre-Construction Activities
 - B. Project Coordination Meetings
 - C. Public Outreach
- 2) Construction
 - A. Recharge Improvement Projects
 - B. Collection of Soil Data
- 3) Monitor Improved Basin Sites
 - A. Monitor and Record Data
 - B. Use of Collected Data to Model Existing and Future Physically Improved Sites
- 4) Reports
 - A. Progress Project Reports
 - B. Inform GWMP and IRWMP Members, Local Agencies, and the Public
 - C. Final Project Report

TECHNICAL METHODS AND ANALYSES

High quality and useful information will be obtained using technically feasible methods. Below is a discussion for the process, methods and equipment planned to be used to puncture through impermeable soils, backfill with pea gravel and top with sandy material, determine the boring locations, depth, spacing, and drilling methods, and how existing information guided in these determinations. Additional discussion is provided on anticipated use and analysis of the information obtained.

Gravity Drains Method

For Basin “P”, FMFCD plans to install twenty (20) gravity drains to an average depth of about thirteen (13) feet. The volume of impeding material to be replaced calculates to about 110 cubic yards. Mirafi 140N filter fabric will be placed inside the drains to help keep the gravel in place and help prevent the top sand layer from mixing into the pea gravel. The gravity drains would be backfilled with 3/8” pea gravel to 1.5 feet or more from the surface. A minimum of 1.5 foot-thick layer of sand will be placed on top to filter suspended solids. A typical cross section of the proposed gravity drains is shown in Figure 1-5.

Basin “CM” has existing soil data that makes it a potential candidate, however, FMFCD proposes utilizing the soils data from the six (6) or more basin sites to evaluate the best potential basin for modification with grant funding. The remaining soils data will be available to select basins for future modification.

If Basin “CM” is selected, FMFCD plans to install 20 gravity drains to an average depth of fifteen (15) feet. The volume of impeding material to be replaced is about 130 cubic yards. Mirafi 140N filter fabric will be placed inside the drains to help keep the gravel in place and to provide a secondary filter. 3/8” pea gravel will be purchased and placed in each gravity drain and topped with 1.5 feet or more of sand.

Depth

According to three soils log taken June 7, 1983 in Basin “P”, there is a clay and silt layer that cover the upper floor. The depth ranges from two (2) to twelve (12) feet before reaching a good sandy material. The layout of the gravity drain is shown in Figure 1-3.

For Basin “CM”, five soil logs were prepared October 26, 1981 and they indicate there are impeding layers along the entire basin except the southeast corner. The depth ranges from three (3) to fifteen (15) feet below the basin floor. The locations of the gravity drains are shown in Figure 1-4.

Spacing

In 2009, the City of Fresno installed seventeen (17) gravity drains at its Leaky Acres site. Their gravity drains were spaced as close as 200 feet and as far as 500 feet apart. After consultation with a geotechnical engineer, it was decided to space the drains sixty (60) feet apart.

Drilling

FMFCD anticipates the gravity drains will be drilled using one of the following drill rigs: truck-mounted drill rig with continuous flight auger, bucket auger drill rig, or a crane-mounted drill rig with single flight auger and Kelly bar.

Over-excavating and Backfilling Method

If FMFCD receives the grant, FMFCD will prioritize the six (6) or more sites based on feasibility of increasing the percolation rates when restrictive layers are penetrated and replaced with more permeable material. And if this method is chosen for improving any future basins, FMFCD has worked with several contractors with Class-12: Earthwork and Paving Contractor license and Class A: General Engineering Contractor licenses. FMFCD anticipates an excavator will be used to dig and remove the permeable material and dispose it into several haul trucks. The haul trucks will transport it and relieve the permeable material at Basin “AY”, located northeast corner of South Cedar Avenue and East Central Avenue. The haul trucks will pick up the sandy material at Basin “AY” and then deliver it next to the



trench area at the improvement sites. After the permeable material within the proposed trench area is removed, a grader will move the sandy material into the trench and compact it with the weight of the equipment. A water truck and a street sweeper will be used throughout the entire process to maintain dust control.

Borings

FMFCD defines under-performing recharge basins as sites that are expected to recharge better than they currently do based on past surface delivery records. These sites may be average, or possibly above-average, recharge basins that FMFCD feels can do much better than their current performance level indicates.

Recharge basins that are labeled poor performing sites have never historically performed well, but FMFCD feels that they can be improved if further investigation is done. With the limited or no soils data for some of these recharge basins it is challenging to tell if the basin is located in area of poor recharge or if there is an impeding layer(s) beneath the basin floor.

There are three criteria that were used to choose the six (6) basins as listed in Table 1-1. An “X” was placed in the column in Table 1-1 for which criteria each basin met. Those three criteria are:

- Does FMFCD have inadequate or lack of soil data for soils below the basin’s finished floor?
- Is the recharge basin site under-performing?
- Does the recharge basin have poor performance?

Depth

One objective of this proposal is to obtain a profile of the soils beneath the floors of several FMFCD basins to determine if there is a restricting layer beneath the basin floor. If one or more exists, FMFCD would then determine if it is feasible to improve the basins groundwater recharge rate that could either be excavated and replaced with more permeable soils or by punctured with the installation of gravity drains to provide a passageway to sandy material below the restricting to improve groundwater recharge at the site.

For example, suppose the first three feet below the basin floor is a clayey soil, but below that is a sandy soil. In order to increase the infiltration rate of the basin, it would be advantageous to excavate those three feet of clayey soil and replace it with a sandy soil. However, it is not economically feasible to over excavate to a depth more than fifteen (15) feet. Therefore a boring depth of fifteen (15) feet below the basin floor was chosen.

The City of Fresno suggested that FMFCD include two (2) borings per basin that go to a depth of about 100 feet above groundwater (approximately 50’ depth). The City recommended this because there may be layers of alternating clay and sand before reaching groundwater. Over excavating the top layer of clayey soil down to a sandy soil may not be sufficient if there is another clayey layer below the sandy soil.

Spacing

FMFCD currently has sufficient boring data on forty-five (45) of its 154 basins. FMFCD typically does a minimum of four (4) borings (one boring in each corner) for smaller basins and no more than ten (10) borings for large basins. For mid-sized basins, boring frequencies are about one boring for every 1.5

acres of floor bottom. Through experience, FMFCD has found this boring frequency to be sufficient to characterize the soils beneath the basins.

Drilling Methods

FMFCD has contracted with and developed a good working relationship with several geotechnical contractors who have for many years done soils classification borings. The test boring will be drilled using a truck-mounted drill rig equipped with a six (6) or eight (8) inch diameter hollow-stem auger. Common boring rigs used are the CME-55 and the CME-75.

RELATIONSHIPS WITH OTHER AGENCIES

The participants have been and continue to be involved in many programs, studies and committees that include groundwater related items in the Plan as part of their focus or charge. The Participants will continue to be involved in these efforts. A summary of some of these efforts is included here.

1986 Water Resources Management Plan

As described in the 1986 Water Resources Management Plan (1986 Plan), the Fresno Irrigation District (FID), City of Fresno, the City of Clovis, the County of Fresno, and the Fresno Metropolitan Flood Control District (FMFCD) have partnered in a cooperative effort to develop and implement a comprehensive surface and groundwater management program consistent with the Water Resources Management Plan for Fresno-Clovis Urban and Northeast Fresno County. The 1986 Plan, prepared with a grant from the Environmental Protection Agency (EPA) under Section 205j of the Clean Water Act, is a water quality and quantity project to plan for the preservation and enhancement of the area water supply.

Integrated Storage Investigation Program

Other basin wide groundwater management efforts include a Memorandum of Understanding (MOU) with the Department of Water Resources entered into on May 24, 2001, as part of the Integrated Storage Investigation (ISI) program. The MOU between DWR, the Kings River Conservation District, Alta Irrigation District, Consolidated Irrigation District and Fresno Irrigation District, formed a cooperative effort amongst the agencies to review and investigate groundwater conjunctive use efforts on the Upper Kings Basin. During the formation of this program, the Kings Basin Advisory Panel was formed to include the basin stakeholders. The primary goal of the Basin Advisory Panel is “to stabilize groundwater in the Upper Kings Basin by halting, and ultimately reversing, the current overdraft of the groundwater aquifer.”

Upper Kings Water Forum

Several of the participants to the Plan are actively involved with the Upper Kings Water Forum. Specifically, the City of Fresno, City of Clovis, County of Fresno, and FID have been involved. Representatives from FID serve on the Upper Kings Forum Planning and Steering Committee. The purpose of the forum has been to develop an Integrated Regional Water Management Plan with assistance from State funding. The forum has also sought funding for construction, or implementation, projects within the region, including projects for the City of Clovis and FID. This Fresno-Area Regional Groundwater Management Plan was incorporated into the Upper Kings Forum Integrated Regional Water Management Plan.

DWR Bulletins 118-80 and 118-03

In DWR Bulletin 118-80, eleven basins, including the Kings Subbasin, were identified as being in a critical condition of overdraft. The overdraft status of these basins was not re-evaluated by the DWR in the DWR Bulletin 118-03; however, the DWR Bulletin 118-03 does acknowledge the groundwater recharge programs being conducted by the City of Fresno, FID, and FMFCD within the Kings Subbasin to ensure that groundwater will continue to be a viable water supply in the future. Collaborative groundwater recharge efforts are continuous and seek to correct the area's critical condition of overdraft as identified by DWR (2008 City of Fresno Final Urban Water Management Plan; full plan available for viewing at <http://www.fresno.gov/Government/DepartmentDirectory/PublicUtilities/Watermanagement/WaterInformation/Default.htm>).

Water and Groundwater Associations

All of the plan participants are active in the groundwater community. Table 5-1 of the Plan is a matrix illustrating the many water and groundwater related organizations that each participant belongs to. Many participants hold memberships in similar organizations, which increase opportunities for groundwater management coordination and the sharing of ideas.

Groundwater recharge efforts within the Plan Area primarily involve using FID's delivery system to deliver portions of the Fresno and Clovis water allocations to specific Fresno Metropolitan Flood Control District basins for recharge during the summer when the basins are not needed to control urban storm runoff. FMFCD owns and operates these basins. Not all basins are used for groundwater recharge, as some have been, or will be, developed for dual use as recreational facilities such as parks or athletic fields. Within the City of Fresno, the City Water Division and Parks and Recreation Division have developed a recommended designation for the proposed use of each basin during the non-storm season. FMFCD refers to this designation as each basin's secondary use designation. The designations include recharge, recreation, or dual use. The dual use designation is used for basins that have been developed for recreation, but also have a significant area of the basin remaining for recharge. The City's recommendation was considered and approved by FMFCD's Board of Directors. As new stormwater basin locations are identified by FMFCD, the City makes a recommended designation for that basin, and it is then presented to FMFCD's Board of Directors for final determination. Recharge capability is an important consideration when making these designations.

To maintain needed groundwater recharge at these basin sites, it is important to preserve the recharge capability provided by the basin sites designated for recharge.

INFORMING GROUNDWATER USERS, STAKEHOLDERS, THE GENERAL PUBLIC, FEDERAL, AND OTHER STATE AGENCIES

Upon award of the LGA grant by DWR, FMFCD will notify the community of the award, and describe the project to be funded. The general public will be informed through submission of a news release to local media outlets, such as newspapers, television and radio stations. Interested people will be directed to FMFCD's web site for more detailed information, to include a project area map, schedule of the work, description of the project and its goals to improve groundwater recharge in Fresno and Clovis.

Neighbors within a 250-foot radius of each of the project's basin sites will be contacted to tell them of the improvements to be done in their neighborhood's basin, the purpose of the project, and when it is expected to start and end.

FMFCD will approach industry publications such as the Association of California Water Agencies' *ACWA News* and the Water Education Foundation's *Western Water Magazine*, with requests to run stories about the grant project and advertise the availability of project information to their readership. FMFCD will also publish a story about the grant project in its quarterly newsletter, which has a circulation of approximately 1,150 people and includes schools, other public agencies at the local and state level, elected officials at the local and state level, a variety of businesses, local chambers of commerce, non-profit organizations, local media outlets, and private citizens.

State and federal agencies identified for project information sharing are the California Department of Water Resources, as required by the grant, the U.S. Bureau of Reclamation (USBR), and the U.S. Geological Survey (USGS). DWR will receive required reports on project progress and results, and USGS staff at the Western Regional Offices and staff at USBR's Fresno office will be contacted personally and made aware of the availability of new soil data and infiltration improvement measurements.

MODELS AND DATA MANAGEMENT SYSTEM MAINTAINED

FMFCD does not employ monitoring wells as part of its groundwater recharge program. FMFCD does closely monitor its recharge basins in an effort to maximize its recharge capabilities. The following are some mechanisms that are used today and will continue to be used to monitor the recharge program.

Monthly Delivery Reports from the Fresno Irrigation District (FID)

Every month, FID provides a delivery report that lists how much surface water, in acre-feet, was diverted to each FMFCD basin. This data is collected, logged and used to determine short-term (monthly) and long-term (yearly) surface water recharge trends of the various basins. Figure 4-1 is an example of a typical monthly report received from FID.

Yearly trends help staff evaluate the effects of siltation at a particular basin. Silt is removed from basins, on average, every five years. A declining yearly trend indicates siltation and the need for desilting.

Surface Water Recharge Model

Prior to each "recharge year," FMFCD creates a surface water recharge model to predict how much surface water will be recharged at each FMFCD basin. The model considers construction, maintenance, excavation projects, and cumulative siltation between maintenance works to determine the estimate recharge of each basin in a given year. Percolation rates are known from previous year's data of the basin operation and this data is used to calculate the estimated recharge.

Recharge model numbers are used as a guideline. When actual delivery numbers vary greatly with those predicted by the model, District staff evaluate these discrepancies and determine if action needs to be taken.

Percolation Rate

FMFCD typically takes percolation rates on its recharge basins every three (3) weeks between April and October. FMFCD has compiled a database of percolation rates conducted over the years and uses this data to model recharge efforts and determine the performance level of its basins. The percolation is an actual measurement of the change in water level over a specific time period between measurements.

Telemetry System

FMFCD employs a telemetry system to monitor various conditions, including basin water level at many basins where power is available. This system allows FMFCD staff to verify that appropriate water levels are maintained. It can also be used to determine percolation rates or rate of fall of water level when delivery is stopped.

The telemetry system is also useful in analyzing long term trends of the water level in a basin. This data can be exported to databases and spreadsheets where further calculations can be performed for further study.

Recharge Reports

FMFCD provides a semi-monthly report of the status of its recharge basins. This reports the observed water levels, the authorized water levels, the position of the interties that divert surface water to the basins, and any comments about a particular basin. FID is a recipient of this report and it provides them data to assist them in routing the appropriate amount of water to recharge basins.

Data provided by these reports is used to determine the efficiency of the surface water recharge program. Included is an example (Figure 4-2) of a semi-monthly recharge report.

Stormwater Recharge Model

In addition to the surface recharge model, FMFCD also models stormwater recharge. This model is slightly different than its surface water counterpart. It is used to estimate how much stormwater was recharged at all FMFCD basins. Water level readings taken throughout the winter, are used, along with basin capacity tables and known percolation rates, to estimate the amount of stormwater recharged.

Estimates provided by this model have reinforced past assumptions that surface water and stormwater recharge have a direct relationship. That is, heavy rainfall years typically reduce the time and capacity available in a basin for surface water recharge. Therefore, heavy rainfall years are, in many instances, followed by lesser surface water deliveries. Results from stormwater recharge models quantify stormwater recharge amounts and how they typically offset subsequent lesser surface water recharge deliveries. In periods of limited rainfall, the reverse is true, less stormwater recharge, but greater volumes of imported water are recharged.

All of these mechanisms are funded by FMFCD as part of its ongoing operations and maintenance. However, the cities partially reimburse FMFCD for silt removal maintenance work.

ONGOING USE

GWMP Group

The Fresno Area GWMP participants have executed a memorandum of understanding to facilitate the implementation of the groundwater management plan. The groundwater management plan and associated agreement, serve as a mechanism for cooperative efforts amongst the participants and other agencies within the region.

A schedule is not provided in the groundwater management plan. Instead existing activities and planned actions are listed in the annual report in Sections 5 through 9. Every six months the Technical Advisory Committee (TAC) meets to monitor the progress of the existing activities and planned actions. The annual report serves several purposes: to document any changes in the ongoing activities, to document progress on planned activities identified in the groundwater management plan or previous annual reports, and identify any new activities that are being planned or implemented.

Fresno Metropolitan Flood Control District

FMFCD is fully committed to continue assessment and planning to improve groundwater management. One indicator to confirm this commitment is past practices and major accomplishments. FMFCD and GWMP members have already committed their staffs and other direct resources to the Groundwater Management Plan (GWMP). The four major reasons for creation of the GWMP are as follows:

- Increase awareness of groundwater management efforts being performed by other local parties.
- Provide benefits of cost savings for preparation, opportunities for regional funding and grant programs, inclusion of smaller local agencies, and the development of more cooperative groundwater efforts.
- Allow smaller agencies to participate that otherwise would not have been able to fund the preparation of a GWMP.
- Include participants with overlapping boundaries.

The products derived from this project will continue as a critical planning tool for FMFCD in the future. FMFCD has experienced staff in data management that will be necessary to continue the program. These future projects will be incorporated in the FMFCD budget process, and will be funded with FMFCD general fund monies.

Elements of the project will also be funded or maintained through other regional partners in the future. The results of this study will be used in long-term planning, which is funded by each agency individually.

Major Accomplishments

The groundwater management plan has improved groundwater management and knowledge of the groundwater basin. Several major accomplishments occurring within the groundwater management plan's boundaries are:

Groundwater Level Monitoring

Kings River Conservation District (KRCD) publishes an annual groundwater report that includes regional groundwater contours (depth and elevation), and changes in groundwater storage for the Kings Basin. Current groundwater conditions are evaluated and compared to the past. The report uses data provided by several agencies on hundreds of wells. KRCD is also the lead agency for a local group that submits groundwater level data to the California State Groundwater Elevation Monitoring (CASGEM) program.

Migration of Contaminated Groundwater

Groundwater within the GWMP plan area is generally of excellent quality for agricultural use. However, serious water quality problems in the southern and eastern portions of the plan area occur due to high

concentrations of nitrate and DBCP. During the time the GWMP was being finalized, one of the planned actions for the City of Fresno was to update maps for all contaminated plumes in the plan area. Since then City of Fresno was able to document the locations of most of the known plumes. Their primary concerns are EDB, TCP, DBCP, and areas of higher nitrate levels. Page 1 of Figure 7 in the draft 2010 Annual Groundwater Report shows locations of the plumes in the City of Fresno and most of the City of Clovis.

There are no plumes in the Basin “P” area. If FMFCD is to encounter any plumes at a potential site for groundwater recharge improvement, FMFCD will coordinate with the City of Fresno and/or the City of Clovis before selecting the second basin site.

Groundwater Recharge

There are several existing and planned activities for groundwater recharge listed in the GWMP, including:

- Increase groundwater recharge capabilities within the Plan Area
- Measure the volume of water delivered to groundwater recharge basins
- Construct additional interties between conveyance facilities and flood control basins to facilitate groundwater recharge

Several major accomplishments have taken place since adoption of the GWMP in 2006:

- Deliveries made for groundwater recharge to Fresno Metropolitan Flood Control District (FMFCD), City of Fresno, and City of Clovis facilities totaled almost 60,000 AF from March of 2011 thru February of 2012.
- Bakman Water Company contributed funds to FMFCD to construct an intertie between FMFCD Basins “X” and “W” to increase groundwater recharge in the vicinity of Bakman Water Company.
- Bakman also installed a flow meter to track water sent from Basin “W” to Basin “X” for recharge.
- FMFCD completed excavation in Basin “CS” and amended agreements with the Fresno Irrigation District (FID) and the City of Fresno added this 22 acre basin to the groundwater recharge program.
- FMFCD constructed pump stations to improve the maintenance of Basins “AB”, “AC”, “AG”, “BH”, “S”, “1G”, “3A”, “5B/5C”, “5F”, and “7C”, all basins used for groundwater recharge purposes during the FID irrigation season.
- The excavation of Basins “AO”, “BE”, “BZ”, “CS”, “EM”, “GG”, “J”, and “RR3” and was completed and expanded the capacity of the basins for groundwater recharge purposes during the FID irrigation season.
- The excavation of Basin “BM” was completed, expanding the capacity of the basin for groundwater recharge purposes. FMFCD completed facilities necessary to deliver water to the basin.
- FMFCD completed the connection of Basin “BH” to Fancher Creek pursuant to previously amended agreements with FID and the City of Fresno to add this 16.6 acre basin to the groundwater recharge program
- Basins “AC”, “CZ”, “EE”, “FF”, “R”, “RR1”, “RR3”, “S”, and “XX” are equipped with surface water irrigation systems, and therefore do not put any demand on the groundwater aquifer to irrigate landscaping.

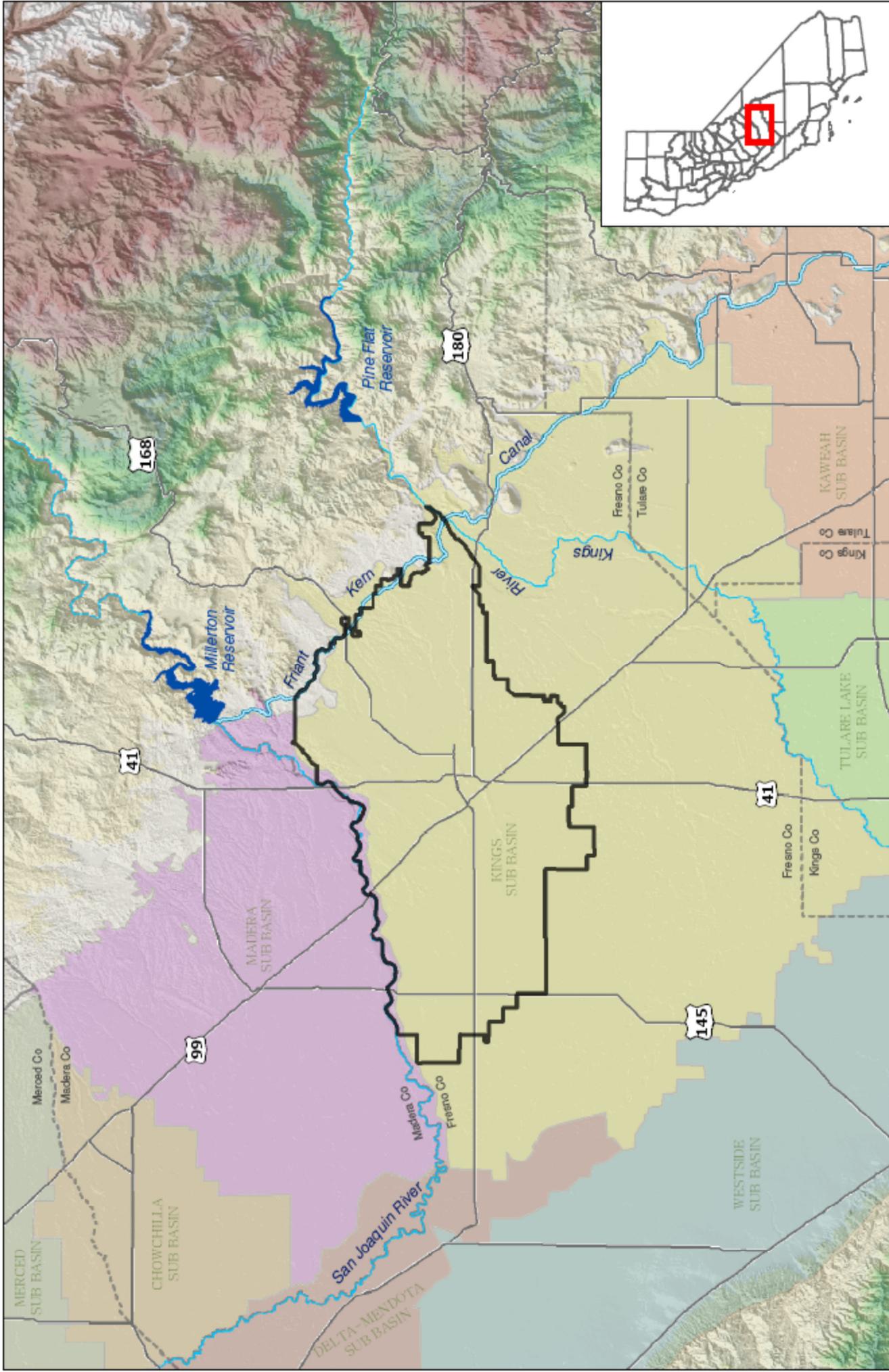


Figure 1-1
Groundwater Basin Map
 Fresno-Area Regional
 Groundwater Management Plan

Groundwater Sub Basins

	Westside
	Chowchilla
	Madera
	Delta-Mendota
	Kings
	Kaweah

GMP BOUNDARY



0 3 6 9 12 Miles

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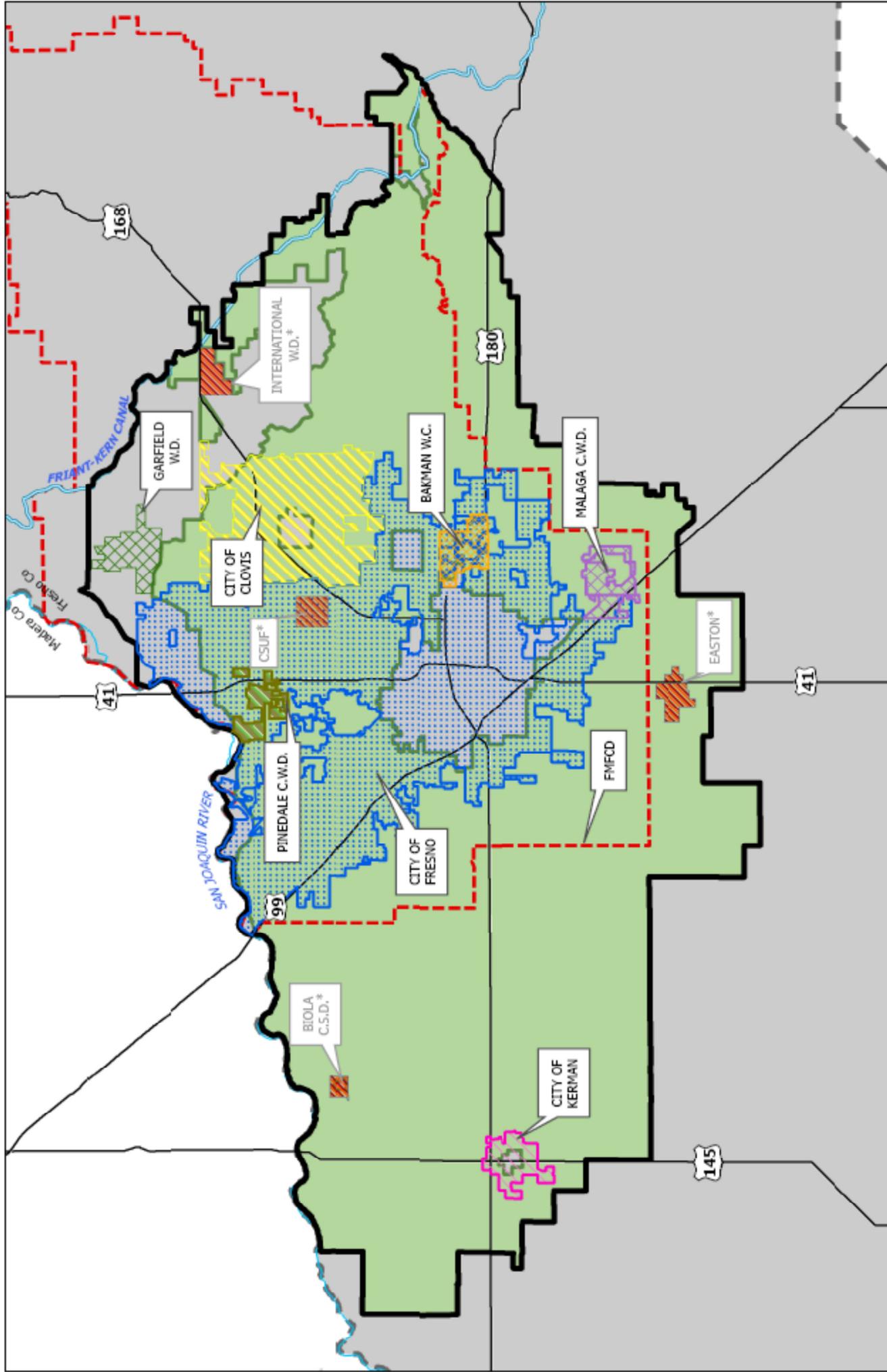


Figure 1-2
Participating Agencies
 Fresno-Area Regional
 Groundwater Management Plan

LEGEND

- GMP BOUNDARY
- FRIANT-KERN CANAL
- COUNTY OF FRESNO
- CITY OF FRESNO
- CITY OF KERMAN
- PINEDALE W.D.
- CITY OF CLOVIS
- BIOLA C.S.D.*
- PINEDALE C.W.D.
- CSUF*
- GARFIELD W.D.
- BAKMAN W.C.
- MALAGA C.W.D.
- EASTON*
- FMFCD
- F.M.F.C.D. Boundary

*Agencies within plan boundary, not participating

The Plan area lies entirely within the County of Fresno, and the County is a participant to the Plan.
 The Plan area lies within the Kings River Conservation District.

0 1 2 3 4 Miles

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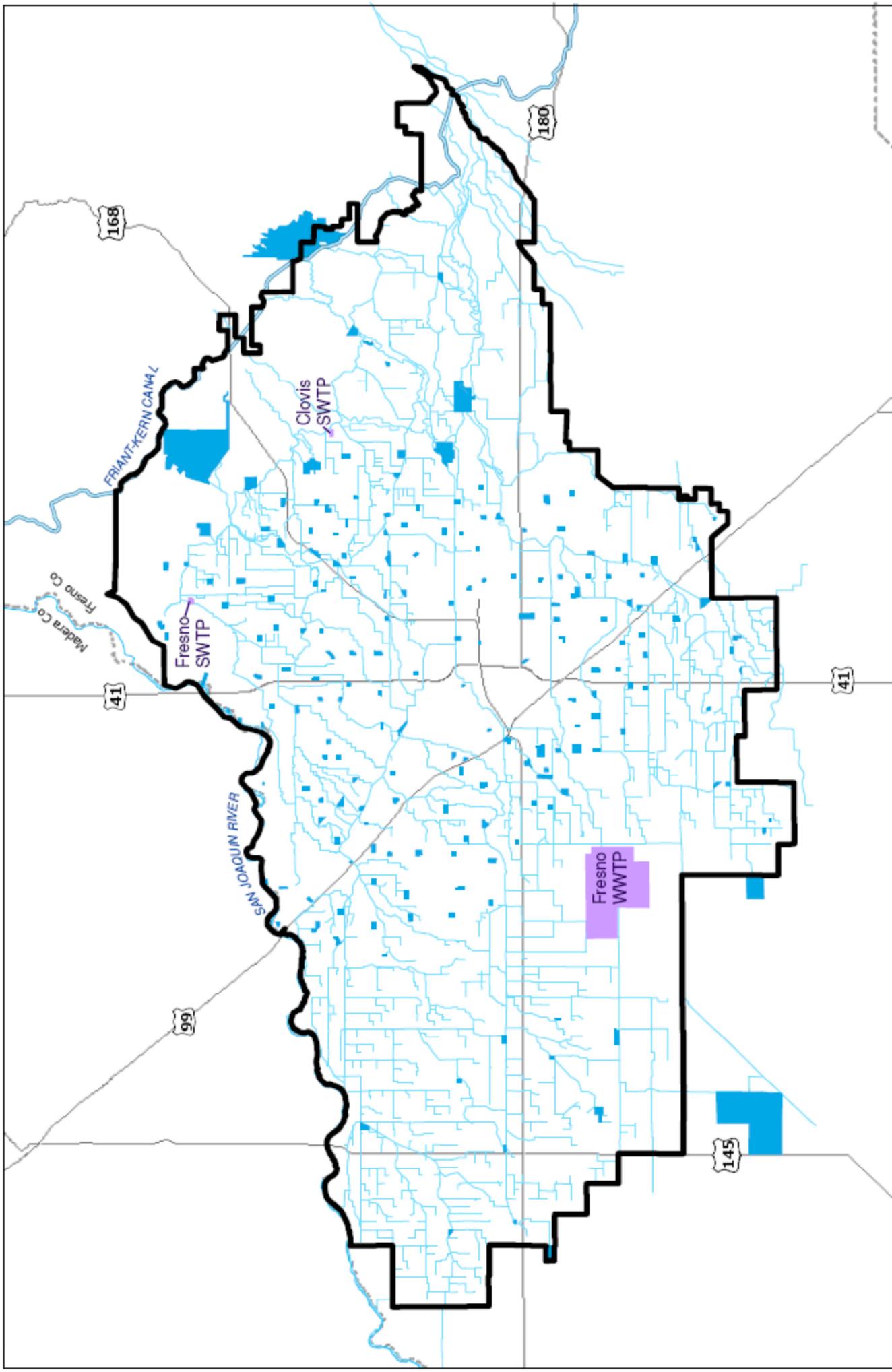


Figure 2-1
Surface Water Facilities
 Fresno-Area Regional
 Groundwater Management Plan

Wastewater Treatment Plant
 GWMP BOUNDARY
 FMFCD Basins and FID Ponds
 Water Facilities (Canals, Pipelines and Streams)

0 1 2 3 4 Miles

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